

# CURRENT OVERVIEW OF GENERAL SURGERY COMPLICATIONS

Editor  
**Dr. Özgür ALBUZ**



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## **Current Overview of General Surgery Complications**

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## **PREFACE**

Surgical complications; Basically, the surgical procedure applied is due to the presence of serious adhesions in the surgical area close to critical organs and especially due to previous surgeries, various anatomical variations, the prevalence of the disease requiring surgical procedure, the delay of the surgical intervention, the knowledge and experience of the surgical team performing the surgery, and the compatibility of the surgical team. may be due to its inability to work. However, surgical complications that occur can still occur, including in the surgical or post-surgical period, even if the above considerations are carried out with utmost care. It is necessary to keep in mind that different complications may develop in the post-operative period, to predict and observe these risks, and to consider this situation especially during the clinical hospitalization period until the recovery period is completed during the clinical follow-up of the patient after the surgery. I believe that the book “Current Overview of General Surgery Complications”, which I edited, is a book that will tell our young colleagues in general surgery about the complications they will encounter most frequently in surgery and will contribute to the management of surgical complications. I would like to thank all the authors who contributed to the preparation of this book.

**Assoc. Prof. Dr. Özgür Albuz**



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## CHAPTER I

# PERIOPERATIVE SURGICAL COMPLICATIONS IN TRAUMA AND EMERGENCY SURGERY

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### Introduction

**I**t has been reported that more than 320 million surgical operations are applied every year all over the world, approximately 50 million patients face perioperative problems and more than 1.5 million deaths result(1,2).

How these complications will result depends on the interactivity between both patient interrelated and nondependent agents(3).

It covers individual comorbidities in patient-related factors, as well as general clinical conditions during surgery. On the other hand, in independent factors; Infrastructure and technical competencies of the hospital and the hospital staff in the perioperative process, patient management, come to the fore(4). In emergency surgery cases, emergency surgery is always provided 24 hours a day, regardless of working hours. Night or after-hours scheduling of elective surgery is a newer practice in order to reduced surgical waiting time and reduce daytime operating room overfulled(5). In the surgical team, individual surgical fatigue can worsen both individual and team performance and additionally lead to the emergence of medical errors(6,7). However, exhaustion is a extensive occurrence during healthcare. Availability of adequately experienced medical practitioners is also less at night or outside office hours. As a result, in this critical period, distressing situations may occur resulting in less qualified perioperative care(8,9). In general surgery, the risk of dying in the postoperative period of patients who underwent emergency surgery is 6 times

higher. However, about half of survivors will experience a complication after surgery(10). Differences in the decisions made by decision makers between elective or emergency procedures are likely to contribute to a higher rate of poor outcomes, particularly in emergency surgical procedures. However, the specific effects on all these application differences have yet to be studied(11). In terms of death and complication percentage; It comes from the ultimate rates in patients undergoing emergency gastrointestinal surgery(12,13). Perioperative intravenous fluid replacement should be performed to adequately replace fluid loss and maintain body perfusion. However, fluid flow into the extravascular space rapidly reduces the effect of intravascular volume. Interstitial edema and counteract tissue oxygenation must be followed.

In addition, sepsis and major surgical procedures may increase the passage of intravenous fluid into the extravascular space, leading to hypovolemia and systemic edema(14). In the literature, studies comparing restrictive or free fluid strategy applications for non-urgent abdominal surgeries; It has been shown that fluid restriction strategies provide a comfortable advantage by reducing the risk incidence of complicating events and the length of hospital stay(15,16,17). The point to be noted here is; An overly restrictive fluid replacement methods may lead to renal failure(18) . It has been reported that cardiopulmonary and tissue healing complications decreased with the almost zero balance approach in elective abdominal surgery(19). In Advanced Postoperative Recovery (ERAS) programs; An increase of no more than 2.5 kg is recommended in a conservative perioperative fluid replacement therapy(20). In particular, post-traumatic pelvic fractures or extensive burn injuries may increase the risk of mortality or complications.

### **Overview of burn traumas:**

Intravenous fluid replacement from the lower extremities is not preferred because of the raised risk of sepsis and death events. In the patient group where the face, neck or respiratory tract is affected by burns; Tracheostomy is not the first choice. Intubation should be the first choice. This is due to the high mortality rate due to burns(21).

Since the mid-1970s, most scientific studies have suggested that excision within 24-48 hours of a burn; They showed that early excision was associated with reduced blood loss, infection, length of hospital stay, as well as reduced mortality and, on the other hand, increased graft uptake(22,23,25). But further more the reduction in mortality only applies to patients, but not include inhalation injury(24,26).

Hand burns have a special importance in wound care. It requires a great deal of care, effort and treatment. Unfortunately, the hands are affected in approximately 30-60% of all burn patients(25).

Depending on the anatomy of the hand, surgical debridement of the burned area is technically difficult and it should always be kept in mind, as it may lead to significant complications[25].

If we list the complications that can be seen in emergency surgery applications;

1. Sepsis
2. Appendicitis
3. Acute Mesenteric Ischemia and thromboembolism
4. Intra-abdominal Hypertension(IAH) and Abdominal Compartment Syndrome(ACS)
5. Cholecystitis
6. Pancreatitis
7. Upper GI Bleed
8. Bowel Obstruction
9. Perforated Gastroduodenal Ulcer (PGDU)
10. Acute Diverticulitis (AD)
11. Coagulation and Hemorrhagic shock
12. Wound Care

In order to reduce patient morbidity and mortality, in the evaluation of postoperative complications in emergency surgery; Perioperative care management determined by current international regulations is very important.

### **1. Sepsis:**

It is defined as the development of functional disorders in vital organs due to an irregular host response due to infection. It can be clinically determined by an increase in the Sequential Organ Failure Assessment (SOFA) score of 2 or higher (26).

On the other hand, if we look at the term septic shock; It can be considered as the extreme part of sepsis, which is associated with a greater risk of death than sepsis alone, especially as a result of the presence of cellular and metabolic abnormalities in the microcirculation (26,27).

In septic shock, it can be defined as a need for vasopressors to maintain the mean arterial pressure of 65 mmHg and above, and a serum lactate level

higher than 2 mmol/L ( $>18$  mg/dL), although there is no volume deficiency in the intravascular space (26,27).

Glasgow coma score (GCS) is 14 or less, systolic blood pressure is 100 mmHg or less, respiratory rate is 22/min or more; It typically indicates the possibility of sepsis evolving into a poor prognosis in cases with at least two of these three criteria(27)

Sepsis requires high-level and meticulous follow-up and intervention.

In patients with severe sepsis or septic shock, according to the Surviving Sepsis Campaign (SSC) guidelines (26,28);

- (1) treatment and resuscitation should begin immediately
- (2) Administration of IV antimicrobials should be initiated as soon as possible after diagnosis (1 hour or less for sepsis and septic shock)
- (3) for the provision of emergency source control in patients with sepsis or septic shock, determining the source of infection in the anatomical area and intervening in this area

***Medical procedures that should be performed within the first hour after the diagnosis of sepsis;***

- \* Measuring the serum lactate level is very important, if the initial lactate level is higher than  $>2$  mmol/L, a repeat measurement should be made.
- \* Blood culture should be taken and evaluated before antibiotics are given.
- \* Empirical treatment with broad-spectrum antibiotics should be initiated before the hemoculture result is obtained.
- \* In the presence of hypotension or if the serum lactate level is greater than  $\geq 4$  mmol/L, 30 mL/kg crystalloid replacement should be administered as quickly as possible.
- \* If the patient's hypotensive state continues during fluid resuscitation or after replacement, vasopressors should be administered.
- \* Mean arterial pressure should be kept above  $\geq 65$  mmHg (26,29)

Although administration of vasopressors via peripheral venous catheters is not the first choice, peripheral administration of vasopressors can be applied to save time during central venous catheterization(26).

Due to the lack of strong discriminant and concurrent currency of the SIRS criteria, the sepsis-connected organ failure assessment (SOFA) scoring system

the more ensure a more strong clinical evaluation for identifying patients with sepsis (30).

## **2. Appendicitis**

Abscess, hematoma and wound complications are expected complications after appendectomy. If the wound site becomes infected, it may be due to *Bacteroides fragilis*. If the appendix stump is left more than necessary during appendectomy, there may be “recurrent” or “stump” appendicitis attacks.

This remnant stump just like an appendix and can obstructed and as a result with infection just as with the initial part. This residual stump may be an attack of obstruction that results in inflammation and infection of a normal appendix structure. For these reasons, it is generally preferred to leave an appendix stump less than 0.5 cm in appendectomy. It may result in the development of enterocutaneous fistula and abscess complication after appendectomy. The most extreme and dangerous complication may result in diffuse peritonitis and sepsis resulting in morbidity and mortality (31).

## **3. Acute Mesenteric Ischemia and thromboembolism**

Superior artery embolism (SMA) is characterized by a very severe acute abdominal pain without a definite localization. “Pain disproportionate to clinical and laboratory symptoms” should always be kept in mind for this condition. In approximately 30% of the cases, there is a possibility of rapid intestinal necrosis due to the occurrence of SMA embolism in the distal middle colic artery. provides a significant advantage. Early diagnosis ensures that patients can keep alive even without the requirement for revascularization. The clinical manifestation of acute mesenteric infarction reason by mesenteric arterial thrombosis is distinctly different from embolic mesenteric infarction and depends on the extent of arterial obstruction and the status of collateral vessels that may bypass this obstruction(26, 32). Acute thrombotic occlusion of the superior mesenteric artery may cause severe pain due to insufficient blood supply to the fulminant intestine, as well as subtle symptoms such as vague abdominal pain, diarrhea, and vomiting. However, in case of acute mesenteric infarction due to atherosclerotic occlusive disease, it may preserve intestinal viability for a longer period of time. This may be due to the natural collateral vascularization that develops alternatively over time. It should be kept in mind that a significant portion of these cases may have previously complained of chronic abdominal pain attacks. (12,26)

#### **4. IAH and ACS**

In literature has been stated that early surgical intervention in acute compartment syndrome results in approximately 80% fewer complications, including infective conditions, sepsis, fistula, and abscesses(33-36).

*In the same time; The risk of abdominal hypertension should be minimized by avoiding the called fatal triad (acidosis, coagulopathy, and hypothermia)(37).*

#### **5. Acute cholecystitis**

After insufficient drainage of bile fluid, venous stasis occurs due to increased gallbladder pressure. After developing venous stasis, arterial stasis leading to ischemia and necrosis of the sac wall may result in perforation(38-40).

##### **5.1. Gangrenous cholecystitis**

Gangrenous cholecystitis in 2-38% of acute cholecystitis cases

It is a complication that may occur due to increased pressure in the gallbladder wall, wall ischemia and eventually necrosis (41,42).

##### **5.2. Choledocholithiasis**

If stones in the gallbladder fall into the common bile duct, gallstones appear clinically as jaundice, elevation of direct bilirubin, and pain in the right upper quadrant, and this complication may occur in 15% of patients with symptomatic cholelithiasis(43-45).

##### **5.3. Mirizzi Syndrome**

It may present as acute cholelithiasis due to gallstones embedded in the gallbladder neck or cystic duct. Cholestasis occurs as a result of mechanical compression of the common hepatic duct and obstruction of the biliary tract. This can cause pain, fever and leukocytosis in the right hypochondrium and obstructive jaundice occurs(45, 46).

#### **6. Pancreatitis and its complications:**

Periodically recurrent cases of acute pancreatitis lead to pancreatic damage, inflammation, and ultimately scar tissue over time, leading to pancreatic function loss, which in turn causes diabetes mellitus and digestive disorders.

Risk factors involved in the etiopathogenesis of acute pancreatitis; Gallstones, chronic alcoholism, complicating conditions due to chronic use of certain drugs, persistent elevation of serum triglyceride levels high serum

calcium levels due to hyperparathyroidism, pancreatic cancers, intraabdominal major surgeries, cystic fibrosis disease, abdominal injury and traumatic pancreatic injuries.

Acute pancreatitis (AP) is a potentially fatal disease, and prevention of infection and sepsis with systemic antibiotic administration is considered the main step in its treatment(47).

## **7. Upper GI Bleed**

The mortality rate in upper gastrointestinal bleeding is higher in geriatric patients or patients with serious comorbidities. (48-49).

If hemorrhage cannot be stopped as a result of endoscopic interventions or medical applications, it should not be late for emergency surgery. Although recent endoscopic developments and radiological embolization seem to have reduced the role of surgery in treatment, surgery is the last treatment option if hemorrhage cannot be stopped despite all endoscopic or medical interventions(50).

## **8. Bowel Obstruction**

In case of intestinal obstruction, the results of early diagnosis and intervention are promising. However, when intestinal obstruction is treated without surgical intervention, the risk of recurrence is much greater than when treated surgically(51).

Some complications that may develop as a result of bowel obstructions:  
Development of intra-abdominal abscess

- Sepsis occurrence
- Wound complications
- Short bowel syndrome
- Development of pneumonia
- Bowel perforation
- Respiratory failure
- Anastomotic leak
- Development of renal failure
- Mortality

## **9. Perforated Gastroduodenal Ulcer (PGDU)**

There is no difference between laparoscopic or classical open gastroduodenal ulcer repairs, and both cases involve significant postoperative morbidity and mortality (52). Postoperative mortality is increased 3 to 5 times in the elderly

population (52). The main reasons for this situation are; Higher medical comorbidities include late admission to the health center, atypical symptoms, presentation and delay in diagnosis (> 24 hours) (52).

## **10. Complications of acute diverticulitis**

Major complications of diverticulitis; It can be counted as abscess, fistula, intestinal obstruction and free perforation. Surgical complications should be resolved with the cooperation of the surgical clinic. Abscesses occur if infective and inflammatory progression in the pericolic tissues continues. Abscess formation should be kept in mind if fever, leukocytosis or a combination of both are present despite the correct antibiotic administration(53). CT-guided percutaneous drainage may be appropriate when stabilizing small abscesses or for surgery in patients with sepsis(54,55). Intestinal obstructions are rarely seen in diverticulitis cases, which corresponds to 2% of cases. Obstruction is most common It occurs in the small intestine and mostly in etiology. There are adhesions. Multiple attacks can progressively lead to fibrosis and strictures in the colon. Free perforation in peritonitis is rare, however, there is a mortality rate of up to 35 percent. The mortality rate is even higher in the case of disseminated peritonitis. The cause of the perforation is related to the nonsteroidal anti-inflammatory drug(53,56).

## **11. Coagulation and Hemorrhagic shock**

A) Hemorrhagic shock: Hypovolemic shock develops due to hemorrhagic shock. While hemorrhage can be seen easily in external posttraumatic injuries, there is a risk of reaching the diagnosis more difficult and late in posttraumatic internal injury(26).

If hypovolemia occurs depend on hemorrhage develops, and if it is late for diagnosis; Systemic complications such as consumptive coagulopathy, endothelial damage and hemodilution may be added (57), increasing the risk of mortality.

The first priority in posthemorrhagic shock is to stop the bleeding by mechanical or surgical intervention. Another important cornerstone too is resuscitation and preventing further tissue ischemia by supporting the stability of the coagulation mechanism(26).

### **Other main principles in hemorrhagic shock;**

- \* Avoiding hypoxemia
- \* Applying supplemental oxygen to the awake patient (excessive oxygen that will suppress breathing should also be avoided)

- \* On the other hand, if the trauma victim has confusion (GCS <8), hypoxia, and hypercapnia, endotracheal intubation may be required to maintain airway patency.
- \* Hyperventilation is indicated in cases with posttraumatic brain injury close to the possibility of transtentorial herniation (58).

In contrast to other causes of hypovolemic shock, the medical strategy for the management of hemorrhagic shock for hypovolemia due to blood loss; It includes controlled hypotension with target systolic blood pressure of 80–90 mmHg (MAP 50–60 mmHg) until bleeding is stopped (26,57).

The main target hemoglobin concentration in cases with posttraumatic acute hemorrhage is 7-9 g/dL (58).

### **Disseminated intravascular coagulation;**

Sepsis has an important place in the disseminated intravascular coagulation entity (DIC), which causes thrombotic coagulopathy. It causes widespread systemic bleeding in all body vessels due to extensive microvascular thrombosis as a result of consumption of platelets, fibrinogen and coagulation factors(59).

In case of suspicion of DIC, if urgent surgical intervention is required; It should be transfused to keep the platelet level  $>50 \times 10^9/L$ , and coagulation factors should be supplemented as cryoprecipitate or fresh frozen plasma (FFP). Ongoing TDP transfusions may be required. However, it cannot be expected that every treatment will be exactly the same depending on the patient's condition, and if possible, the DIC process should be carried out in coordination with a hematology service(59).

They are very important in follow-up, as there are irregularities in prothrombin time (PT) and activated partial thromboplastin time (aPTT) due to consumption of coagulation factors. In addition, there is a decrease in fibrinogen levels and a decrease in platelet count(59).

## **14. Wound Care**

Wound care is a fundamental subject of surgery, and it can include many different and serious complications ranging from the mildest complications such as delayed wound healing to superficial wound infection, deep wound infection, and sepsis. Especially the subject; If the trauma is surgical or includes emergency surgical interventions, these complicating situations may naturally be more.

Major wound complications; It can be basically classified as hematoma, seroma, wound infection, wound dehiscence and wound evisceration, keloid and hypertrophic scars.

Although each complication has a separate risk here, it can be thought that the most important risk is benefit site infection.

The most important cornerstone here is the condition of the wound in the surgical wound classification(60).

- a) Clean:Non-infected clean operative incisional wounds (Aseptic rules intact);such as breast, hernia, thyroid operations etc.
- b) Clean contaminated; Urinary system, genital, respiratory and gastrointestinal system operations without contamination
- c) Contaminated; Acute non-purulent inflammation, local gastrointestinal perforation and contamination, surgical procedures applied to open traumatic wounds, penetrating abdominal trauma, acute cholecystitis, acute appendicitis
- d) Dirty; Surgical procedures for old traumatic infected wounds, traumatic wounds containing dead tissue, and widespread clinical infection or organ perforation;perforated appendicitis, disseminated necrotizing soft tissue infections

There are four sequential progressions in wound healing: Hemostasis, inflammation, proliferation, and maturation.

Biofilm formation as a result of disruption in healing and subsequent microbial invasion, disruptions in signal transmission, genetically defective enzymatic structures, changes in wound metabolism, repetitive traumatic conditions, and ischemic conditions at pressure points may be caused (61).

As a result, since wound care includes many complex factors, a professional team must be formed and the communication and consultation process between clinics must be fast and effective.

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## CHAPTER II

# THE COMPLICATIONS OF THE DAY CASE SURGERY

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**D**ay case surgery: Defines the discharge of the patient on the same day, whose surgical treatment is provided effectively and safely (1). In addition to laparoscopic surgery techniques, day-to-day surgery applications have increased gradually due to developments in anesthesia applications, meeting health costs and patient preference(2,3,).It has been reported that comprehensive information and training given to the patient and their relatives in the preoperative period increase the success in day surgery applications(4). On the other hand; It has been reported that concerns related to surgical intervention or anesthesia-related interventions adversely affect recovery in the postoperative period(5). The decision-making period for the surgery mostly covers a short period of time, which dates back to a week. In a comprehensive review on this subject, it have been reported that the day surgery plan was made in a week or less(6).

It is absolutely necessary to inform the patients about the surgical intervention and the anesthesia to be applied, together with the consent form.

Along with the developments in surgical and anesthesia techniques, some surgical procedures that were not considered as day case-ambulatory in previous years have now started to be included in the scope of day surgery in appropriate centers.

We can list them as follows;

- \* Some laparoscopic process; Hysterectomy, nephrectomy, prostatectomy
- \* Mastectomy
- \* Surgical operations about for vaginal sagging

- \* Lumbar discectomy operations
- \* Total hip and knee replacements processes
- \* Craniotomy proces
- \* Emergency laparoscopic cholecystectomy operation
- \* Laparoscopic appendectomies

### **Patient selection:**

\*\*\* In some situations, some patients who come to the hospital for outpatient treatment may be transferred to day surgery from clinic departments, emergency service and primar caring centers

\*\*\* The some publications in the medical scientific literature of good outcomes in cases with multiple comorbidities, as well as advances in surgical and anesthetic techniques, and the importance given to day surgery have naturally changed case selection.

\*\*\*The majority of patients are considered suitable for day surgery, unless there is a significant medical condition that an overnight hospital stay would be beneficial after surgery.

\*\*\*On the other hand, if in patient surgery is considered; In order to conduct that the case is treated on a daily basis, it is crucial to evaluate whether any strategy can be implemented, bearing in mind whether such a available situation exists.

\*\*\*\*\*There should always be suitable an interaction between the surgical team and the anesthesia department for patients scheduled for day surgery.

\*\*\*This communication and cooperation; A multiclinical collaboration with agreed protocols for patient evaluation is recommended locally to be agreed upon which patient to include in day surgery or which patient to exclude from day surgery, including criteria to be specified for this (7).

\*\*\*.Patient evaluation in day surgery can be examined under three main headings;

- I. Social
- II. Medical
- III. Surgical.

## 1. Overview of social factors

Cases presenting for surgery should definitely understand the risks of surgery and what the post-operative care process may bring, and give an informed consent form for outpatient surgery.

In the day surgery procedure; Traditional criteria for discharge may include a patient care presence for 24 hours postoperatively.

It is recognized, however([8]), that postoperative 24-hour care may be an extreme requirement for some minor surgical procedures, whereas it may be insufficient for more complex surgical procedures.

## 2. Overview medical factors:

Whether it is suitable for a procedure; The ASA should be related to the functional status of the patient as determined in the pre-anesthesia evaluation, not to age or body mass index(BMI) (9-11).

Since patients with persistent conditions such as diabetes mellitus are expected to have minimal disturbance in their daily routine, it is generally thought that they can be better managed as day-to-day cases if necessary precautions are taken (12).

If surgery is required due to an emergency (eg malignancy) before the patient's condition is optimized, then the patient's treatment may require inpatient treatment in terms of hospital stay.

Of course, patients with a high body mass index will have a higher incidence of complications during surgery or early recovery, but on the other hand, these problems can still arises from in clinical care and will usually be resolved or treated by the time of discharge of a one-day case (13).

They also benefit from short-term anesthesia techniques and early mobilization is other advantages for day surgery in obese patients (14, 15).

One of the most important points is to consider prolonged deep vein thrombosis prophylaxis (16).

Therefore , obesity is not an obstacle to day surgery because morbidly obese patients can be managed soundly with specialists as long as appropriate resources are available. However, this requires extra time for anesthesia and surgery, as well as the availability of competent assistants and equipment(13).

In terms of day surgery; Obstructive sleep apnea (OSA) is not an absolute contraindication for this procedure.

Grown-up who may be at risk with the help of 'STOP-Bang' scoring for cases with OSA should be evaluated in detail before anaesthesia.

Particularly emphasized point; Postoperative use of opioid drugs should be avoided in these patients.

The optimal anesthetic technique for this patient group is regional anesthesia, if possible.

The Society of Ambulatory Anesthesia, for adult patients with OSA scheduled for outpatient surgery; They published a consensus statement on the choice of preoperative anesthesia, emphasizing that patients diagnosed with OSA through screening tests such as the STOP-Bang questionnaire and patients with optimized comorbid conditions are also candidates for outpatient surgery if predominantly non-opioid analgesic techniques can be applied postoperatively.

Patients with a diagnosis of OSA with screening tests such as the STOP-Bang questionnaire and patients with optimized comorbid conditions should also be considered for outpatient surgery if predominantly non-opioid analgesic techniques can be applied postoperatively (17) . In addition, patients using nasal CPAP (continuous positive airway pressure) at home should be hearten to have nasal CPAP (continuous positive airway pressure) with them, and whether the appropriateness of being discharged on the same day should be considered(13).

### **3. Surgical Overview:**

The procedure should not pose a risk of complications such as serious postoperative bleeding or cardiovascular complications that require immediate medical attention.

In terms of postsurgical signs such as pain and nausea; It should be controlled using a integration of oral medication and local anesthetic methods.

The surgical process applied shouldn't prevent the client from continuing oral intake within a few hours after the procedure.

Before discharge, the patient must be mobilized. However, if complete mobilization cannot be performed, correct venous thromboembolism prophylaxis must be initiated and maintained.

### **Daily emergency surgical procedures:**

In medical conditions with an indication for emergency surgery, cases can be treated effectively and rationally as day-to-day cases in a semi-elective method (18).

Most patients can be discharged home immediately after the initial assessment and then called for surgery at an appropriate time by adding them to the daily case list or to the surgery list.

The remaining patients can be discharged to the day surgery service immediately.

With this method, the triage of priority cases will reduce the likelihood of the surgery being delayed again and again (19-21).

**Some emergency day-to-day procedures can be listed as follows;**

**a. General surgery**

Draining the formed abscess

Laparoscopic cholecystectomy, appendectomy applications

Biopsy of the temporal artery

**b. Gynaecology**

Evacuation application for products of conception

Laparoscopic applications for ectopic pregnancy

**c. Trauma**

Tendon repair

Plating of fractured bone

MUA of fracture

**d. Maxillofacial**

MUA fractured nose

Operative repair of fractured mandible

(MUA, manipulation under anaesthesia )

**Recovery phases after day case surgery;**

**First phase :** This phase starts with the end of the operation and It covers the interval from general anesthesia to full awakening of the patient.

Patients should be able to maintain their airways with the return of their protective mechanisms such as coughing and gag reflexes. Depending on the constitution of the patients and the anesthesia method applied, the early rescue stages vary, and some cases may be almost completely awake when they come out of the surgery. At this stage, the trustworthy area for recovery is the

operating room area, where anesthesia and surgical reinforcement are suitable. Patients who have been operated under regional or local anesthesia will pass the first recovery stage under normal conditions. To complete the second stage of recovery, patients are sent directly to the relevant clinic's own department, and this stage ends (22).

**Second phase:** This is a process that exists in clinical patient rooms. It lasts until patients are ready to be discharged from the hospital. These units are usually wards close to the day surgery unit. These areas should have experienced personnel who can deal with common postoperative problems such as nausea, vomiting, pain and bleeding(22).

**Late(third phase) recovery:** This period lasts from weeks to months and it encompasses a status of complete physical and psychological healing and ends when the patient is fully recovered(22).

**The main factors required for the surgical procedure to be called day surgery;**

- \* Minimum blood loss expectation
- \* Short surgery time (<1 hour)
- \* No intraoperative or postoperative complications aren't expected under normal conditions
- \* No any requirement for specialist care requierment for postoperative care
- \* Main advantages of day surgery were shorter hospital stay, lower infection rates and is more economical.

Appropriate case preevaluation and end determination are two important issues in outpatient surgery. In the declaration of the Association of Anesthesiologists of Great Britain and Ireland (AAGBI), anesthesia must be done during the day and accompanied by a consultant physician. Thanks to regional and local techniques, it is easier to avoid the complications of general anesthesia, in addition, it is more advantageous as it provides shorter recovery times, and it also facilitates discharge(22).

**The following criteria should be considered for patient discharge after surgery;**

Ability to tolerate oral intake, albeit in small amounts

Having minimal PONV (postoperative nausea and vomiting)

The patient has a low pain score or no pain

Non confuse ve bilincli durumda olmak

Being non-confused and conscious

Easy access to surgeons and anesthesiologists when needed

Absence of any immediate postoperative complication (eg, bleeding from the dressing site, infection, abscess, etc.)

Having a stable blood sugar level in patients with diabetes mellitus

No problem in urination ( It should be taken into account that it may also be related to the surgical procedure and anesthesia) (22).

If there is a problem in the inpatient ward; Necessary facilities should be provided to the patient for day surgery transfer(22).

**a) Presentation of service**

More efficient use of operating room time due to less variable situations

Providing simplified service in special units

More affordable in terms of cost

**b) In terms of patient's**

Minimal change in daily life

Patients have less waiting duration

(Case-oriented management :Lower risk of cancellation due to insufficient number of beds or other emergencies )

**c) In terms of clinical results**

Better clinical outcomes with a faster recovery time

Less morbidity due to the absence of long-term clinical hospitalizations

Much lower risk of thromboembolic or hospital-acquired infections(22).

**Disadvantages of day surgery**

It can be seen as a disadvantage that a responsible person needs to monitor patient care at home for the first 24-48 hours after the patient goes home after day surgery, and this is not possible in home conditions(23-25).

Due to the lack of a professional health worker to respond to the treatment and care problems faced by the patient/relatives at home in the postoperative

period, family physicians/general practitioners are consulted and their workload may increase(24, 26).

On the other hand, if we look at the factors affecting patient anxiety in day surgery; Özşaker et al. (2019) stated in their study that patient anxiety may be related to fear , mainly due to complications that may develop after surgery. From this perspective; Nurses have an important responsibility to inform the patient about possible complications in order to ease the recovery process by reducing the patient's anxiety level(27). Otherwise, complications triggered by patient anxiety (hypertension, tachycardia, arrhythmia etc.) may develop. In another study, Michel et al. stated that patient concerns in day surgery were related to the possibility of failure of the surgical intervention, the possibility of complications after the surgical intervention, or the thoughts of not being able to wake up after the surgery(28).In another study investigating the factors affecting anxiety in day surgery; It is stated that marital status has an effect on the level of anxiety, and unmarried individuals may experience more anxiety due to issues such as the lack of support factors, the perspective of the society and the feeling of loneliness(29).

In conclusion, outpatient surgery should be performed after appropriate preoperative planning and medical evaluation, taking into account the entire peroperative process. However, it should always be kept in mind that it is an operative practice that has a separate dynamic evaluation process, advantages and disadvantages in itself.

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## CHAPTER II

# COMPLICATIONS OF THYROID SURGERY

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### 1. Introduction

**T**hyroid surgery is one of the most common surgical procedures in today's surgical practice. While it was a very feared surgical field in the past, today it is applied with much less morbidity and mortality thanks to the developments in surgical technique and technology.

It was poorly developed until the middle of the 19<sup>th</sup> century (1,2). Thyroid surgery began to develop more rapidly as the result of improved anesthesia, infection prophylaxis, new hemostatic procedures, and surgical techniques. This also helped Theodor Kocher to lower the mortality rate of these operations to just 0.5% out of the total number of as many as 5000 thyroid procedures that he performed. The horizontal neck incision that he was using in his later years is still in use today (3).

Theodor Billroth, famous thyroid surgeon, also performed a large series of thyroidectomies at the time but with a slightly rougher surgical technique and with less regard for hemostasis. However, when comparing these two surgeons, he had much more hypocalcemias (2). In 1891, Gley hypothesized that this complication was probably due to the accidental removal of the parathyroid glands or their devascularization, so he ultimately realized that the lower thyroid artery should not be clamped at its main trunk (4).

Unlike hypoparathyroidism, recurrent nerve injury was recognized as a complication much earlier, so Kocher and Billroth were both leaving the posterior part of the thyroid capsule, thus avoiding nerve damage. In the early 20<sup>th</sup> century, surgeons started to actively search for and expose the nerve in order to minimize the risk of accidental injury. Kocher is responsible for the description of another significant complication, hypothyroidism, although he

did not attribute the symptoms to a lack of thyroid hormones at the beginning. All of his total thyroidectomy patients experienced such symptoms, but most patients who underwent partial thyroidectomy did not, so he advocated only partial removal of thyroid tissue.

## 2. Minor complications

Complications can be roughly divided into milder (or minor) and more serious (or major) ones. The formation of seroma and more pronounced scarring of the wound are classified as milder complications. According to the definition, seroma is the accumulation of clear fluid that occurs as a result of exudation after trauma or surgery. (5) If a minor seroma develops, it can be left untreated until it spontaneously resorbs, while aspiration or dilation of the wound under sterile conditions is suggested for larger seromas. There have only been a few studies so far that have examined the frequency of seroma formation after thyroidectomy. In general, we can say that the incidence is slightly lower when using newer coagulation devices such as an ultrasonic knife. (6, 7) A good preventive measure for the occurrence of seroma is certainly the installation and timely removal of the drainage of the wound.

Aesthetic results are particularly important in thyroid surgery, as patients are mostly women and sometimes young adults and the incision is in a highly visible anatomic location on the neck.

Conventional thyroidectomy, unlike rarely used endoscopic techniques, has the highest possibility of scarring, which is not only visible but also it can lead to feeling of a foreign body in the throat and difficulties with swallowing. In these cases, scar tissue is present not only in the skin but also extends across the strap muscles all the way to the thyroid cartilage, thus becoming fixed to a certain degree. Kim et al. analyzed the risk factors for hypertrophic scarring after thyroidectomy and showed that obesity, prominent sternocleidomastoid muscles, and small distance between the incision and the jugular were associated with a higher incidence of hypertrophic scars. (8) Studies on hypertrophic scarring are also rare and so are the descriptions of correction of this extensive fibrous tissue for symptomatic patients (dysphagia and foreign body sensation). Z-plasty using a platysma flap is an example, as described by Jeon et al. (9) To a certain degree, the patient can prevent scarring by massaging the scar in order to prevent fibrous fixation of deeper structures. Cremes against scarring can also be helpful.

Postoperative dysphagia is not necessarily the result of scarring, but may be caused by altered vascular supply or damage to small recurrent nerve

branches that innervate the cricopharyngeal muscle. The more extensive the surgical procedure is, the more pronounced the postoperative dysphagia. It is particularly often seen after paratracheal lymph node dissection and surgical treatment for hyperthyreosis. (10, 11)

### 3. Major complications

#### 3.1. Postoperative bleeding

As after any other surgical procedure, bleeding and hematoma formation are also possible after thyroidectomy. Blood supply to the thyroid gland is very abundant, thus increasing the possibility of bleeding. It is not a very common complication, but consequences can be very severe and life-threatening. The bleeding usually happens after clamp and tie technique failure, poor coagulation of smaller vessels, increased blood pressure after operation, or damage to remnant thyroid tissue that was not removed. (12) The incidence of bleeding is the highest in male patients, in case of a toxic goiter and after total thyroidectomy, but it is possible after any surgical intervention on the thyroid gland. (13) The most common presentation of this complication is neck swelling, neck pain, skin ecchymosis, and stridor and hypoxia in more severe cases symptoms of airway obstruction such as dyspnea. The neck swelling is not always a sign of severe bleeding, as it can sometimes be caused by minor superficial bleeding just under the skin, superficial to strap muscles. But one should keep in mind that much more dangerous deep-region hematomas and bleeding may not present with large neck swelling, making this life-threatening complication harder to recognize. This is especially common if the strap muscles are completely sutured. When bleeding occurs, the pressure in this relatively small compartment can increase rapidly, causing pressure on the denuded trachea, sometimes dislocating it and leading to respiratory distress, stridor, and hypoxia with possible lethal consequences. Increased pressure also produces venous and lymphatic stasis in the endolarynx, causing laryngeal edema which makes endotracheal intubation during revision surgery even more difficult or even impossible. This is why hematoma formation in a deeper region of the neck is far more dangerous than in superficial ones. (12) The majority of hematomas form in the first few hours after the initial surgical procedure. In an extensive study performed by Promberger et al., postoperative bleeding occurred in 336 (80.6%) of 417 patients within the first 6 hours after surgery. (14) Upon review of 6 other studies, we found that the incidence within the first 8 hours varied from 0-25% and the largest study being the one by Lacoste on more than 3000 thyroidectomies. (15-20) Bleeding occurs very rarely after 24 hours.

Postoperative hematoma occurs at a rate of approximately 0.1% to 1.1% (21, 22), but in highly experienced departments that rate usually does not exceed 1%. (23) Many of factors can lead to a higher likelihood of postoperative bleeding, including factors related to the patient, the surgeon, or both. Prevention should be initiated during the procedure itself, by performing precise hemostasis. Conventional hemostatic methods include large vessel ligation and bipolar coagulation of smaller vessels. Bipolar coagulation is usually very efficient and relatively safe in thyroid surgery regarding the damage to the nerves and parathyroid glands. On the other hand, monopolar surgery should be avoided because of higher temperatures and much more collateral damage to the adjacent tissues. Use of ultrasonic dissection technology can also reduce intraoperative and postoperative bleeding, along with much less thermal injury of other important anatomical structures. (24) Some authors proposed putting some hemostatic material directly into the wound at the end of the procedure. That was most often an oxidized cellulose mesh sheet. In a study performed in 2013, Amit did not demonstrate any significant advantage of these materials, only adding to drainage output without reducing the number of revision surgeries for hematoma. (25) Observation for up to 24 hours is recommended for the majority of patients undergoing thyroid surgery. If hematoma develops with the symptoms of stridor and breathing difficulties, the surgical incision should be urgently reopened, draining as much hematoma as possible, and the patient must be returned to the operation room for revision by completely opening the wound and performing a precise hemostasis.

### ***3.2. Recurrent laryngeal nerve damage and dysphonia***

One of the best-known and described thyroid surgery complications is injury of the recurrent laryngeal nerve (RLN). It is a branch of the tenth cranial nerve (vagus) that supplies all the muscles of the larynx except the cricothyroid muscles. Nerves are not symmetrical in their course. The left nerve makes a loop under the aortic arch while the right nerve loops under the right subclavian artery, and after that they return to the neck. They are intimately associated with the thyroid gland during their course in the tracheoesophageal groove, and they enter the larynx at the level of the cricothyroid membrane. RLN injury most often occurs near the point of entrance to the larynx.

Immediate flaccidity of the ipsilateral vocal fold occurs in case of unilateral paralysis, along with the loss of abduction and adduction, severe dysphonia to complete paralytic aphonia, pneumophonia, and in many cases aspiration of

food and drink into the trachea. (26) The paralyzed vocal fold atrophies through time, causing the voice to deteriorate even more.

In the case of bilateral recurrent nerve injury, biphasic stridor, respiratory distress, and aphonia occur due to the closure of the glottis, often requiring urgent intubation or tracheostomy. The symptoms usually occur already at the time of extubation after total thyroidectomy. (27)

However, unilateral or bilateral RLN injury does not have to be complete. In such cases, the symptoms of unilateral or bilateral paresis occur but are milder, and their prominence depends on the extent of axon damage. There are a few main reasons for nerve damage: inadequate visualization of the nerve, anatomic variations of the course of both nerves, bleeding in the operative field, postoperative edema, or a combination of these factors.

Identifying the RLN during thyroid dissection is the gold standard in avoiding neural injury which, of course, is not always straightforward, especially in cases of large goiters, malignancy, or reoperations. (28) The fact that there are many anatomic variations of its course and branching also makes the identification more difficult. RLN is a very delicate anatomic structure that can be damaged not only by cutting/transection, but also by stretching, compression, thermal injury, etc. (29)

The majority of authors still claim that the best way to prevent RLN injury is its exact dissection and identification during the procedure, while some hold the opinion that this is not necessary since the attempt to identify the whole course of the nerve in tracheoesophageal groove adds to the likelihood of stretching and compressing it, thus increasing the incidence of transitory pareses. (30) Devices for intraoperative recurrent nerve monitoring can also be very helpful, especially in cases of large goiters, reoperations, malignancies, and other more complex cases. Permanent RLN injuries have been documented in 0.5% to 5.0% of patients, whereas transient injuries are observed un between 1% and 30% of patients, according to various studies. (31,32) Of course, more experienced institutions and surgeons report much less injuries of the recurrent nerve.

### ***3.3. Hypoparathyroidism***

Hypoparathyroidism is an extensively described complication of thyroid surgery. It significantly contributes to patient discomfort, lowering the quality of life, prolonging the hospital stay, and increasing the costs of treatment. There are usually four small parathyroid glands (80% population) in a close relationship with the thyroid gland. Three glands can be found in 1-7% of population, and

3-6% of the population has more than four parathyroid glands. Each operation can result in their direct trauma, devascularization, or their accidental removal. (33) The etiology of transient hypoparathyroidism and hypocalcemia is still not completely understood and may be related to temporary ischemia of the parathyroid glands or to an increased release of the acute phase protein endothelin. (34,35) This transient or permanent loss of their function results in lower parathyroid hormone (PTH) levels, which are associated with different levels of hypocalcemia, as this hormone is crucial in maintaining calcium level homeostasis. Hypocalcemia is considered permanent if calcium levels do not normalize within 6 months (1.3-3.0% of cases). In some cases, hypocalcemia remains asymptomatic because the decrease of calcium levels is not that severe. It can only be detected by routine calcium and PTH blood tests. In cases of more severe hypocalcemia, the following symptoms may occur: Chvostek's and Troussseau's signs, muscle cramps and paresthesia, or even ECG changes (prolonged QT interval) and neurological symptoms. Pattou et al. showed that patients were at high risk for developing permanent hypoparathyroidism if fewer than three parathyroid glands were left intact during surgery or the early serum PTH level was less than 12 pg/mL. (36) In order to assess patients for hypoparathyroidism, intact parathyroid hormone (iPTH) along with total and ionized serum calcium should be measured during the first 24 hours after surgery. As with recurrent laryngeal nerve, the best prevention of parathyroid gland damage is proper visualization, hemostasis, and careful dissection. Use of new coagulation/dissection devices also helps in their preservation, lowering the thermic effect on adjacent tissue. (37,38) Hypocalcemia is treated by administering supplemental calcium, usually in form of carbonate and supplements of vitamin D. Parenteral calcium gluconate is usually added to the treatment in high-risk and symptomatic patients with low PTH and calcium levels. In selected cases where this therapy is not efficient enough, PTH can be administered in form of an injection, improving calcium levels.

#### **4. Results**

The first step in the prevention of all these complications is appropriate preoperative preparation, intraoperative systematic and careful dissection and the experience of the surgeon. When complications are encountered in the postoperative period; Morbidity and mortality are reduced thanks to the correct management and appropriate treatment of complications.

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## CHAPTER IV

# THYROID SURGERY COMPLICATIONS

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### 1. Introduction

Thyroid surgery is a procedure performed by many surgeons around the world for malignant or benign reasons(1). The thyroid gland brings many complications due to its anatomical neighborhood. The knowledge and experience of the surgeon significantly reduce the possibility of complications. A study showed that the risk of complications is decreased considerably when the surgeon performs a total of 25 thyroid surgeries per year(2). Although there are many complications, the most common complications are recurrent laryngeal nerve injury and hypocalcemia(3). Patients should be informed about complications in detail before the operation and necessary surgery should be performed. consent should be obtained. Before the operation, the anesthesia department should be consulted for preoperative preparation and the otolaryngology department should be consulted in terms of possible additional pathology.

We can list the complications of thyroid surgery as follows;

- Recurrent laryngeal nerve injury, superior laryngeal nerve external branch injury
- Hypocalcemia / Hypoparathyroidism
- Hematoma/Bleeding
- Thyroid crisis
- Horner syndrome
- Trachea, esophagus injury
- Pneumothorax
- Chylous fistula

- Tracheomalacia
- Keloid and hypertrophic scars
- Seroma
- Infection

## 2. Complications

### 2.1 Recurrent Laryngeal Nerve Injury

It is one of the most feared complications during the thyroidectomy procedure. It should be carefully exposed during the procedure and carefully dissected from the surrounding tissues. The lateral approach, inferior approach, and superior approach methods are used to expose the nerve. The most common of these is the lateral approach. The superior approach is preferred in retrosternal located or large thyroids. The inferior approach is preferred in patients who have undergone neck surgery before. Dissection should be done carefully while applying these methods(4). Intraoperative nerve monitor is used to reveal and defining the nerve. Duclos et al. showed that using a nerve monitor affects the dissection with the confidence it provides, prolongs the learning curve, but increases the surgeon's experience in recognizing the nerve(5).

Depending on the type of nerve injury, vocal cord paresis or vocal cord paralysis occurs. In case of complete incision, there is paralysis. Paresis usually occurs in conditions such as heat damage with cautery or hemostatic instruments, and excessive traction(4). The symptoms that occur in the case of paresis are usually temporary. Nerve injury can be unilateral or bilateral. The most common cause of bilateral vocal cord paralysis is thyroid surgery. Its rate has been reported as 0.4% in the literature(6).

The patient's clinic should be evaluated first when unilateral nerve injuries. The vocal cord on the uninjured side can provide compensation. After the evaluation, patients with aspiration risk or who cannot tolerate the loss of voice should undergo early intervention(7). Arytenoid adduction, vocal cord medialization, vocal cord injection, and voice therapy can be applied in treatment options(4).

Respiratory stridor, acute dyspnea develops in bilateral vocal cord paralysis and requires urgent reintubation (4). Steroids should be added to the treatment. Tracheostomy should be performed in case of persistent vocal cord immobility. Procedures such as posterior vocal cord resection, arytenoidectomy, arytenoidepexy, and laryngeal reinnervation can be performed for remedialization of paramedian-fixed cords(8).

## 2.2 *Superior Laryngeal Nerve Injury*

Injury to the external branch of the superior laryngeal nerve, also known as the Galli Curci nerve, causes a decrease in a high-pitched tone. Italian soprano Galli Curci ended her career because she could not say high-pitched sounds after thyroidectomy, and this nerve injury was named after her. It is a condition that usually affects sound artists.

This nerve is seen at a rate of 2-10% in a normal operation. It is located very close to the vessels of the upper pole of the thyroid (9). The type that is close to the upper pole with the highest probability of injury was classified as Type 2b by Cernea et al (10). It was determined that this type can be as high as 54% in large goiters. For this reason, extra attention should be paid during the dissection of the upper pole in large goiters (11). Voice training is beneficial in its treatment (12).

## 2.3 *Hypocalcemia / Hypoparathyroidism*

It is the most common complication of total thyroidectomy surgery (13). It is divided into two temporary and permanent hypocalcemia. Transient hypocalcemia is hypocalcemia lasting less than 6 months. Persistent hypocalcemia is hypocalcemia lasting longer than 6 months. While the rate of transient hypocalcemia is 19-38%, the rate of permanent hypocalcemia has been reported to be 0-3% (14).

Hypocalcemia results from iatrogenic removal or ischemic state of the parathyroid glands located in 4 different locations. Parathyroid glands show anatomical variations. It can occur anywhere between the hyoid bone and the superior mediastinum. Generally, the lower parathyroid glands are located anterior to the recurrent laryngeal nerve, and the upper parathyroid glands are located posterior to the recurrent laryngeal nerve. In addition, the parathyroid glands may be located intrathyroidal (15).

Careful dissection should be performed to prevent ischemia in the parathyroid glands. While dissection of the upper and lower pole vessels, it should be done close to the thyroid capsule and ligated (16). Another reason that increases the risk is the wide dissection performed with cancer surgery. In one study, the rate of permanent hypocalcemia after cancer surgery was reported as 3.3% (6). Graves' disease, large goiter, and recurrent surgeries are among the factors that increase the risk of hypocalcemia.

After the thyroidectomy procedure, the specimen and the surgical lodge should be examined. If a parathyroid gland is seen on the specimen or an

ischemic parathyroid gland is seen at the surgical site, the parathyroid tissue should be cut in 1-2 mm and transplanted into the sternocleidomastoid muscle or the muscles in the anterior forearm. This procedure has been shown to reduce the risk of developing hypocalcemia(17).

Hypocalcemia is usually asymptomatic. Early symptoms are fingertips and peroral numbness and tingling (13). Chovestek and Troussseau findings are found in symptomatic patients. In case of hypocalcemia, serum albumin levels should be checked. Each 1g/dL decrease in albumin value causes a 0.8mg/dL decrease in ionized calcium value. Therefore, the corrected calcium value must be calculated. In addition, it is instructive to measure the serum PTH level at the 6th postoperative hour to detect hypocalcemia in the early period(18).

If there are symptoms in patients with a corrected serum calcium value of  $>7\text{mg/dL}$ , oral calcium is sufficient. However, in patients with a corrected serum calcium value of  $<7\text{mg/dL}$ , intravenous calcium infusion, and vitamin D should be initiated.

#### **2.4 Bleeding/Hematoma**

It is an important life-threatening complication. Its incidence is between 0-6.5% (19). It is generally seen in the first 6 hours postoperatively in patients. However, there are studies reporting that 10% of patients with bleeding complications occur after the postoperative 24th hour first day(20).

Inadequate ligation of the vessels and insufficient hemostasis are the causes of postoperative bleeding and hematoma. In addition, additional diseases of the patient may cause bleeding in the anticoagulant and antiaggregant treatments used. Although the opening of the superior thyroidal artery is the first reason that comes to mind, bleeding focus is detected in 73% of the patients(21).

Postoperative bleeding, because the thyroid chamber is a narrow area, compresses the trachea in a short time and causes dyspnea. Therefore, urgent exploration is required. Since it is an emergency, a bedside incision should be made and the hematoma should be evacuated, and then surgery may be required to detect the bleeding focus (21).

After thyroidectomy, the anesthesia team should be asked to perform the Valsalva maneuver. In this way, possible postoperative bleeding foci can be detected.

#### **2.5 Thyroid Crisis**

Today, the incidence has decreased due to the use of antithyroid drugs and the fact that patients are operated on as euthyroid. It is a potentially fatal

condition. Arrhythmia, fever, and tachycardia are its prominent symptoms. If it is intraoperative, the operation should be terminated. In order to avoid this complication, patients should be operated on as euthyroid.

## ***2.6 Horner Syndrome***

It is a very rare complication. Ptosis, miosis, anhidrosis, and enophthalmos are the classic four findings. Horner's syndrome due to thyroidectomy occurs as a result of injury to the sympathetic nerves that go to the head, face, and neck. It is usually caused by dissections made in the lateral neck of the large thyroids. Careful dissection is required in this region.

## ***2.7 Trachea And Esophagus Injuries***

These are injuries that develop due to the instruments used intraoperatively. It is usually injured with a scalpel and cautery. If it is not noticed intraoperatively, it may present with subcutaneous crepitation in the postoperative period. It should be explored and necessary repairs should be made(13).

## ***2.8 Pneumothorax***

Pneumothorax is a rare complication during retrosternal thyroid surgery (22). It has symptoms such as hypoxia, difficult ventilation, and absence of breath sounds during ventilation. If detected, pneumothorax can be alleviated by entering a wide-mouthed needle through the 2nd intercostal space. Patients may need to have a chest tube inserted.

## ***2.9 Chylous Fistula***

It occurs when the ductus thoracic duct is injured during dissection. It gives symptoms with milk-colored liquid coming from the drain. Diagnosis is made when the triglyceride value measured in the incoming fluid is more than 100mg/dL (4). It is a complication that can be fatal if left untreated.

## ***2.10 Tracheomalacia***

It is a long-term complication that can occur in multinodular goiter and enlarged goiter surgeries. Tracheostomy may be required.

## ***2.11 Seroma***

It is usually due to premature withdrawal of the resistor. It accumulates under the flaps in the upper part of the clavicle. Diagnosis is made by a puncture. It

usually regresses with follow-up. It can be treated with pressure dressing and drainage.

### **2.12 *Infection***

It usually occurs with the abscess of the seroma or hematoma accumulated at the operation site. Its incidence has been reported as 0.3%(6). Since thyroid surgery is a clean wound, prophylaxis is not required. In case of an abscess, drainage should be done and antibiotic therapy should be started.

### **2.13 *Keloid And Hypertrophic Scar***

It is a cosmetic complication. In order to reduce the possibility of its formation, the incision to be made should be made where the skin folds are. As much as possible, cautery should not be used near the incision. Despite all precautions, keloid or hypertrophic scars may occur in patients. If necessary, steroid injections can be applied (15).

## **3. Conclusion**

Thyroid surgery is successfully applied in many clinics. In order to reduce the possibility of complications, it is important to perform intraoperative dissection on the anatomical plane. The recurrent laryngeal nerve, the external branch of the superior laryngeal nerve, and the parathyroid glands should be preserved. Vascular ligation and hemostasis should be done carefully. In addition, patients should be followed carefully in the postoperative period. This will significantly reduce the likelihood of complications. In this case, the surgeon's knowledge and experience come to the fore. Even if all the rules are followed, complications can occur. All surgeons dealing with thyroid surgery should know about possible complications and treatment management. In this way, the possibility of complications will be reduced, and if necessary, the necessary treatments will be applied and the negative consequences for the patient will be minimized.

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## CHAPTER V

# POST-THYROIDECTOMY COMPLICATIONS AND THEIR MANAGEMENT

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### 1. Introduction

The thyroid is an essential endocrine gland responsible for managing lifelong metabolic processes starting from the neonatal period (1). Thyroidectomy performed for benign and malignant thyroid diseases is the only treatment method for some patients (1, 2). As the current practice made it relatively easy to detect the surgical pathologies of the gland with high worldwide prevalence, the procedure became one of the most common endocrine surgeries (3).

Thyroidectomy, whose history dates back to the 1860s, was a banned surgery for a period due to its severe complications and high mortality rates. Currently, it is one of the most frequently performed operations on the head and neck region (1, 2) thanks to the “safe thyroidectomy” trend started by Emil Theodor Kocher at the beginning of the 20th century and to the developing techniques and technology today (1).

Although thyroidectomy is generally a safe operation with overall complication rates of less than 3% (4), the incidence and prevalence of complications of thyroidectomy still have not decreased to the desired level (1, 5). Due to complications, including nerve damage (up to 2%), hypoparathyroidism (up to 20%), and bleeding/hematoma (up to 1%), post-thyroidectomy mortality reaches 2% especially among patients  $\geq 70$  years of age (1).

Previous studies revealed certain risk factors for post-thyroidectomy complications such as older age, male sex, comorbidities (such as congestive heart failure, hypertension, bleeding diathesis), wound infection, usage of some

medicines like steroids, and antithrombotics, or the risk factors reported by American Society of Anesthesiologists (ASA) as class  $\geq 3$  (1, 6, 7, 8).

Post-thyroidectomy complications can be divided into minor and major complications:

## 2. Minor Complications

These less life-threatening complications include wound healing and seroma.

### 2.1. Seroma Formation

Seroma, which occurs due to the accumulation of exudate fluid in the affected area during the postoperative period, treatment options may differ according to the size. Small seromas are left alone for spontaneous reabsorption, while it is recommended to drain larger seromas under sterile conditions. The incidence of seromas after thyroidectomy is low due to more effective coagulation with new energy devices. However, operation on large goiters or extensive cervical lymph node dissection remains among the predisposing factors for seroma formation (7, 9).

### 2.2. Scar formation

Although it is considered a minor complication, the condition of the wound is a disturbing phenomenon in thyroidectomy operations. In traditional thyroidectomy operations, poor wound healing in the incision length affects the patient's daily life.

In addition to cosmetic concerns, any wound healing problem affecting the area from the subcutaneous tissue to the thyroid cartilage can cause a foreign body sensation in the throat or dysphagia (7). In a few studies about post-thyroidectomy hypertrophic scarring, risk factors for hypertrophic scar formation include poor wound healing, obesity (9, 10, 11, 12), incision closer than 1 cm to the sternal notch (7), and prominent sternocleidomastoid muscle (7, 11).

Proper wound care should be provided with rapid response to wound infections and drainage of the wound when deemed necessary(9), and the patient should be asked to gently massage the incision area to prevent fibrosis from fixing deep tissues with proper wound healing (7, 9).

## 3. Major Complications

Post-thyroidectomy major complications are life-threatening complications that should be prevented as much as possible, and when they are noticed, they need to be intervened quickly.

### ***3.1. Postoperative Bleeding and Hematoma***

The thyroid is an organ famous for its good blood supply. Therefore, although it is not seen very often, bleeding noticed during or after thyroidectomy is quite dangerous (7).

The thyroid is an organ known for its good blood supply. Hence, although it is not observed very often, bleeding during or after thyroidectomy should be taken seriously. After all, bleeding after thyroidectomy is fatal at a rate of 0.6% (4).

The incidence of post-thyroidectomy hematoma was reported to vary between 0.07 and 4.3% (4, 13, 14, 15); this rate is expected to be below 1% in centers experienced in this field (4, 7).

Risk factors identified for reoperation due to post-thyroidectomy bleeding are similar to those for general complications like older age because of the poor vascular condition(1, 15, 16, 17, 18), male sex (16, 17, 18), (19) (7), non-Caucasian race (19), comorbidities (hypertension (1, 15, 19) and bleeding diathesis (17, 19) which quadruples the risk of bleeding (15), antithrombotic drug usage (15, 18), presence of toxic goiter (7, 20, 21) (Graves' disease in particular (1)), reoperations (16, 18), cervical lymph node dissection (18), which is different from the general complications is the type of the surgery; total, subtotal, and hemithyroidectomies(7, 8), were found to be other risk factors in terms of bleeding.

In general, increased postoperative blood pressure (4, 7, 15), Valsalva maneuver (4, 15), retching or vomiting (4, 15), coughing (15), and bleeding from the surface of the thyroid (4) are among the causes of intraoperative or postoperative bleeding.

Beyond all these, the main problem in post-thyroidectomy bleeding or hematoma formation arises from the surgical technique (4, 7, 15). Mainly bleeding originates from the superior and inferior thyroid arteries and veins (4). Inadequate ligation and coagulation of major and minor vessels, especially the loss of complete ligation and coagulation of the superior thyroid artery with sutures or energy devices (4), make bleeding control very difficult (4, 7, 15). Likewise, if the strep muscles are cut, their homeostasis must be adequately done (4).

In a study that overviews the systematic reviews of the effects of antithrombotic use on post-thyroidectomy bleeding and neck hematomas, it was emphasized that antithrombotic agents should be discontinued one week before the operation, and it was found that the risk of bleeding continued despite this.

(1). However, the issue of antiplatelet/antiaggregant agents is still in question. In some studies, it was found that acetylsalicylic acid used at 100 mg/day posology did not cause a statistically significant change in the occurrence of cervical hematoma and other early complications (22, 23).

Approximately 85% of post-thyroidectomy bleeding occurs within the first 24 hours. Most of them are seen in the first eight hours (7, 15). However, bleeding and hematomas should be kept in mind among the late complications, as there are cases of bleeding and hematoma occurring even after 20 days in the literature (4, 14).

### ***3.1.1. So why should we take post-thyroidectomy hematomas seriously?***

Although it usually manifests itself with neck pain and swelling, visible blood on the dressing, ecchymosis, coughing, dysphagia, in more severe cases, tachycardia, hypotension, stridor, hypoxia, and dyspnea can also be detected (4, 7).

Post-thyroidectomy hematomas rarely cause serious consequences such as stroke, cardiac arrest, and emergency tracheostomy, which may have a morbid course (7, 8). In addition, as noted in a review, these hematomas are found to be associated with other complications (RLN palsy, hypocalcemia, and more general complications), as well as with hospital readmission, length of hospital stay, and return to the operating room. (4)

When hemorrhage occurs, tracheal compression or shift may be seen with increased pressure because the affected area is so narrow, manifested by dyspnea, stridor, and hypoxia. In the presence of hematomas located deep in the neck, besides the tracheal pathologies, the pressure on the vascular structures and lymphatics will also increase, making it challenging to intubate the patient during the reoperation due to edema of the vocal cords, epiglottis, and larynx (4, 7, 14).

### ***3.1.2. How to prevent it, and what to do when you notice it?***

It is necessary to take precautions from the intraoperative period to prevent post-thyroidectomy bleeding and hematoma, ensured by meticulous and precise hemostasis. Since the cases are seen more in the first 24 hours postoperatively, hospitalization of the patient and a close follow-up are recommended during this period. In the presence of a significant hematoma or when respiratory distress begins, prompt intervention is required for drainage. If necessary, the patient should be returned to the operating room for revision (4, 7). Previous studies

have shown that drains do not prevent post-thyroidectomy hematoma formation (19); besides, they may even cause delayed detection of postoperative bleeding due to occlusion of drains by hematoma (1, 4, 19).

In a previous study, it was found that hemostasis with energy devices was more effective in preventing postoperative hematoma, but in other studies, it was not found to be superior to suture ligation (24). In studies comparing energy devices, no statistically significant difference was found between devices (19, 24, 25). Likewise, hemostasis must be carried out thoroughly in case the strap muscles are cut (4).

The clinical presentation of bleeding can give clues about the bleeding focus. Especially in the presence of a dark-colored ecchymosis, a more superficial hemorrhage (located between the strap muscles and subplatysmal area) should be considered, and the focus should be sought just below the ecchymosis (4). In deeper-located bleeding (the presence of hematoma in the plane between the trachea and strap muscles), the ecchymosis of the skin will be less noticeable (4).

When the hematoma causes serious clinical symptoms, it should be acted very quickly, the incision line should be opened at the bedside, and the hematoma should be drained. Then, the patient should be taken back to the operating room to detect the origin of the bleeding, and the operation site should be carefully re-examined (4).

As a result, preventing post-thyroidectomy bleeding/hematoma is the responsibility of the entire surgical and anesthesia team, and fatal complications can be prevented by proper management of the process (4).

### **3.2. RLN Injury**

One of the most known major post-thyroidectomy complications (7, 26) is paralysis of the RLN, a branch of the N.vagus. As a result of its injury, temporary (neuropraxia) or permanent (axonotmesis and neurotmesis) damage occurs (27).

In studies, the incidence of RLN palsy was found to be 0.3-38%.

Since it innervates all the larynx muscles except the cricothyroid muscles, in unilateral injury, the ipsilateral vocal fold instantly loses its tone and cannot perform its abduction and adduction tasks permanently. Therefore, depending on the degree of innervation loss (extent of the axonal damage), dysphagia, dysphonia, or aphonia, chronic tracheal aspiration, and the paralytic muscle group eventually atrophies, leading to a deterioration in voice quality (7, 27, 28).

The compensation mechanism of the contralateral vocal cord may increase the vocal quality in the following periods. Speech therapy significantly improves vocal disorders. Nevertheless, voice problems occur again in the following periods due to fibrosis of the compensating cord due to excessive use. (27).

When there is bilateral nerve injury, symptoms and findings may range from aphonia, severe dyspnea, and biphasic stridor to the need for urgent reintubation or tracheostomy, depending on the extent of the axonal injury and the position of the vocal cords paralyzed (paramedian or median) (7, 26, 27).

Most injuries result in temporary loss of function and resolve within six months (7, 29).

Post-thyroidectomy RLN palsy can be divided into two according to the onset of early and late-onset and whether it is temporary or permanent. Generally, paralysis lasting more than one year is considered permanent (7).

Late-onset RLN paralysis is usually associated with hypoxic damage due to nerve compression of the hematoma and complete cord palsy due to fibrosis of the adjacent tissues and nerve itself (7).

It was noted in previous studies (7, 26) and the “2015 American Thyroid Association (ATA) Guidelines” that iatrogenic neural damage could be prevented via identifying the RLN during thyroid dissection. 2015 ATA Guidelines suggested using one of three methods (with a lateral, inferior, or superior approach) for the identification of RLN.

In the routinely used lateral approach, the gland is pulled medially, and the nerve is searched at the mid-polar level after the v.thyroidea media partition. In revision (reoperation/completion) thyroidectomies, with the inferior approach, the nerve is sought in the tracheoesophageal groove proximal to the point where the a.thyroidea inferior crosses. The superior approach, in which the nerve is searched between the cricothyroid junction and the tubercle of Zukerkandl, is less frequently preferred (30).

However, identifying RLN is not always as easy as it is said because the anatomical variations of the structures in the region are high, and when the presence of glandular cancer, large goiter, and secondary surgeries are added to this, things get complicated (7).

The presence of atypically located and traced RLN, intrathoracic goiter, reoperations, and the surgeon’s experience were highly associated with RLN damage (27). The type of thyroid disease (Graves’ thyroiditis or malignancy), large multinodular goiter, prolonged operation time, central lymph node dissection, urgent reoperation due to hematoma, and volume are among other factors that determine the probability of injury (28, 31, 32).

In studies on IONM, which is used to determine RLN localization, no statistically significant difference was found in terms of preventing injury. However, the frequency of IONM use is increasing day by day (28). After all, IONM relieves surgeons by providing information about RLN location and function (26).

### ***3.3. Hypoparathyroidism and Hypocalcemia***

Parathyroid glands are under constant threat during thyroidectomy because of their proximity to the thyroid. Post-thyroidectomy hypoparathyroidism can be seen in the patient due to accidental excision or direct damage due to mechanical or thermal reasons and the devascularization of the gland () (7, 33). When it is symptomatic, it negatively affects the quality of life of the patient. In addition, it increases the cost as it causes prolonged hospital stay and long-term/lifelong additional drug use (33).

Symptoms and findings include tingling/paresthesia, muscle cramps, Chvostek's signs, carpopedal tetani with or without Troussseau's sign, prolonged QT interval, and neuropsychological symptoms. (7)

Hypoparathyroidism is among the most common post-thyroidectomy complications, with the incidence and prevalence ranging from 0.5- 65% (3, 34) and 13-49% (35), respectively. It can be divided into two according to whether it is temporary (with an incidence of 19-49% (33, 34) and a prevalence of 1.6-53.6% (35) or permanent (with a prevalence of less than 3% (3) and an incidence of 0-14.5% (33, 35).

There is an ongoing debate over determining the postoperative period for temporary and permanent hypoparathyroidism. While some studies argue that six months is too early to conclude that post-thyroidectomy hypoparathyroidism is permanent and that it should be waited up to 1 year (36), some previous studies (7) and a systematic review of the American Thyroid Association and the European Society of Endocrinology stated that six months is sufficient (35). Those who argue that six months is too early found that more than 0.66 of the patients had temporary hypoparathyroidism, and most of them recovered at the end of 1 year and stated that after one year, a diagnosis of permanent hypoparathyroidism should be made if the serum iPTH value was still low (36).

In the aforementioned systematic review, it is also said that there is no statistically significant difference between the number of patients diagnosed with hypoparathyroidism in the sixth postoperative month and postoperative 1st year. Therefore it is unnecessary to follow up for hypoparathyroidism for more than six months. Moreover, it is recommended that at the end of this

follow-up period, patients should be told that they will have to continue their hypoparathyroidism treatment for life. (35).

### ***3.3.1. Predictive Factors for Post-thyroidectomy Hypocalcemia:***

#### ***3.3.1.1. Biochemical Factors***

Previous studies have shown that a comparison of preoperative and postoperative PTH values can be used to indicate transient biochemical hypocalcemia. It was found that this ratio should be  $<0.253$  or a decrease in preoperative PTH of  $>44\%$  (in another study  $>61\%$ ) in the postoperative period to indicate transient biochemical hypoparathyroidism. It has excellent sensitivity and specificity as a predictive factor, especially when there is a  $>62\%$  decrease in the preoperative PTH value on the second postoperative day (37).

Studies have shown that low calcium levels are essential in predicting transient and symptomatic hypocalcemia; however, the same cannot be said for permanent hypocalcemia (37).

#### ***3.3.1.2. Surgical Factors***

Although total thyroidectomy is thought to cause more damage to the parathyroid glands temporarily compared to other types of thyroidectomy (34), the results of the studies discussed in this review were found to be ambiguous, and the extent of the thyroidectomy was not found to have a predictive value for temporary or permanent hypocalcemia (38).

In the same review, contrary to popular belief, the addition of neck lymph node dissection to thyroidectomy was also found to be associated only with symptomatic and permanent hypocalcemia, not transient hypocalcemia (37). In another review, it was emphasized that central neck lymph node dissection is a risk factor for hypoparathyroidism since it includes liberal excisional approaches, and performing this procedure outside of indications will increase the possibility of hypoparathyroidism (36).

In order not to encounter post-thyroidectomy hypocalcemia, it is evident that it is necessary to be gentle when handling the parathyroid glands and to be extra careful, especially for its circulation (3, 7).

The surgeon's experience is of great importance here. When in doubt, the frozen section or "float or sink" method can be used for confirmation, but today it is still a reliable non-invasive method that can demonstrate the viability of the parathyroid glands during surgery (3).

Still, new imaging modalities show promise. In a few studies, it is emphasized that Indocyanine green (ICG) angiography and parathyroid

autofluorescence can identify the gland, and extra information can be obtained about the gland's viability with ICG (34).

Although all precautions are taken, the surgeon should be alert for hypocalcemia; consequently, intact parathyroid hormone (iPTH) and serum calcium levels (both ionized and total and ionized) should be measured in the first 24 hours postoperatively. (7)

In general, it is recommended to start calcium replacement when the serum calcium level is found to be  $<8$  mg/dL (2 mmol/L) in studies or when symptomatic hypocalcemia occurs. The problem here is at what hour postoperative blood tests should start and the cut-off level of calcium. The cut-off levels for calcium are different from each other in the studies, but since starting treatment rapidly according to the blood values is recommended without allowing symptomatic or deep hypocalcemia to occur, the PTH value is more important. Hence, it is recommended to start calcium replacement if a 10-15 pg/mL decrease in iPTH value or a  $>70\%$  decrease in preoperative value is detected within the first 4 hours postoperatively. (36). In addition, if serum calcium levels are low on the first postoperative day, it is recommended to add calcitriol preparations to the calcium replacement therapy during the discharge. (36)

Another variable in the hypocalcemia equation is vitamin D deficiency in the population. A previous study showed that vitamin D supplement therapy started in the preoperative period reduced acute symptomatic post-thyroidectomy hypocalcemia in patients who underwent thyroidectomy (2). A review article also noted that previous studies have found prophylactic calcium supplementation more cost-effective when considering the costs of treating symptomatic hypocalcemia. Therefore, the authors of the review recommend starting a routine postoperative calcium and vitamin D combination, claiming that this reduces the risk of both temporary and permanent hypoparathyroidism (3). Other studies also noted that prophylactic calcium (in combination with Vit D preparation) administration in high-risk patients reduces the risk of post-thyroidectomy hypocalcemia and the need for parenteral calcium administration, but overtreatment is still controversial (35).

An article advocates that patients can be safely discharged early based on postoperative PTH and corrected calcium values (39). Calcium preparations in the form of carbonate are usually given together with Vitamin D in the form of carbonate for treatment. In addition, parenteral calcium gluconate can be given to patients with high-risk or symptomatic hypoparathyroidism and hypocalcemia. In cases where these treatments are not sufficient, parathormone can be given parenterally (7).

## 4. Rare Complications

### 4.1. Tracheal injury

Injuries to organs adjacent to the thyroid (esophagus and trachea) are rare after thyroidectomy, with an overall incidence of 0.06% (9, 40).

Although the tracheal injury is rare, it can be mortal if not treated quickly. There are two types of injuries according to the timing of their diagnosis: ones that are noticed intraoperatively and the others with delayed clinical manifestation. Generally, these injuries are noticed on-site and repaired with absorbable sutures intraoperatively (5, 40).

Risk factors for late-presenting tracheal injuries include toxic goiter, local infection, female gender, central neck dissection, overuse of energy devices or bipolar electrocautery (may cause full thickness damage) (5), or thyroid cancers with tracheal invasion (40). In addition, a history of benign thyroid disease, prolonged intubation (especially with high cuff pressure), excessive postoperative cough, and tracheomalacia can be counted among the risk factors (5). In a study emphasizing that tracheomalacia is not as common as it is thought, it was stated that tracheal pathologies could be eliminated if necessary precautions are taken in the presence of predisposing factors such as large goiter (41).

Most tracheal injuries do not require repetitive interventional intervention, and covered tracheal stents for tracheal leaks usually work well (9).

### 4.2. Horner's Syndrome

Horner's syndrome is characterized by miosis, facial anhidrosis, ptosis, and enophthalmos due to oculosympathetic conduction blockade. Although it is a rare complication in the post-thyroidectomy period, it should be kept in mind (42).

Permanent damages mainly occur with stubborn maneuvers in retrosternal goiter, during lifting of the gland from the sternum, or with injuries due to cervical hyperextension and sympathetic nerve chain coming forward in thin-necked patients. (9). When reversible causes are eliminated with early intervention and steroids are started quickly, the results are satisfactory (42).

## 5. Risk Factors for Post-thyroidectomy Complications

### 5.1. Total Thyroidectomy versus Subtotal Thyroidectomy

Although thyroidectomy is a frequently performed procedure, it can cause rigorous complications, as mentioned above. When total and subtotal

thyroidectomy is compared, there is no statistically significant difference in hematoma formation. However, the risk of RLN paralysis and hypocalcemia is higher in total thyroidectomy (43).

### **5.2. Completion and Reoperative (Secondary) Thyroid Surgery**

The general opinion is that reoperations have a higher risk of Post-thyroidectomy complications. The reason for this is the disappearance of the landmarks in the second operation due to edema, inflammation, fibrosis, and anatomical changes in the site (44). In support of this, a previous study reported that Post-thyroidectomy complications were more common in complementary operations than in the first operation (45). Nevertheless, in a study of 152 cases, which stated that the complication rates of reoperative thyroidectomies were higher due to fibrosis and loss of normal anatomical plans, it was emphasized that every possible way should be tried to prevent recurrent disease in order to avoid secondary operation (46).

However, in many other studies, it was found that there was no statistically significant increase in complications in complementary thyroidectomy (44, 47, 48), and there was an acceptable morbidity rate (44).

A meticulous reoperation will not increase the risk of complications. There was no difference between the first and second thyroidectomies using IONM and possible RLN complications, especially in centers with high surgical experience (49). In a cohort study of a high-volume center, lobectomy, total thyroidectomy, and complementary surgery were compared, and no significant difference was found between complication rates (50).

In some studies, it is stated that the time of reoperation is vital regarding the risk of complications (51, 52). A systematic review and meta-analysis found an increased risk of complications during the dissection of the RLN, vascular structures, or fibrotic and inflamed tissue around the parathyroid glands when 7 to 90 days pass between the first surgery and the second surgery in particular, compared to this period exceeding 90 days (52).

### **5.3. Obesity**

Although some studies claim that Post-thyroidectomy bleeding is more common in obese patients with thyroid cancer (53), It has been noted in a previous study that there is no link between obesity and Post-thyroidectomy complications (especially bleeding, RLN injury, and surgical site infection)

in randomized controlled studies. However, data show that obesity increases overall complication rates and prolongs hospital stays (54).

However, transoral thyroidectomy is a scarless method that can be safely preferred in obese patients without causing any change in complication rates and technical difficulties (55). Besides, a study presenting the single-center experience argues that obesity does not increase the risk of complications even if it prolongs the hospital stay after thyroidectomy and can be performed safely in these patients (56). Another study supporting these results reported no link between obesity and thyroidectomy complications (57).

Moreover, a study even states that obesity has a protective effect against post-thyroidectomy hypoparathyroidism (58). This result was named the “obesity paradox” in a study by the Society of Asian Academic Surgeons (59).

#### **5.4. Operator's Experience**

In studies evaluating the aforementioned complications, the experience of the surgeon and the high volume of the center were found to be important. In the study of the European Society of Endocrine Surgeons (ESES), which compiled these studies, this situation was emphasized as follows: *“In accordance with global data, a caseload of < 25 thyroidectomies per surgeon per year appears to identify a low-volume surgeon, while > 50 thyroidectomies per surgeon per year identify a high-volume surgeon. A center with a caseload of > 100 thyroidectomies per year is considered high-volume.”*, and high-risk patients were recommended to be operated in high-volume centers (60).

However, in a single-center study, total thyroidectomy data of general surgery residents and general surgeons were compared, and no difference was found in terms of both overall complication rates and severe complications, including hypocalcemia and RLN paralysis. Therefore, it was concluded that it is safe for general surgery residents supervised by an experienced specialist to perform total thyroidectomy (61).

### **6. Minimally Invasive Thyroidectomy Techniques and Complications**

#### **6.1. Transoral Endoscopic Thyroidectomy via Vestibular Approach (TOETVA)**

Some studies state that the TOETVA technique, which has certain inclusion criteria, has higher infection rates due to the entry site of the trocars (oral flora) and prolonged operation time compared with the conventional thyroidectomy.

Nevertheless, it is a safe technique considering the cosmetic results in well-selected patients (62). Still, sometimes unconventional complications may occur during TOETVA (applied with an endoscopic or da Vinci robot) (63), such as CO<sub>2</sub> embolism (64, 65), injury of the mental nerve (65), and skin perforation (65, 66), burns (65, 66), and trauma due to remote access to the thyroid region (65) have been reported.

In another study, it was reported that when a particular learning curve was completed, TOETVA did not differ from classical thyroidectomy in terms of complication rates and hospital stay, and even the operation time was close to that of classical thyroidectomy (TOETVA was found to be completed in only 20 minutes longer) (67).

### ***6.2. Minimally Invasive Video-Assisted Thyroidectomy (MIVAT)***

In a systematic review evaluating previous controlled and noncontrolled trial studies, it was found that there was no statistically significant difference between MIVAT and conventional thyroidectomy in terms of complication rates (especially RLN paralysis and hypocalcemia). Therefore, it was concluded that the technique is safe as long as patients suitable for MIVAT indications are selected (67).

### ***6.3. Other minimally invasive techniques***

A systematic review and meta-analysis comparing the eight most commonly used minimally invasive thyroid surgery methods (MIVAT, bilateral axillo-breast approach endoscopic thyroidectomy (BABA-ET), bilateral axillo-breast approach robotic thyroidectomy (BABA-RT), TOETVA, retro-auricular endoscopic thyroidectomy (RA-ET), retro-auricular robotic thyroidectomy (RA-RT), gasless transaxillary endoscopic thyroidectomy (GTET) and robot-assisted transaxillary surgery (RATS)) among themselves and with classical thyroidectomy, found that there was no statistically significant difference between the minimally invasive techniques and conventional thyroidectomy in terms of complication incidence and length of hospital stay. This study emphasized that these techniques are advantageous in selected patients, especially since there is no visible incision scar on the neck (68).

## **7. Conclusion**

To sum up, thyroidectomy is the most commonly performed endocrine surgery. It is necessary to proceed with a surgical method suitable for the indications and

a meticulous surgical technique to prevent complications related to the gland or the adjacent organs and structures.

In addition, we must be enthusiastic about new techniques and technologies in thyroidectomy and follow up-to-date guidelines, but always be alert for the new complications they bring.

Finally, we should be vigilant about RLN injury, hypoparathyroidism, and injury to neighboring organs or structures, which may occur despite all precautions, and manage complications properly.

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## CHAPTER VI

# COMPLICATION AND MANAGEMENT AFTER PARATHYROID CANCER SURGERY

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### 1. Introduction

Fritz De Quervain reported the first case of parathyroid cancer in 1909. Parathyroid cancer is rare malignant tumor which comprises 0,5-5% of patients with primary hyperparathyroidism.(1-3) As opposed to female predominance in begin causes of hyperparathyroidism. Parathyroid cancer has equal frequency of occurrence in both sexes and is usually diagnosed in the fifth decade of life.(4-5) The challenge to the clinician is to distinguish parathyroid cancer from the far more common parathyroid adenoma or hyperplasia, as there are no specific clinical, biochemical or radiological characteristic of parathyroid cancer. Indeed, the diagnosis of malignancy is often made after surgery, and sometimes after recurrence. (2,3)

Complate surgical resection is the only known curative treatment for parathyroid carcinoma. In order to avoid local recurrence, the lesion must be removed en-bloc with clear margins. Although patients with parathyroid carcinoma have a long survival, they often develop local recurrence and/or distant metastases. Most patients die not from tumor burden directly but from uncontrolled severe hipercalcemia.(1,5-6)

### 2. Epidemiology

Parathyroid cancer usually represents less than 1% hiperparathyroidism cases. (1,4-6) Altough a higher proportion has been reported in Asian populations.(7)

### 3. Etiology and pathogenesis

The etiology of parathyroid cancer unknown. An increased incidence of parathyroid cancer has been associated with previous neck irradiation (8-9) and in patients with kidney end stage disease.(9) Parathyroid cancer may occur as part of specific syndromes although it is more frequently sporadic. General, syndromic forms genes acting on similar and somehow shared molecular pathways(CDC73 or MEN1 genes) The CDC73 gene encodes for a tumor suppressor protein called parafibromin.(10) Most of the mutations are nonsense and result in a loss of parafibromin expression.(11) In fact, tumors harboring CDC73 mutations display loss of parafibromin expression and loss of nuclear parafibromin expression has been found majority of Parathyroid carcinoma. (4,12) Other frequent mutations occur in the PRUNE2 gene as well as ADCK1 ,FAT3,AKAP9 and ZEB1 .(13,14)

### 4. Clinical features

Preoperative suspicion of Parathyroid carcinoma. Is of paramount importance, as it may guide the extent of the initial surgical procedure. Some clinical and biochemical features may raise the suspicion of a Parathyroid carcinoma. First, most are functioning, and the signs and symptoms are primarily because of hypercalcemia and high(10%) levels of PTH and not to the tumor mass. In some patients the finding of a palpable cervical mass and laryngeal nerve palsy in a hypercalcemic patient may suggest the presence of PC. Nodal and distant metastases at presentation are rare (<10%) Most patients with PC show markedly elevated levels of calcium (13-15 mg/dl) associated with symptoms of hypercalcemia ( polyuria, polydipsia, weakness, anorexia, vomiting, weight loss, confusion ) The combined finding of a large parathyroid lesion ( 3 cm) and severe hypercalcemia ( 12 mg/dl) should raise the suspicion of PC. Sometimes (<10%) the PC is nonfunctioning, being characterized by the involvement of surrounding structures by the tumor mass and in these cases it presents as a palpable solid neck mass associated with hoarseness and dysphagia.

Proposed TNM staging systems for parathyroid cancer

T classification

-(Tx ) Not defined by authors

-T1 : Primary tumor <3cm

-T2: Primart tumor >3 cm

-T3 :Primary tumor of any size with invasion of the surrounding soft tissues i.e.,thyroid gland ,strap muscle ,etc

-T4:Massive central compartment disease invading trachea and esophagus or recurrence parathyroid cancer

N classification

-(Nx) Not defined by authors

-N0:No regional lymph node metastases

-N1 : Regional lymph node metastases

M classification

-(Mx) Not defined by author

-Mo:No evidence of distant metastases

-M1 :Evidence of distant metastases

Differentiated classification system-Classes I to IV

I T1 or T2 N0M0

II T3N0M0

III Any T,N1,M0 or T4

IV Any T ,M1

High and Low risk

Low :Capsular invasion combined with invasion of surrounding soft tissue

High:Vascular invasion and/or lymph node metastases and /or invasion of vital organs and /or distant metastases

## 5. Diagnosis

### 5.1. *Laboratory testing*

The main clinical indicators of malignancy have been reported in many studies and as stated above, are severe hypercalcemia and high levels of PTH, as well as a large lesion.(4,7,15,16)

Bae. et all. found that alkaline phosphatase levels, in combination with tumor size, can also predict the benignity or malignancy of a suspicious parathyroid lesion. The cutt-off level with highest discriminatory power was a serum alkaline phosphatase level of 285IU/L and a tumor size greater than 3.0 cm. Below these levels, the suspicious enlarged gland is more likely to be benign.(16)

### ***5.2. Imagine studies***

Ultrasonography and MIBI (  $^{99m}\text{Tc}$ -sestamibi scintigraphy) imaging are most used imaging studies for detecting parathyroid abnormalities in patients with primary hyperparathyroidism.

Ultrasonography plays a major role in the preoperative localization of enlarged parathyroids glands. Large size ( $>3$  cm ) and marginal irregularity with local tissue invasion, heterogeneous echotexture, calcifications, and palpability had a high probability of being a parathyroid cancer.(17,18)

CT and MRI scans are useful for detecting the parathyroid mass and invasion of surrounding tissues and for distant metastases.

PET/CT with  $^{18}\text{F}$  -FDG could provide additional information related to the location and extent of parathyroid carcinoma, compared to CT, MRI and  $^{99m}\text{Tc}$ -sestamibi. The impact of PET/CT in staging was mainly addressed to evaluate loco-regional and distant spread of disease, adding data on lesion metabolism. PET/CT may also be useful in the identification of suspected tumor recurrence and evaluation of potential residual disease after primary treatment.(19)

$^{18}\text{F}$ -fluorocholin-PET ( $^{18}\text{F}$ -Choline -PET) is promising novel method for preoperative localization of parathyroid masses.(20) Isoleted case reports have shown that parathyroid cancer are  $^{18}\text{F}$ -choline-PET positive, suggesting that this agent should be considered in the future for parathyroid carcinoma work-up. (21,22) However, brown tumors also are  $^{18}\text{F}$ -Choline -PET positive, which must be considered and should not be confused with metastasis.(23)

### ***5.3. Fine needle aspiration biopsy***

Fine needle aspiration biopsy (FNAB) is not recommended when parathyroid cancer is suspected because cytology is poor distinguishing malignancy in a parathyroid tumor.(24) Moreover, the rupture of lesions capsule and the spreading of neoplastic cells has been reported.(25)

Selective venous catheterization with PTH measurement has been utilized for localizing recurrences when the imaging studies with the other noninvasive techniques are negative or equivocal.(26)

## 6. Treatment

### 6.1. Medical Treatment

Medical management for lowering serum calcium and correcting metabolic abnormalities is the main treatment of patients awaiting surgery and those with inoperable PC. The first step is hydration with normal saline infusion as hypercalcemic patients are often dehydrated.(27) Next step in management usually includes intravenous administration of bisphosphonates (pamidronate and zoledronic acid). Bisphosphonates inhibit osteoclastic activity, which is the major mechanism responsible for severe hypercalcemia and are the treatment of choice, but onset of action is slow.(27,28)

### 6.2. Radiotherapy

The role of radiation therapy in the management of Parathyroid carcinoma is controversial. Parathyroid carcinoma is a radio-resistant tumor and there is no indication for the use of radiotherapy as a primary treatment.(3)

### 6.3. Chemotherapy

Cytotoxic chemotherapy has not been shown to be effective in the treatment of Parathyroid carcinoma. The chemotherapy regimens reported in these cases include monotherapy using dacarbazine or combination therapy consisting of fluorouracil, cyclophosphamide, and dacarbazine or a combination of methotrexate, doxorubicin, cyclophosphamide and lomustine.(29) The only targeted therapy that has shown efficiency against PC in case reports sorafenib. Sorafenib was successfully used in a young female patient with metastatic PC, carrying a germline CDC73 mutation.(30)

### 6.4. Surgical Treatment

The only curative treatment of PC is surgery and best chance of cure can be achieved by complete excision at the first operation. The gold standard treatment is en-bloc resection of the tumor with the ipsilateral thyroid lobe, and adjacent involved structures as necessary with gross clear margins, with care to avoid spillage of tumor cells into the surgical field.(15,29,31) En bloc resection has been established as the standard of treatment and it includes performing a parathyroidectomy, ipsilateral thyroid lobectomy, central neck dissection, and, if necessary, resection of the thymus. The tumor should be removed, via open approach. If there is evidence of lymph node involvement they have to

be removed, while prophylactic neck dissection is not recommended, since it does not prolong survival but rather increases morbidity. The tumor should be removed with minimal manipulation avoiding the rupture of capsule and the spill over of the tumoral cells in the surgical field. Nodal metastasis were 7.5 times more frequent in patients with tumors  $>3$  cm. The management of recurrent disease is mainly surgical. Reoperation is indicated for locally recurrent or metastatic disease control hypercalcemia.

## 7. Postoperative Parathyroidectomy Complications

### 7.1. *Wound hemorrhage*

Wound hemorrhage with hematoma is an uncommon complication reported in 0.3% to 1.0% of patients in most large series.(32) Wound infections, usually caused by *Staphylococcus* or *Streptococcus* species are considered to be rare events, occurring in 0.3% to 0.8% [2] of cases. However, it is a well-recognized and potentially lethal complication. A small hematoma deep to the strap muscles can compress the trachea and cause respiratory distress. A small suction drain placed in the wound is not usually adequate for decompression, especially if bleeding occurs from an arterial vessel. Swelling of the neck and bulging of the wound can be quickly followed by respiratory impairment. Wound hemorrhage with hematoma is an emergency situation, especially if any respiratory compromise is present. Treatment consists of immediately opening the wound and evacuating the clot, even at the bedside. Pressure should be applied with a sterile sponge and the patient returned to the operating room. Later, the bleeding vessel can be ligated in a careful and more leisurely manner under optimal sterile conditions with good lighting in the operating room. The urgency of treating this condition as soon as it is recognized cannot be overemphasized, especially if respiratory compromise is present.

### 7.2. *Neural, Vascular, and Visceral Lesion*

Injury to the cervical sympathetic trunk causes Horner's syndrome, characterized by a constricted pupil, drooping eyelid, and facial dryness

### 7.3. *Seroma*

Incidence of seroma development" between 0 and 6% after parathyroid surgery(33,34,35). Although it is said that the incidence of seroma development increases when drainage is not applied, it is sufficient to "reduce" the occurrence

of seroma by using a drain data are not available. Use a drain "lmas" or make a basque dressing man "lmas" does not prevent seroma formation, but drains can treat seroma effectively and thus there is no need for aspiration. The most appropriate treatment for seromas requiring repeated lateral aspiration is flexible, contaminated the skin is a "lan closed" dre naj system to prevent the entry of microorganisms. Infected seromas require proper drainage.(36,37)

#### **7.4. *Edema***

Laryngotracheal edema can be a cause of respiratory obstruction after extensive thyroid surgery. Pharyngolaryngeal edema, in addition, is a well-recognized complication caused by the endotracheal tube or laryngeal mask and can also occur in association with an anaphylactoid reaction (38) Steroid therapy, occasionally in combination with temporary reintubation, leads to **rapid relief**.

#### **7.5. *Adverse Scarring***

In general, parathyroidectomy incisions are nearly invisible when fully healed. However, just like in any surgical procedure, there is low risk of adverse scarring that should always be disclosed to the patient. African Americans and patients with history of keloids or exuberant scars should be approached cautiously. A good practice is to ask the patient to reveal previous surgical scars to anticipate potential wound complications. Intraoperatively, the incision should be placed in a skin crease if at all possible. Care must be exercised with skin retraction, particularly in small incisions that provide limited exposure. Excessive retraction traumatizes the skin edges, leaving a short but noticeable scar in the neck. If the exposure is insufficient, is better to extend the incision than to risk an unsightly scar derived from excessive retraction. If a keloid scar is identified postoperatively, compression therapy, and intralesional corticosteroids should be initiated as early as possible.

#### **7.6. *Injury to the Recurrent Laryngeal Nerve***

While unilateral palsy or paresis might result in significant impairment of the quality of life, bilateral palsy might be lethal. Routine visual nerve identification and preservation have been shown to significantly reduce RLNP rates. Clinically, unilateral RLN injury presents as dysphonia. While in bilateral vocal fold paralysis voice quality is typically good, airway patency is jeopardized by the paramedian position of the vocal folds.

### 7.7. *Injury to the Lymphatic Structures*

Patients in whom lymph node dissection is a component of thyroid surgery are at risk for injury to the thoracic duct on the left side and to the lymphatic duct on the right side. Development of chyloma is the hallmark of this complication. If the injury is evident during surgery, ligation of the duct should be performed. In cases of delayed diagnosis a conservative management by continuous drainage and reduction of chyle production by TPN or by oral administration of a low fat, high carbohydrate, and high protein diet may be carried out. In our experience additional systemic administration of somatostatin proved extremely efficient. If the chyle leak persists correction with an aim to ligate the fistula should be considered.

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## CHAPTER VII

# COMPLICATIONS IN THYROID AND PARATHYROID SURGERY

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**T**hyroid and parathyroid surgery; It requires the entire surgical team to be experienced, patient, meticulous and have a good command of anatomy. Possible surgical general complications that may develop are postoperative wound infection, edema development, bleeding, complications due to incorrect positioning during surgery. Let's take a look at each of them;

### \*The complication of the wound infection

They are soft tissue infections mainly due to Staphylococcus or Streptococcus bacteria. It has been reported to occur in 0.3% (1,2) to 0.8% (1,3) of patients. It is not normally considered an expected complication for thyroid surgery. Prophylactic antibiotic therapy should be kept in mind in cases with reduced immunity or in patients with cardiac valve disease. should be remembered. Mild neck cellulitis usually regresses with medical treatment. On the other hand, rapid incision and drainage are essential in abscesses. In case of delay in this surgical intervention, devastating mediastinitis may develop.

Good results can be obtained with percutaneous aspiration in clinically manifested seromas(1).

### \*Laryngeal and/or vocal cord edema complication

It is the main cause of stridor that occurs within 24 hours after thyroidectomy.

Its main symptom is difficult breathing. Treatment includes acute administration of racemic epinephrine. In addition, corticosteroid administration to patients who are thought to be at high risk before surgery may be an alternative that helps to reduce this complication(1,4).

On the other hand, pharyngolaryngeal edema is a complication that may occur in endotracheal tube application, more prominently in difficult intubation, or due to laryngeal mask application. It should always be kept in mind that it may also occur due to an anaphylactoid reaction(5).

#### \* Postoperative acute hematoma formation and bleeding

The incidence of bleeding requiring postoperative intervention in thyroid surgery has been reported as 0.1–1.5% in the literature (6-10).

This complication manifests itself with swelling in the neck, discoloration of the skin, pain in the neck, pressure and shortness of breath. In addition, if the rapid and sudden onset of bleeding is considered, it may push the trachea in a life-threatening manner, leading to airway obstruction. In general, it is most likely to occur within the first 24 hours after surgery. Depending on the size of the hematoma due to bleeding, it is very important to urgently evacuate the hematoma with an incision. In cases of larger hematomas, it may be more sensible to allow the patient to breathe spontaneously while avoiding tracheal compression by drainage through a small incision before securing the airway with an endotracheal tube for safety(1,4).

\* Plexus brachialis and nervus ulnaris are at risk due to incorrect positioning on the operating table. In order to prevent nerve damage, both arms should be fixed in adduction. On the other hand, hyperextension of the head has the potential to cause nausea and headache in the early postoperative period(1).

However, the incidence of temporary or permanent recurrent laryngeal nerve injury and brachial plexus injury, especially due to transaxillary thyroidectomy, has been reported in the literature as 1.23%, 0.27%, and 0.2%, respectively(11).

In endocrine neck surgery less than 1.5% of cases for morbidity-related conditions not related to general surgery various complications have been reported. According to the complication frequency, respectively; Respiratory complications in 1.5%, urologic complications in 0.9%, gastrointestinal complications in 0.8% and cardiologic complications in 0.5% were reported in the literature. In addition, complications due to allergic reactions, drugs or other unexpected situations were reported at a rate of 0.4%(3).

#### Specific complications related to thyroid and parathyroid surgery

Before thyroidectomy operations, endoscopic laryngeal examination is so important. Because this is important in terms of clarify vocal cord status. The

most common complications after thyroidectomy are vocal cord paralysis, bleeding and hypocalcemia (12).

### **Unilateral Injury to the Recurrent Laryngeal Nerve**

The recurrent laryngeal nerve is the mixed nerve, with the exception of the cricothyroid muscle, which supplies the motor nerve of all intrinsic laryngeal muscles and the sensory nerves of the mucosa under the vocal cords. It is located in the tracheoesophageal Groove(13,14,15). It may be damaged due to traction, ligation, diathermy, cutting, bleeding. The best way to avoid injury to the nerve is to expose the nerve along the nerve trace. In unilateral injury, the voice weakens or becomes coarse. If bilateral nerve cuts occur, airway obstruction intubation and tracheostomy may be required due to the fusion of the vocal cords in the midline. In bilateral complete incision, the cords enter the cadaveric position, the sound disappears completely. As the cough is insufficient, respiratory tract infections develop, requiring cuffed tracheostomy(13).

If we look at the factors to be considered in the exploration of the bolus for the recurrent laryngeal nerve; Caudally, at the intersection with the common carotid artery, adjacent to the inferior thyroid artery. Cranially, the nerve can be found in the anatomical structure hollowed out by the Berry ligament, the cricoid cartilage, and the condensation of the posterior thyroid capsule near the upper tracheal rings, as well as by direct palpation of the tracheal wall below the lower thyroid pole, in addition to visual identification. Kocher emphasized that nerve injury from direct exposure could certainly be avoided by fully exposing the recurrent nerve with a careful thyroid dissection technique to prevent postoperative hoarseness(16).

The RLN (inferior laryngeal nerve) traveling from the thoracic inlet to the cricothyroid joint should be carefully searched for and carefully dissected from tissues with various approaches during surgery. However, anomalies such as non-recurrent nerve, especially on the right side, should be kept in mind(17). Otherwise, RLS injury may occur. RLS injury can be temporary, permanent, unilateral or bilateral(17). Transient RLN injury may be due to unnecessary dissection of the nerve, stretch-induced axonal injury, thermal injury due to cautery, viral neuritis, and difficult endotracheal intubation. Permanent RLN damage is thought to be mostly due to direct invasion of the nerve with a thyroid mass or severe damage to the nerve as a result of careless surgery (17).

## Bilateral Recurrent Laryngeal Nerve Injury

It is a rare but serious complication. It occurs when the vocal cords are positioned at or near the midline. Unfortunately, a variable range of airway obstructions can be seen, from the mildest to the most severe. In the literature, Rosato et al. stated that bilateral paralysis (diparalysis) may occur in 0.4% of cases after total thyroidectomy (1,4,18). This condition is generally diagnosed by developing immediately after the patient is extubated or in the early postoperative period. As soon as the diagnosis is made, the patient should be reintubated and replaced with systemic corticosteroid support as soon as possible. Systemic steroid support is important in regression of vocal cord edema. If the nerve injury has occurred as reversible; Under appropriate conditions, the patient's extubation can be done within the first 24-72 hours and no further treatment is required. if the airway obstruction is not resolved, the injury is not reversible; reentubation and tracheostomy should be opened. For approximately 9-12 months, patients are followed up on an outpatient basis and if the vocal cords have not recovered at the end of this period, the final solution is to maintain tracheostomy or to provide airway patency with transverse laser cordotomy (1,19).

## Injury to the Superior Laryngeal Nerve

Due to the close neighborhood with the superior thyroid vascular structures; The external branch of the superior laryngeal nerve (SLN) is at risk during thyroid surgery. Incidence of intraoperative injury of the external branch of the SLS. It is between 0-20%. Most publications state that this rate has fallen below 5% today(20-22).

The external branch of the superior laryngeal nerve(SLN) runs along the lateral surface of the inferior pharyngeal constrictor muscle in close proximity with the superior thyroid artery to innervate the cricothyroid muscle. The external branch accompanies the superior thyroid artery and lies medial to the artery. The pathways of these two structures diverge at the upper border of the thyroid lobe, where the nerve terminates at the cricothyroid muscle. Nerve is not seen in 25% of cases(24).

Normally, ligation of the superior thyroid vessels close to the capsule of the thyroid gland prevents SLN injury. However, the external branch of the SLS follows an aberrant course in 20% of cases and may accompany the superior thyroid vessels below the upper border of the thyroid lobe[23,24]. In such cases, the probability of damage to the nerve is high, especially if the superior thyroid pedicle is truncated without dissecting the branches(25).

If the branches of the superior thyroid pedicle are individually dissected and tied along the surface of the thyroid gland while the superior pole is retracted inferiorly, the possibility of nerve damage is minimized(24).

Bilateral damage to the SLN external branch results in a more symmetrical laryngeal appearance but produces a weak, breathy voice. Both vocal cords may be arched, and the epiglottis may be elevated anteriorly, making glottic examination difficult. Voice therapy is the main treatment for damage to the external branch of the SLN(26).

### **Tracheomalacia**

Tracheomalacia, which can be seen among the complications following the removal of large goiters, can lead to tracheal collapse. In these cases, endoluminal stenting may be required for tracheal stabilization. It is also tried on external splints with custom made rings or Marlex mesh. However, if all treatments fail, the ultimate treatment option is tracheostomy(1). When the patient shows symptoms of severe malaise, both overlapping in dynamic thorax CT and dynamic bronchoscopy If the symptoms accompany, surgical treatment should be considered after the general condition of the patient and comorbidities are evaluated(27,28).

### **Hypoparathyroidism**

It has been reported in the literature that hypoparathyroidism can reach up to 20% due to thyroid surgery. If the lower thyroid artery is connected close to the trunk in the dissection performed for lymphadenectomy, the risk of devascularization of the parathyroids will increase. The risks of devascularization of the lower parathyroid glands increase due to central cervical lymphadenectomy. If perfusion is thought to be impaired or accidentally removed, lower parathyroid glands can be autotransplanted into the sternocleidomastoid muscle(29).

In terms of hypocalcemia, one should be alert in the early postoperative period.

### **Hypocalcemic tetany**

Postthyroidectomy hypocalcemic tetany; It may be due to multifactorial causes. These are respectively; Failure to protect the parathyroid glands due to surgical technique errors (parathyroid damage, edema, infarction, ischemia), conditions where the width of the thyroidectomy margins increases, hyperthyroidism, autoimmune diseases, malignancy, factors such as ligation of the inferior thyroid,

completion thyroidectomy, neck dissection are the factors that responsible a major status in the etiology(30). Transient hypocalcemia has been reported between 6.9% and 25% in the literature(31,32) . In tetany, typical symptoms and a decrease in serum calcium are seen in the first few days after surgery. Clinical findings occur due to increased neuromuscular excitability. These clinical findings that give symptoms after hypocalcemia; Numbness in the extremities and around the mouth, anxiety, carpopedal spasm, laryngospasm, convulsions and numbness, tetany(30).

If permanent hypoparathyroidism occurs, cataract, calcification in the basal ganglia and cerebellum in the brain, and papilla edema are the prominent and important complications(33).

While hypocalcemias that improve with treatment up to the first year postoperatively can be considered temporary, after the first year, hypocalcemias that still require exogenous calcium and vitamin D supplementation and that are below the biochemical normal value if supplementation is not performed are considered permanent hypocalcemia(30,34).

There are also studies that accept this period as 6 months(34). Although many medical factors may be responsible for transient hypocalcemia, permanent hypocalcemia is directly related to the surgical technique that causes hypoparathyroidism(35,36). The main determinants in the complication of permanent hypocalcemia after thyroid surgery: It has been emphasized that bilateral central ligation of the inferior thyroid artery is an independent risk factor and that the inferior thyroid artery should be ligated close to the thyroid capsule in order to reduce the risk of hypoparathyroidism (36,37).

In other words; Parathyroid arterial circulation during thyroid resection Ligation of the main body of the vessel should be avoided in order not to deteriorate, and instead, the peripheral branches of the lower thyroid artery should be ligated separately(1). It should always be kept in mind that if two parathyroidal glands are accidentally resected, the risk of temporary or permanent hypocalcemia will obviously increase (36,38,39).

### **Complications involving neurovascular or visceral tissues, which are rarely seen ;**

Damage to the anterolateral wall of the esophagus can sometimes be seen in recurrent thyroid surgery or extensive dissections. If the surgeon has difficulty in finding the recurrent laryngeal nerve in the presence of a changing anatomy,

the possibility of this complication increases. This can be seen in large multinodular goiters. In medical management; It includes direct suturing and total parenteral nutrition (TPN) for 2-3 days. Another complication that can be seen in thyroid and parathyroid surgery is the mobilization of the carotid artery due to an enlarged dissection of the thyroid gland and sloppy retraction may occur due to extravagant lateral retraction, especially in a diseased artery with arteriosclerosis(1).

The cervical sympathetic trunk may be damaged very rarely (1:5,000 cases), especially when dissecting the retroesophageal processes of the thyroid glands[38]. The important cornerstone here is; During the mobilization of the carotid sheath, it is necessary to proceed meticulously with maximum care in protecting the prespinal surface. Damage to the sympathetic trunk leads to a clinical condition called Horner's syndrome(38).

### **Thyroid Storm**

Thyroid storm is a serious thyrotoxic crisis and is a life-threatening complication affecting many systems. Despite all treatment and supportive measures and modern medical advances, the mortality rate is around 8-25%. The critical point in reducing mortality is early diagnosis and initiating aggressive treatment as soon as possible(40). In treatment; The increased adrenergic system is stabilized by beta-blockers.

With the help of thionamide, thyroid hormone synthesis is reduced. Iodine solution is used to reduce the secretion of serum hormone. The transformation of peripheral T4 to T3 is achieved with the help of glucocorticoids, propyl thiouracil, propanolol, and radiocontrast agents. In addition, bile acid sequestrants can be used to reduce the enterohepatic recycling of thyroid hormone(40).

There is an indication of operative approach possibly in cases with Graves' disease because of hyperthyroidism. In such a case, the operation can usually be performed one week after the patient is medicated preoperatively with betablocker, glucocorticoid and iodine support before the surgical treatment(40-42).

Treatment for thyroid storm includes intravenous (IV) fluid replacement, oxygen, attempts to cool the patient, and special measures to treat hyperthyroidism in addition to treatments such as acetaminophen. If deemed necessary in thyroid storm, patients should be kept under cardiac monitoring and followed up in the intensive care unit with respiratory support(42,43).

## Injury to the Lymphatic Structures

The rate of chylous fistula formation after surgery due to injuries in the lymphatic system or ductus thoracicus is around 1-8%(44-46). Approximately 75% of lymph leaks occur on the left side(44-46).

As a result, thyroid and parathyroid surgery requires great care and mastery of anatomy. The necessity of a good pre-operative risk assessment, in which there is an experienced surgical community that has managed to become a team and it is an operation that requires patience. It has a very different place, especially if we consider that some of its complications are irreversible and affect the patient's quality of life for a whole lifetime. For these reasons, as in other surgeries, it is very important that surgeons who have completed the learning curve in the company of experienced surgeons perform this surgery.

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## CHAPTER VIII

# PERIOPERATIVE COMPLICATIONS IN THE LAPAROSCOPIC COLORECTAL SURGERY

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### Introduction

Today, although laparoscopic colorectal surgery is widely preferred due to both oncological etiology and obesity surgery, it brings different risks and complications depending on the underlying surgical requirement. On the other hand, it is of vital importance to take the necessary precautions by considering the laparoscopic colorectal surgery burden due to the risks brought by the patient's co-morbidities before the operation.

Surgical procedures, surgical techniques, and additionally perioperative care have made tremendous advances in the last few decades. Especially in terms of oncological outcomes, the laparoscopic approach has now been accepted as the standard treatment in almost all colorectal diseases, due to its improved short-term postoperative results with no harmful effects when oncological principles are complied with classically open surgery and laparoscopic surgery (1,2).

The prominent advantages of laparoscopic surgery are seeing the area from a wider perspective, less intraoperative bleeding, much less tissue trauma, and naturally associated with a lower inflammatory response (3). Despite all these outstanding strengths of laparoscopic surgery, the laparoscopic approach for colorectal resections has not been able to achieve a significant reduction in the incidence of anastomotic leakage to date. Most meta-analyses in recent studies have declared rates similar to open surgery (4). Since there are certain spatial adhesions of the colon to the abdomen or other organs in the retroperitoneum

in laparoscopic subtotal and total colectomy surgery, it is very important to advance the surgery in the right plan. In addition, as in open surgery, fully knowledge control of the anatomical structure of the colon blood supply is very critical for a safe resection. Segmental dissection sequence is listed as cecum, ascending colon, hepatic flexure, transverse colon, splenic flexure, descending colon, sigmoid colon, and in necessary cases, rectum, as in open surgery. Even if these principles are followed, different complications may occur(5).

Laparoscopic surgery complication rates reported in the literature are not different from open surgery. Reported complication rates are between 1% and 36%(6)

In the literature, it has been determined that complications occurring during abdominal insertion do not exceed 1%(7,8).

Approximately 76% of injuries during abdominal insertion occur due to intestinal and retroperitoneal vascular injuries. Small bowel injuries take the first place with a rate of 25%. Then, iliac artery 19%, colon 12%, retroperitoneal vein 9%, mesenteric vein branches 7%, aorta 6%, inferior vena cava 4%, abdominal wall vessels 4%, bladder 3% and liver 2% too have being determined with injury. On the other hand, the association of open access techniques (such as Hasson) with fewer complications has not been proven[9]In the literature, it has been stated that the injuries that result in the most death are aorta and inferior vena cava injuries. It has been observed that approximately 50% of bowel injuries are noticed after at least 24 hours(10).

### **The main perioperative complications can be listed as follows;**

Anastomotic leaks

Postoperative bleeding

Peritonitis

Small bowel obstruction and ileus

Internal hernia

Iatrogenic bowel injury, iatrogenic ureteral injury,

Wound discharge , incisional hernias(5,11,12).

Anastomotic leaks in anastomoses due to colorectal surgery may be due to many factors. It is known that colorectal leak rates vary according to the anatomical location of the anastomosis, and in the literature, the leak rates of distal colorectal, coloanal and ileoanal anastomoses vary between 1% and 20%. On the other side

colonocolonic leak rates are between 0% and 2%, and it has been reported to between 0.02% ileocolonic leak rates and 4% (13-16). Postoperative fever, prolonged ileus, leukocytosis, abdominal pain are important findings suggesting postoperative anastomotic leakage.

In diagnostic imaging; Direct x-rays and CT examinations of the abdomen and pelvis are applied with the use of water-soluble contrast material. A localized abscess related to anastomosis leak has a chance to close spontaneously with discontinuation of oral intake, bowel rest, antibiotic therapy, percutaneous drainage, and total parenteral nutrition. However, if the clinical course progresses after strict medical monitoring and observation, the patient should be taken to the operation without delay and the necessary surgical procedure should be performed(5).

In today, complications of laparoscopic bariatric surgery including especially small bowel bypass operations should not be overlooked too. Briefly, complications requiring emergency surgery in laparoscopic R N Y gastric bypass, which is one of the bariatric surgical procedures, can be counted as small bowel obstruction, early postoperative vomiting and early postoperative hematemesis(17).

In terms of the intraoperative bleeding; Whether open or closed; Completing the learning curve is very important in all surgical operations. In laparoscopic colorectal surgery, there will be blood loss as in open colorectal surgery, but this complication is less in laparoscopic colorectal surgery in the same normal conditions(18). On the other hand; The reasons for switching from laparoscopic surgery to open surgery is bleeding from a large vessel during dissection (19) This complication of laparoscopic colorectal surgery can be a dangerous process leading to mortality as a result of unprepared or late intervention.

Peritonitis after laparoscopic surgery can result in mortality, which is the most undesirable situation in minimally invasive surgery. Peritonitis due to laparoscopic surgery can only be eliminated by a highly experienced medical team, with the perfect technical approach possible(12).

Incisional hernias are less common in laparoscopic surgery than in open abdominal surgery(20). However, as in all laparoscopic surgical procedures, it is important to control and repair the fascial openings at the port insertion at the end of the operation.

Laura A Graham et al. in their study on wound complications after colorectal resection; Among the factors they found, they stated that laparoscopic colorectal surgery was more prominent than open colorectal surgery(21).

For small bowel obstructions and ileus; Gradual increase in intra-abdominal distension, the patient's problems with gas and stool removal, nausea, vomiting, oral intake intolerance, and in addition to all these, the addition of abdominal pain, first increase in bowel movements in the proximal part of the obstruction, then decrease in bowel motility, air-fluid level in standing direct abdominal X-ray. are important indicators(5).

In this case, a strict medical follow-up and treatment process is required in order to stop the patient's oral intake, insert a nasogastric tube, provide intravenous fluid replacement and nutritional support if necessary. In case of mechanical bowel obstruction , the addition of the paralytic ileus should be prevented with good medical follow-up and treatment. On the other hand, if necessary, the port entrances for laparoscopic surgery should be checked with whole abdominal ultrasound or abdominal tomography. If the clinical process progresses to peritonitis and leukocytosis despite medical follow-up and treatment, a rapid surgical process should be initiated, including skilfully separate adhesions, including bowel resection with necrosis due to obstruction(5). Although internal hernias is seldom, unfortunately they are related with mortal complications , in colorectal surgery(22) .

For this reason, after performing laparoscopic colorectal surgery, the surgeon should definitely check the mesenteric places where there may be internal herniation and repair the openings he sees with suturing.

in general, urethral injury is more common in laparoscopic colorectal surgery than in open surgery (23,24) .

Kirchhoff P et al. defined anastomosis problems, intestinal and urethral injuries as more advanced problems in laparoscopic colorectal surgery and stated that surgical procedures are needed[25].Ureteral injuries is encountered in almost 2% of pelvic surgeries[26]. Ureteral injuries usually occur in almost 2% of pelvic surgeries. It may occur during pelvic dissection or the cauterization close to the ureter[27,28]. Bladder injury too may occur during pelvic region surgeries such as lower anterior resection and its incidence is less than 0.5%(29).

When we look at bowel injuries in laparoscopic surgery, approximately 1/3 of them occur during trocar insertion. The remaining 2/3 occur during inappropriate use of electrocautery, dissection or manipulation of tissue(30).

In addition, gas embolism may occur in laparoscopic colorectal surgical procedures, as in other laparoscopic surgical procedures. Complications related to patient position may also develop. A good example of this is; Venous accumulation in the inverted Trelendenburg position and Hypotension may develop due to decreased venous return to the heart.Although gas embolism

is clinically rare; laparoscopic by transesophageal echocardiography performed during surgery It has been shown that subclinical gas embolism develops between 17 and 100% (31,32,33).

Gas embolism may occur after direct venous injection of carbon dioxide or venous injury during abdominal insufflation with a Veress needle. Sudden hypotension, hypoxemia, arrhythmia, and a decrease in end-tidal carbon dioxide pressure should alert us to gas embolism.In such a situation, intra-abdominal pressure should be reduced rapidly, left lateral decubitus (Durant maneuver) and Trendelenburg position should be given to the patient, and hyperventilation should be performed(26).

### **In preventing complications that may occur in laparoscopic colorectal surgery;**

The surgeon should be able to exploration with a successful intra-abdominal visualization and the area to be operated should be clearly revealed.

To avoid injury of the intestine and vascular injury during lymph node dissection; Careful cutting and ligation of the vascular pedicle and must be carefully in dissection and bowel mobilization, while cutting and traction .

Additionally the proper placement and firing of the stapler in transection and anastomosis, the use of tissue-appropriate laparoscopic staplers are cater for the minimization of complicating risks such as anastomotic leaks or bleeding(11).

Knowing the contraindications in laparoscopic colorectal surgery and choosing the patient by knowing them will also minimize the possibility of complications.

### **Contraindications in laparoscopic colorectal surgery(34);**

#### **&Absolute contraindications**

##### **Patient related**

- Portal hypertension
- Coagulopathy
- Pregnancy
- Major cardiac diseases

##### **Tumor related**

- Adjacent organ involvement (T4 tumor)
- Acute complications (Obstruction, perforation, etc.)
- Severe pulmonary disease

## &Relative contraindications

### Patient related

Morbid obesity  
Dense adhesions  
Previous multiple abdominal surgeries

### Tumor related

Large mass (greater than 8–10 cm)  
Primary tumor with resectable liver metastases  
Transverse colon tumor  
Carcinomatosis peritonei

Briefly; Respect for tissue, master the intraabdominal anatomy, an experienced and compatible surgical team in laparoscopic colorectal surgery are important cornerstones.

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## CHAPTER IX

# COMPLICATIONS IN BARIATRIC SURGERY

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### Introduction

**O**besity is a health problem that threatens public health and increases rapidly, especially in the young population. In short, it is a disease characterized by abnormal fat storage in body areas. A large number of parameters are used to measure and classify the degree of obesity. The most commonly used measure in the definition of obesity is body mass index. If people have a body mass index of 30 Kg/m<sup>2</sup> and above, they are considered obese. Morbid obesity is considered to be a body mass index of 40 kg / m<sup>2</sup> and above. Depending on the concomitant diseases seen with obesity, it creates problems both sociologically and economically, both personally and socially. Concomitant diseases associated with obesity, especially type 2 diabetes mellitus, cardiovascular system diseases, hypertension, lipid metabolism disorders, sleep apnea syndrome, gallstones, steatohepatitis, osteoarthritis, gastroesophageal reflux, infertility, psychiatric problems and urinary incontinence are included (1,2). Obesity is also known to be linked to some types of cancer. Morbid obesity is known to reduce life expectancy by up to 15 years. Since it is a preventable disease, it is tried to be prevented especially with endocrinology, diet and exercise treatments. In the treatment of obesity, medications, healthy nutrition programs, psychological support programs and exercise programs cannot provide adequate treatment, especially for the long term (2,3). Today, the most effective and permanent method in the treatment of Morbid Obesity is surgery. Along with weight efficiency, it also leads to improvement in concomitant diseases and increases the quality of life and life expectancy of

patients. With the satisfactory results of bariatric surgery and the development of advanced laparoscopic techniques, more than 50 surgical procedures have been developed. The increase in the number of surgeries is accompanied by an increase in surgical complications. Preventing and treating complications has also gained a special importance, and advances in this regard have minimized patient losses (4-6).

The most commonly used surgical methods today are: laparoscopic sleeve gastrectomy, laparoscopic roux-en-y gastric bypass laparoscopic adjustable gastric band, laparoscopic OAGB, laparoscopic SASI bypass, biliopancreatic diversion, laparoscopic bipartition, laparoscopic gastric plication operations. We can classify obesity surgery complications as perop complications, early stage complications, late complications and surgical procedure-specific complications. Most complications are common to bariatric surgical techniques. Diagnosis and treatment processes also show similarities.

Although these surgical methods have their own complications, the complications of obesity surgery in general are as follows.

## Complications After Bariatric Surgery

### A-Early Complications

- Hemorrhage
- Anastomosis or stapler line leaks
- Pulmonary embolism
- Portomesenteric thrombosis, spleen infarction
- Remnant stomach rotation
- Dumping syndrome
- Persistent Nausea vomiting
- Organ injuries

### B-Late Complications

- Nausea and vomiting
- Metabolic disorders
- Gallstones
- Ileus
- Internal hernia
- Anastomosis stricture
- Marginal Ulcer
- Osteoporosis
- Trocar hernias

### C-Surgery-Specific Complications

- Slippage: Adjustable gastric band
- Gastric obstruction: Adjustable gastric band and sleeve gastrectomy
- Band migration Adjustable gastric band
- Stapler Line Leaks: Sleeve Gastrectomy
- Gastric Stenosis: Sleeve Gastrectomy, Gastric Plication
- Sialore: Gastric plication
- Perforation: Gastric plication
- Hypoproteinemia, anemia, neurological problems: Biliopancreatic diversion and duodenal switch

## 2- Obesity Surgery Complications in General

### *2.1- Complications that may occur during surgery :*

These are common complications seen in laparoscopic procedures. Bowel and vascular injuries due to trocar ingress, solid organ injuries, bleeding

## **2.2. Early complications:**

### **2.2.a Bleeding:**

Although it is most likely seen in the stapler line, it can also be seen in the dissection area. Although it depends on the surgical method used, it is seen in 1%-6%. Bleeding may be into the stomach or into the abdominal cavity. To reduce bleeding, stapler line stitches or hemostatic agents that are thought to reduce bleeding are used. Bleeding is detected by vital function and hemoglobin monitoring, drain follow-up and, if necessary, endoscopic methods. First of all, supportive treatment and endoscopic methods are performed. In cases where endoscopic and supportive treatment cannot be achieved, surgical methods should be used. Mortality due to bleeding in obesity surgery after serious follow-up and treatment is negligible (7,8).

### **2.2.b Pulmonary Embolism:**

It is a complication that leads to mortality that can be seen during and immediately after surgery. Pulmonary embolism is seen in 0.7% of the obese population. This rate is already 2 times higher than the normal population. Prophylactic use of low molecular weight heparins, which do not increase surgical bleeding, prevents the development of pulmonary embolism in morbidly obese patients. Embolism socks and early mobilization are effective in pulmonary embolism prophylaxis. Despite all these precautions, pulmonary embolism may develop in bariatric surgery and sometimes fetal course (8-12).

### **2.2.c Nausea-Vomiting:**

The frequency varies according to the surgical procedure performed. It is most commonly seen in methods that reduce food intake. Adjustable gastric band, sleeve gastrectomy, gastric plication are the most commonly used of these methods. Apart from these methods, nausea and vomiting may be a symptom of bowel obstruction in disruptive surgeries (8,9,13).

### **2.2.d Anastomosis or stapler line leaks :**

It is one of the most feared complications of bariatric surgery. It cannot be detected and may cause mortality if treatment is delayed. The risk of leakage is associated with high body mass index, advanced age, male gender, type 2 DM with obesity, hypertension and respiratory problems. Fugitives can be even on the first postoperative day and are called acute leaks. They appear on the

same day as there is a hematoma or ischemia in the stapler or anastomosis line. Early leaks are leaks that occur between 1-6 days. In early leaks, it may develop as a result of anastomosis or bleeding in the stapler line, ischemia, infection. Late leaks are leaks that are seen up to 12 weeks. Chronic leaks are leaks that last more than 12 weeks. Although the leakage rates vary according to surgical techniques, they are seen between 1-6%. The most important clinical signs of anastomosis or stapler line leaks are abdominal pain, signs of peritonitis, fever and tachycardia. Abdominal CT with oral contrast and scopy are important in diagnosis. Delays in diagnosis turn into a picture that leads to abdominal sepsis and multiple organ failure. The treatment approach is made according to the flow rate of anastomosis or stapler line leaks, the presence of peritonitis, sepsis. Each patient should be given a special treatment approach. As a basic rule, chronic leaks are treated surgically. Conservative and endoscopic stent treatments can be tried in controlled leaks that do not threaten the patient's life. Surgical treatment should be performed in sepsis and general condition disorder that threatens the life of the patient (13-15).

#### ***2.2.e: Dumping Syndrome:***

It is one of the complications of obesity surgery. It occurs due to the rapid passage of food into the small intestine after food intake. Foods with high osmolarity that enter the intestinal lumen quickly lead to fluid withdrawal into the intestine. With the triggering of the release of gastrointestinal hormones, various metabolic problems arise. Gastrointestinal and vasomotor symptoms appear. Early dumping syndrome is called early dumping syndrome if it happens within the first hour of food intake, and late dumping syndrome if it happens within one to three hours. Here, as a result of the formation of a hyperinsulinemic response, attacks of hypoglycemia occur. Dietary adjustments, continuous nutrition, various medications, and changes or conversion surgeries in the surgical procedure are used in treatment (16-18).

#### ***2.2.f: Portal And Mesenteric Vein Thrombosis:***

These complications, which can also be seen in morbid obesity surgery, are rare complications seen in intra-abdominal surgical operations. In particular, mesenteric vein thrombus can lead to delays in diagnosis. After diagnosis, antiembolism treatment, interventional radiological methods are the first choice in treatment (19,20).

**2.3- Late Stage Complications:****2.3.a: Nutritional Problems:**

Although it is more common in disruptive surgical methods, vitamin, mineral, protein, trace element deficiencies are seen in morbid obesity surgery. Among these surgical methods, the most malabsorption is biliopancreatic diversion, roux-en-y gastric bypass and other absorption disrupting methods. The most deficient vitamins and elements are vitamin B12, iron, vitamin D deficiency, folic acid, vitamin A, vitamin E, vitamin K. Patients undergoing bariatric surgery should be followed up for life. According to the surgical method, follow-up periods can be determined. Iron deficiency is seen in 45-55% of dysraptic surgical methods. Protein malnutrition is most commonly seen in biliopancreatic diversion operations. In other disruptive surgeries, the average protein malnutrition is seen at 5-21% rates. Patients should be given regular controls and nutritional support treatments (21-23)

**2.3.b: Gallstones:**

Their frequency increases with rapid weight loss. This rate is higher in disruptive surgical methods. Gallstone formation can be seen in 40% of the first year after biliopancreatic diversion operations. After sleeve gastrectomy and adjustable gastric band operations, it is seen in 22%-30% rates. For surgeons, the treatment of gallstones confined to the gallbladder does not cause problems. Cholecystectomy can be performed easily. If there is a formation of gallstones or primary bile stones that have fallen into the biliary tract, there are difficulties in treatment because ERCP cannot be performed. Pharmacological agents containing ursodeoxycholic acid, pancreas and bile enzymes are successful in preventing the formation of gallstones. There are centers that recommend prophylactic cholecystectomy in methods such as biliopancreatic diversion, Rox-en-y gastric bypass (8,24.25)

**2.3.c: Anastomotic Ulcer:**

It can be seen in all bariatric surgery methods including gastroenterostomy. It can be seen even in the first 6 weeks. there is a 16% incidence in the first 12 months. The most important risk factors include smoking, alcohol use, the use of anti-inflammatory drugs, helicobacter pylori infection. Medical treatments are used in the treatment of anastomotic ulcer, surgical treatment is applied in the formation of bleeding, perforation and anastomotic stenosis (9,26,27).

**2.3.d: Anastomosis Stenosis:**

It can be seen in 3-21% of all bariatric surgery methods including gastroenterostomy. Clinical manifestations in the form of nausea-vomiting, difficulty in swallowing appear. The first choice of treatment is endoscopic balloon or spark plug dilatation. A stent can be placed endoscopically. If there is no response to endoscopic treatment, surgical treatment is considered (8,9,28,29).

**2.3.e: Bowel Obstructions:**

The frequency of patients undergoing bariatric surgery is between 0.5-7.5%. En important causes are internal herniation and abdominal wall hernias. Even hernias of the place of the trocar can be the cause. Internal herniation is the most important cause in patients undergoing bariatric surgery and accounts for about half of small bowel obstructions. Even internal herniation CT can be missed in 60-70% of cases and is difficult to diagnose. It is especially common after biliopancreatic diversion and gastric bypass surgery. If the blockage concerns the feeding leg or the common canal, nausea-vomiting and burning in the chest occur. If it concerns the biliopancreatic leg, distension develops in the remnant stomach and biliopancreatic leg. If the joint duct involves obstruction, a symptom of bile vomiting appears. (8). The location of the obstruction determines the treatment option and conservative and surgical treatment options are considered according to the patient's condition. In surgical treatment, laparoscopic intervention can be performed according to the experience of the surgeon. The most important condition that should not be missed is the development of remnant gastric distention and necrosis due to congestion, and this is a very urgent situation (30-32)

**2.3.f: Gastroesophageal Reflux:**

Gastroscopy should be performed before bariatric surgery and appropriate surgical method should be selected for patients with reflux. The hiatal hernia detected before bariatric surgery should be corrected. Gastroesophageal reflux can be seen in 12% of cases due to deterioration of the feeling angle after sleeve gastrectomy. This usually occurs within the first year. In the adjustable gastric band, reflux complaints are reduced at first, but can be seen up to 22% later. Gastric bypass operation is preferred as the first choice in patients with gastroesophageal reflux before surgery. The first option is conservative treatment. In cases where

there is no response to conservative treatment, the best revision surgery option is gastric bypass, especially after sleeve gastrectomy (34,35).

### **3. Complications According to the Surgical Method**

#### ***3.1. Specific Complications After Laparoscopic Sleeve Gastrectomy:***

##### ***3.1.a Stapler Line Leakage And Fistulas:***

Laparoscopic sleeve gastrectomy is one of the most widely used bariatric surgical methods today. The operation is performed laparoscopically and is the vertical removal of part of the antrum, corpus and fundus under the guidance of a spark plug placed in the stomach. Generally, intragastric spark plugs are used in the range of 32-46 F. The most important complication after laparoscopic sleeve gastrectomy is stapler line leaks seen in 1.5-2.4% of cases. In some case series, this rate can be up to 7%. Leakage and fistula rates increase in returns to sleeve gastrectomy from other restrictive methods. Stapler line leaks are most commonly seen at the esophagogastric junction level. For this reason, resection is recommended without completely disturbing the feeling angle. The leaks are usually from the junctions between two consecutive staples. It is classified as acute, late, too late, chronic. Approximately 20% of stapler line leakage and fistulas occur in a bariatric surgery center before the patient is discharged. In such cases, early treatment is a chance. Early discharge of patients ensures that acute leaks can be seen in other centers. Late, very late and chronic leaks are more common than acute leaks. 80% of Stapler line leaks occur in this way (37,38). Postopertaf appears in the range of 3-14 days. Clinically, pain in the left shoulder, fluid collection in the left pleura, abdominal pain, fever, tachycardia, respiratory distress, diffuse peritonitis findings are present. Flat abdominal X-ray with contrasis accompanied by scopy can be used as a simple method, accompanied by hemogram and biochemical parameters support the diagnosis. Today, the most important diagnostic method is abdominal and thoracic CT . Here we can accurately diagnose both leakage and lung problems. The first thing to do is to urgently operate patients with persistent symptoms whose hemodynamics have begun to deteriorate. The abdomen is cleaned, washed, numerous drains are placed. If there is sufficient experience, it can also be performed laparoscopically. It is necessary not to be too stubborn for fistula tract repair. In order to eliminate abdominal contamination and peritonitis, it is necessary to interrupt oral food intake, start appropriate antibiotics and perform parenteral nutrition. Endoscopic stent application and percutaneous drainage

methods can be applied in leaks that do not disrupt the hemodynamics of the controlled patient (37,38).

### ***3.1.b. Stenosis after sleeve gastrectomy:***

The most important reason is not to use an intragastric spark plug when performing sleeve gastrectomy operation and to perform it over a very narrowly calibrated tube when the spark plug is used. In some centers, sutures for support or hemostasis are the most important reasons for the stapler line. It develops in the middle part of the stomach and is seen in as much as 4% of some case series. In patients with stenosis, persistent vomiting and food intolerance and dehydration are observed. After liquid electrolyte therapy, endoscopic dilatation is applied to patients. The majority of patients are relieved after 3-4 repetitive dilations and return to their normal lives. If dilation fails in patients with stenosis, vertical seromyotomy is performed laparoscopically or gastric bypass may be required under elective conditions (37,38).

### ***3.2. Specific Complications After Laparoscopic Adjustable Gastric Band:***

It continues to be one of the most widely applied surgical methods in the world. It includes a port that adjusts the width of the gastric band placed under the skin and an adjustable silicone band that is placed around the stomach fundus. The method is applied laparoscopically. It provides weight loss by restricting the passage of food to the stomach. The most important complication of adjustable gastric band is the belt slippage. It is the most common complication that requires surgery. It is seen between 1% and 20% in case series. (39,40) According to the pouch formed on the band, front, back and symmetrical pouch dilatation occurs. They have symptoms such as vomiting, nausea, painful swallowing, burning sensation in the esophagus. General condition disorders due to dehydration, cardiovascular problems may occur. Biochemical parameters and blood profile give important clues. The condition of the enlarged pouch and band can be seen with abdominal X-ray with oral contrast. First, the fluid inside the gastric band is drained from the subcutaneous port. Stomach acid is suppressed, pharmacological agents are used for nausea-vomiting. The patient is treated with liquid electrolytes and nutrition. If possible, a nasogastric tube is inserted. If the symptoms and complaints do not regress, surgical intervention can be performed within 3 days. The important thing is to be able to intervene before stomach necrosis and perforation occur. If gastric necrosis is detected,

laparoscopic treatment is most appropriate if there is no open surgery. The band is removed, if necessary, resection is performed (39,40).

### ***3.2.a. Gastric Obstruction:***

In patients who have undergone adjustable gastric band, obstruction may occur in patients who are difficult to digest, swallowed quickly and in large bites. It manifests itself in pain and vomiting. It can be removed endoscopically. Here, too, the fluid in the gastric band is drawn from the subcutaneous port and the passage is expanded (39,40).

### ***3.2.b. Complicated Intragastric Band Migration:***

Band migration into the stomach is a complication that can be seen in 4% of adjustable gastric band applications. Intra-abdominal infections are detected and subcutaneous port infections can be seen as the first symptom. Chronic intra-abdominal and port site infections and related symptoms occur. Abdominal pain, vomiting, back pain, digestive system bleeding and even melena can be one of the symptoms. Nutritional habits, tight placement of the band, excessive swelling of the band are the most important reasons. For all these reasons, the gastric band slides into the stomach by eroding the stomach wall. This causes bleeding and ongoing infections. The diagnosis is made by endoscopy and radiological methods. The band must be removed definitively. It can be removed by endoscopic methods in experienced centers. It can also be removed using laparoscopic and open surgical methods (39,40).

### ***3.3. Specific complications after laparoscopic gastric plication:***

Although it is a method that has increased in popularity in recent years, it does not have large case series like other methods. The method is performed laparoscopically. The great curvature is liberated and the fundus and corpus are narrowed by sutures towards the gastric lumen. Complications are reported as 15% in case series. 5% of these patients are re-operated. Bleeding from the suture line to the abdomen or lumen line, necrosis and perforation in the suture line are serious complications. More of these complications are obstruction, nausea-vomiting and sialore (41,42). In complications of gastric plication, primarily liquid electrolytes and stomach acid removers, motility regulators are used. With these methods, nausea, sialore and vomiting can be prevented. These are mostly due to prolapse in the stomach layers, fluid accumulation in the edema and plication area. In stubborn obstructions, the area with endoscopically obstruction is dilated. After unsuccessful endoscopic dilatation, laparoscopic

surgery is the choice. In laparoscopy, obstruction is opened by removing suture materials in the area where obstruction develops. In gastric plication, necrosis and perforation of the suture line may also develop. Leaks may occur in this case series as 1.6%. According to the resulting table, surgical treatment is applied. Treatment of peritonitis and sepsis may require open or laparoscopic surgical intervention (41,42).

### ***3.4. Specific Acute Complications That May Occur After Gastric Bypass***

Gastric bypass is performed in the form of Roux-en-Y gastrojejunostomy with a small gastric pouch and in the form of a single anastomosis gastrojejunostomy with a sleeve gastrectomy of 15-20 cm length, called mini gastric bypass. Roux-en-y gastric bypass is the most preferred surgical method that has proven itself among surgical procedures. In both roux-en-y and mini gastric bypass methods, anastomotic leakages and complicated marginal ulcers are complications. In the mini gastric bypass method, enterogastric reflux is seen since there is no deflective y anastomosis (14,15,43).

#### ***3.4.a Anastomosis Leakage:***

If there are signs of sepsis and peritonitis that disrupt the hemodynamics of the patient, surgical treatment is performed. It can be seen up to 6% in case series. In the early period, they appear as subacute, chronic. Oral contrast contrast passage X-ray, abdominal CT, biochemical and hematological parameters are evaluated in the diagnosis. Endoscopic stent, liquid electrolyte and parenteral nutrition methods are applied in controlled leaks and fistulas.

Emergency surgical treatment should be considered in hemodynamically unstable patients with severe and persistent symptoms. The inside of the abdomen should be intensively washed and a large number of drains should be placed. If experience is sufficient, laparoscopic intervention is the best option. Final surgical treatment should be performed in the referred bariatric center (14,15,43).

#### ***3.4.b. Enterogastric reflux:***

It is one of the complications of mini gastric bypass. Vomiting with bile, gastoesophageal bile reflux, dyspeptic complaints occur. The diagnosis is made by endoscopy. Motivity regulators, ursodeoxycholic acid are used in the treatment. In treatment-resistant cases, revision surgery is performed laparoscopically. It is converted to roux-en-y bypass (43,44).

### ***3.4.c. Complicated Anastomosis Ulcer***

It is an ulcer formed at the junction point of gastrojejunal anastomosis in gastric bypass operations performed in the form of gastrojejunostomy. Up to 16% incidence is indicated in case series. Half of the ulcers are located in the anastomosis line and 40% in the jejunum. Smoking is the only independent risk factor. Many risk factors such as the patient's age, gender, surgical technique, suture material used, ischemic heart disease, type 2 DM are effective. Clinical symptoms are seen as pain in a maximum of 63%. 24% bleeding and 1% perforation (26.43).

### ***3.5. Specific acute complications after biliopancreatic diversion and duodenal switch***

Biliopancreatic diversion is the most effective procedure in bariatric surgery. The types of complications are similar to other surgical procedures, but in this surgical method, conditions such as protein malnutrition, anemia, neurological problems, liver failure may occur additionally (44).

## **Results**

Bariatric surgery continues to develop with the addition of laparoscopic techniques. New techniques are developing and complications are gradually decreasing. The most important problem is to diagnose complications early and to intervene in a timely manner. The pulmonary and cardiovascular capacity of a morbidly obese patient is already reduced. Especially if type 2 DM, hypertension and pulmonary comorbidities are added to the obesity situation, surgical complications will lead the patient to problems that are difficult to treat in a short time. With the increase in the reliability of the devices and instruments used in laparoscopy, patients are discharged within 24-48 hours after surgery in most centers. As a result, some early complications arise outside of centers where bariatric surgery is performed. For this reason, whether or not they perform bariatric surgery, surgeons have the obligation to recognize the complications that may occur in bariatric surgery.

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## CHAPTER X

# COMPLICATIONS IN BREAST SURGERY

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### 1. Introduction

Considering both medical and cosmetic reasons, breast operations are one of the most frequently performed surgical procedures. Complications related to breast surgery are not generally associated with high mortality, since it is located outside the major body cavities and does not assume any vital function. In addition to nonspecific complications such as wound infection, seroma, hematoma, which can be seen in almost any surgical intervention, specific complications related to breast reconstruction and axillary surgery, should be evaluated separately. Again, it should not be forgotten that complications related to complementary interventions such as brachytherapy or radiotherapy applied simultaneously with or after cancer surgery are closely related to surgical complications.

### 2. Nonspecific Complications

#### 2.1. Wound Infection

Breast surgeries are known as clean surgical procedures. When optimal sterilization measures are taken before and during such operations, the rate of wound infection is expected to be approximately 1-2% (1). There are studies reporting wound infections at rates of up to 20% after breast surgery, depending on patient-related features such as age, comorbidity, drug abuse, and immunosuppression, as well as other factors such as operation time, surgical technique, and use of drains(2). Staphylococci are one of the most common skin flora microorganisms in wound infections(2, 3). According to the literature, the infectious agent is gram positive cocci such as staphylococcus aureus

and staphylococcus epidermidis with a rate of 60%. However, streptococci, enterococci, pseudomonas and anaerobes are other agents that can be isolated(4). Although breast surgeries are considered clean surgery, there are authors who state that a single dose of cephalosporin injection 30 minutes before the procedure reduces infection rates by up to 40% (3, 5). Platt et al. observed that although the prophylaxis group was at high risk, significantly less wound infection developed compared to the other group(3). In another phase 3 study involving 118 breast cancer patients, it was concluded that prophylactic antibiotics did not provide a significant reduction in wound infections(5). According to a meta-analysis of 5 different studies, it can be concluded that prophylactic antibiotics reduce wound infections in breast surgery with an average relative risk of 0.6 (95% CI) (6). Therefore, prophylactic antibiotic use is recommended especially in risky patients and breast surgeries using synthetic prostheses. The rate of sepsis due to wound infection after breast surgery is low when high-risk patients are excluded. However, prolonged wound infections will result in poor cosmetic results and even delayed cancer treatment after surgery. Beta-lactam antibiotics can almost always be used as the first choice in treatment, but should be modified according to the antibiogram result. It should be noted that the sensitivity to lincosamides and macrolides is less (7). A small percentage of wound infections may result in abscess formation; in which case the main treatment should be incisional drainage.

## **2.2. Seroma**

Postoperative lymphatic fluid and plasma accumulation under the skin and dead spaces is called seroma. It is the most common complication after breast surgery. The fact that the breast is rich in lymphatic drainage explains the seroma rate of 85% in some case series (8). Although its etiology has not been fully elucidated, one of the most widely accepted theories is that it develops due to increased fibrinolytic activity in the serum(9). The patient's quality of life may decrease due to stiffness, pain and discomfort, but most importantly, it may cause delay in cancer treatment after surgery. For this reason, from past to present, the search continues in order to reduce the formation of seroma. In the literature, there are articles showing advanced age, additional diseases, previous surgery, breast size and drug use as risk factors for seroma formation(10, 11). In their randomized controlled study in 2021, Unger et al. suggested that high body mass index, diabetes, high American Society of Anesthesiologists score and short surgical time increase seroma formation(12).

The positive relationship between the width of the surgical dissection and seroma formation, which we observe in our daily practice, has been proven by many studies(13, 14). All innovations in breast surgery are advancing in favor of the concept of less dissection. Radical mastectomy was followed by modified radical mastectomy, and now the breast-conserving approach has been standardized in cancer surgery. Again, according to the results of sentinel lymph node biopsy, axillary lymph node dissection is no longer performed in patients who meet certain criteria (ACOSOG Z0011 & SINODAR ONE), and studies like INSEMA are continuing to completely abandon sentinel lymph node biopsy(15). There are many authors recommending flap fixation to reduce dead space(16). The use of drains is a subject that has been used for years, but there are contradictions in the literature about its usefulness. There is even evidence in some articles that the duration of the drain itself increases seroma formation(17, 18). Seroma formation that does not cause pain and discomfort and does not limit arm and shoulder movements is not required to be drained because serious complications such as delay of adjuvant therapy or sequelae may develop in case of infection.

### **2.3. Hematoma**

Hematoma is seen with a frequency of 2-10% after breast surgery. Insufficient surgical hemostasis can be considered as the main cause of hematoma, except for prolonged bleeding diathesis of the patient. It is important to avoid anti-platelet drugs in the preoperative period. It should also be recommended to discontinue herbal products such as Ginkgo extract, which are known to increase the tendency to bleeding. The significant decrease in hematoma rates with the use of electrocautery and other energy devices shows the importance of hemostasis. At the same time, closing the lumpectomy space with dissolvable suture material will help to reduce both seroma formation and hematoma formation(19). Postoperative measures are also important in reducing hematoma formation. There are studies pointing out that the postoperative use of ketorolac and similar anti-inflammatory drugs increases the risk of hematoma(20). Especially in sagging breasts, the use of postoperative supportive bras should be recommended against the possibility of avulsion in the veins due to the effect of gravity. Small-volume hematomas may resorb without causing any adverse condition other than ecchymosis, but large-volume hematomas that develop suddenly should be drained because of the possibility of infection and tension-related pain.

## **2.4. Fat Necrosis**

Fat necrosis and fat cysts, which can be seen after biopsy, lipofilling and trauma, are seen at rates of up to 10% after breast reduction surgeries. Development of necrosis in adipocytes due to insufficient blood supply of adipose tissue appears as lesions that can mimic malignancy radiologically. There are studies reporting 4-25% fat necrosis, especially in patients receiving adjuvant therapy after surgery(21). While small lesions can be expected to resorb, surgical excision or liposuction may be considered for lesions that cause discomfort and pain to the patient.

## **2.5. Venous Thromboembolism**

Breast surgeries, excluding reconstruction, are procedures that take a short time and have relatively less fluid loss. There are studies reporting that the risk of thromboembolism is below 0.2% in cases where systemic prophylaxis is not applied, even if it is due to cancer (22). For this reason, systemic prophylaxis for venous thromboembolism is generally not recommended in order not to increase the risk of bleeding and hematoma. In the presence of different conditions that increase the risk of coagulation, or before long-term operations, the use of low molecular weight heparin and the use of compression devices may be considered.

## **2.6. Chronic Pain**

Chronic pain is a condition that persists for more than 6 weeks after breast surgery and its incidence may increase up to 20% in some series. It is a serious problem that not only reduces the quality of life, but also affects relationships in social life. The degree of pain is sometimes so high that it can cause depression. Brummett et al. argued that this condition is associated with opioid addiction(23). Apart from this, it is thought that the psychosocial structure and the degree of anxiety also play a role in this clinical picture. There are literature studies indicating that younger age and higher body-mass index and inadequate treatment of acute postoperative pain are also risk factors for chronic pain. While the width of the dissection correlates with the degree of postoperative acute pain, its relevance to chronic pain is not entirely clear. Spivey et al. did not find a significant relationship between the type of surgical procedures other than axillary dissection and chronic pain(24). Wilson et al. proved that axillary dissection is associated with severe pain exceeding 6 weeks(25). Gerber et al., on the other hand, emphasized that the incidence of chronic pain was

significantly higher in axillary dissection patients combined with postoperative radiotherapy(26). No correlation could be demonstrated between the high incidence of postoperative chronic pain and sentinel lymph node biopsy. In this case, studies aimed at protecting the patient from aggressive axillary surgery gain more importance. The fact that chronic pain both disrupts daily activities and causes psychosocial destruction necessitates taking some preoperative measures. Determining preoperative therapy and analgesia strategies in individuals at high risk of postoperative chronic pain by evaluating the type of surgery to be performed, physical and hereditary characteristics of the patient, and anxiety levels may form the basis of a preventive strategy. Although many treatment modalities have been tried for chronic pain, as Larsson et al. stated in their review, tricyclic antidepressants, anti-epileptics, topical capsaicin and autologous oil injection are known as 4 modalities with proven effectiveness in the treatment of chronic pain.

### **3. Complications Related to Mastectomy**

#### ***3.1. Skin Flap Necrosis***

Skin flap necrosis is a common complication after mastectomy. Although it is seen between 4% and 7% after simple mastectomy in the literature, there are publications stating that it increases up to 30% after skin sparing or nipple sparing mastectomy, especially in patients who underwent reconstruction in the same session(27). Sometimes it can develop in a very limited area, while sometimes widespread and full-thickness necrosis can be seen. It is thought that one of the most important reasons for this situation is the blood supply defect due to flap length. It is known to occur less frequently in late reconstructions after skin sparing mastectomy and nipple sparing mastectomy(28). According to the skin necrosis grading system (SKIN) described by the Mayo Clinic, the depth of necrosis after mastectomy is scored from A to D, and the area of necrosis is scored from 1 to 4. This scoring system was helpful in identifying necrosis(29). Skin flap neurosis is not an easy condition to manage. Aesthetic problems, infectious problems, loss of prosthesis if used, delay in adjuvant treatment and psychological problems that may be caused by all these should not be ignored. The most important risk factor for the patient is smoking. This is followed by age, diabetes, obesity and other comorbid diseases, scars from previous surgery, radiotherapy and large breasts. Surgical factors include wise pattern incisions, thin flaps, long surgery time, and excessive inflation of tissue expanders, if used.

Preoperative weight loss program, blood glucose control, smoking cessation are recommended to exclude patient-related factors. Again, regression of tumors close to the skin with neoadjuvant therapy will provide an advantage to achieve optimal skin flap thickness. Preferring a smaller implant or not over-inflating the expander in patients who are considered for reconstruction can be considered as other precautions. In high-risk patients, it would be a very wise decision to postpone the reconstruction until after the adjuvant treatment. Conditions related to breast reconstruction will be discussed separately under the heading of “Oncoplastic Breast Surgery Complications”. Evaluating intraoperative flap blood supply and capillary filling with traditional methods may not always yield optimal results, so the use of doppler devices may be considered if possible. Due to its cost, it is a reasonable approach to use indocyanine green dye fluorescent angiography only in high-risk cases and to excise the skin areas with impaired blood supply. Nitroglycerin creams or strips that can be applied to the skin in the postoperative period may help prevent skin flap necrosis(30). Although it is recommended to use a bra after breast surgery, care should be taken not to disturb the blood flow. Depending on the extent and depth of necrosis, a wide variety of methods are needed, from simple wound care to extensive surgical resections. In limited and incomplete thickness cases, follow-up of the patient with serial dressings may be considered to ensure debridement of necrotic tissue and re-epithelialization. In the meantime, antibiotic wound dressings and vacuum dressing systems can be used. Where possible, hyperbaric O<sub>2</sub> therapy may be considered. In advanced cases, revision surgeries including extensive surgical debridement, removal of the implant, autologous graft or flap techniques are on the agenda.

### ***3.2. Positive Surgical Margins and Poor Cosmetics***

With the spread of radiotherapy in cancer treatment, breast-conserving surgery has become the standard approach in appropriate cases. Prevention of organ loss helps in overcoming many psychological problems related to cancer. But at the same time, it is important not to compromise on oncological principles. When oncoplastic surgery techniques are not applied, sufficient volume of tissue cannot be excised, and as a result, the need for re-resection may arise due to positive margins. At the same time, seroma formation may develop in dead spaces that cannot be adequately filled with conventional techniques. Although it is thought that good cosmetic results are obtained in the early postoperative period, destruction may be inevitable after radiotherapy. To

avoid such complications, a certain tumor shrinkage should be achieved in breast-conserving surgery candidates with neoadjuvant chemotherapy. Then, oncoplastic surgery techniques should be applied meticulously.

#### 4. Complications Related to Axillary Surgery

##### 4.1. *Lymphedema*

Lymphedema is a serious complication that causes swelling, pain and loss of mobility in the arm. It can be described as more than 10% increase in arm volume 3 months after the operation. According to Armer, for a diagnosis of lymphedema there must be a volume difference equal to or greater than 2 cm interlimb difference or equal to or greater than 200 ml. (31). The most obvious cause of lymphedema is axillary surgery. Radiotherapy to the axilla is a secondary cause. Warren stated that 31% vs 21.9% lymphedema was observed in patients who received supraclavicular + posterior axillary burst radiotherapy during 2-year postoperative follow-up, compared to those who received radiotherapy only to the chest wall(32). Rockson et al also mentioned risk factors such as chemotherapy, smoking, infection and obesity(33). There are also articles that argue that chemotherapy does not have a significant effect on the development of lymphedema(34). Although lymphedema is seen in 2-8% after sentinel lymph node biopsy, it has been reported that it can be seen up to 25% after axillary lymph node dissection(35). In another study, it was reported that lymphedema, which is seen around 6% in patients with less than 10 lymph node excisions, can increase up to 27% in those who have 10 or more lymph node excisions(36). Schünemann and Willich showed that after modified radical mastectomy, axillary radiotherapy increased the incidence of lymphedema from 19.1% to 28.9%(37). The lower incidence of lymphedema after axillary surgery compared to radiotherapy alone has led many studies such as IBCSG 23-10, AMAROS Z0011 to state that interventions to the axilla should be less invasive. In the prevention of lymphedema, in addition to limited application of axillary surgery, it may be recommended to reduce the risk factors of the patient with lifestyle modifications such as weight loss and smoking cessation. Although it is claimed that the “Lymphatic Microsurgical Preventive Healing Approach” (LYMPHA) technique, which is based on shunting between the lymphatics and the axillary vein, significantly reduces the incidence of lymphedema, its widespread applicability seems difficult. It is argued that visualization and preservation of the lymphatics of the arm with dye applied to the upper extremity (remapping)

is another measure that reduces the incidence of lymphedema. Physical therapy exercises should be initiated to the patient in the postoperative period. It should also be recommended not to lift heavy loads with the affected arm. Not cutting nails too deeply and using protective gloves before risky procedures are other points to be considered. The other arm may be preferred for procedures such as vascular access or blood pressure measurement. Combined decongestive therapy has been defined for the treatment of developing lymphedema. This treatment includes massage, compression therapy, arm-shoulder physiotherapy and breathing exercises. Losing weight will help regression of lymphedema as well as arm and shoulder physiotherapy. Again, anti-inflammatory drugs can contribute to both increased arm mobility and regression of inflammation. More studies appear to be needed for other alternative treatments such as acupuncture and stem cell transplant.

#### **4.2. Paresthesia**

Sensory loss is the most common complication of axillary surgery. After axillary dissection, numbness in the axilla, arm and superolateral of the breast is seen at rates of up to 35%. It is known that this rate is less after sentinel lymph node biopsy(38). In the ALMANAC study, 11% versus 31% less numbness or tingling was noted after sentinel lymph node biopsy compared to axillary dissection(39). It occurs due to damage to the intercostobrachial nerves (ICN). The innervation of these regions belongs to T2. In a randomized study conducted in 2019, it was stated that although preserving the ICNs during axillary surgery did not reduce sensory loss or pain, the quality of life was higher in the nerve preserved group(40). There are also studies where preservation of ICNs contributes to the reduction of hypoesthesia(41), but there is no evidence that it increases pain and arm mobilization. It is a fact that ICNs are often sacrificed due to technical difficulties. Paresthesia is expected to decrease over time, but there is no definitive cure except for some palliative measures.

#### **4.3. Restricted Shoulder Range of Motion**

Restriction in flexion, adduction and medial rotation movements after axillary surgery has been reported up to 50%(42). According to Blomqvist, the rate of loss of strength in the arm can reach 40%. The major factor causing this limitation may develop due to thoracodorsal nerve injury. In addition, winged scapula can be seen in patients due to injury to the long thoracic nerve. It is known that post-surgical radiotherapy can increase weakness due to nerve damage. After axillary dissection, 15% of patients state that they have difficulty in doing their daily

activities(43). As in lymphedema and paresthesia, there are studies showing that the rates of axillary dissection are much higher in patients with arm-shoulder range of motion than sentinel lymph node biopsy(38). An effective physical therapy program should be applied together with breathing exercises in order to eliminate shoulder movement limitation and to regain arm strength. Lotze et al reported that exercises started on the 1st postoperative day cause more wound complications and recommended that these exercises be started on the 7th postoperative day. In the same study, similar range of motion improved in both the early and late physical therapy groups(44)i A successful physical therapy program will restore arm strength and mobility within 6 months.

#### ***4.4. Axillary Web Syndrome***

After axillary surgery, cord-like structures may occur on the same side, starting from the axilla and extending to the arm, which can be felt with palpation and even seen with examination. It was first described in 2001. Moskovitz was of the opinion that this condition may develop due to thrombosis in both lymph and blood vessels(45). It is known that this condition, which occurs in the early period, can continue for more than 12 weeks. An incidence of 6% to 72% is mentioned. Restriction of abduction and flexion of the arm may lead to serious deterioration in quality of life and facilitating effects in the development of lymphedema. Koehler defined low body mass index as a risk factor for axillary web syndrome(46). Although various physiotherapy protocols are recommended today, it is not possible to talk about a treatment algorithm for conditions that last longer than 3 months.

#### ***4.5. Allergic Reaction***

The incidence of allergy to dye or radioisotopes used for sentinel lymph node biopsy is below 1% on average. Mild symptoms manifesting as urticaria and generalized rash cover more than 90% of all allergies. Moderate reactions accompanied by hypotension are around 8-9%, while severe reactions that can cause cardiovascular collapse are only around 1%. In addition, there are publications mentioning that allergy due to methylene blue causes skin necrosis(47, 48). No special intervention is recommended other than the classical treatment approach.

### **5. Rare Complications**

Major vessel injury, thoracic duct injury and pneumothorax may occur, especially during axillary surgery. In addition, brachial plexus damage may occur due to

the patient's malposition on the operating table. Although such complications are very rare, it should not be forgotten that they can cause serious morbidities and sequelae.

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## CHAPTER XI

# COMPLICATIONS RELATED TO ONCOPLASTIC BREAST SURGERY

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### 1. Introduction

**A**ccording to the data of the World Health Organization, with the diagnosis of 2.26 million women in 2020, breast cancer remained the most common type of cancer in the world after non-melanoma skin cancers. Statistics of the same year show that approximately 685,000 people died due to breast cancer, and 7.8 million women who were diagnosed with breast cancer in the last 5 years were still alive, which makes breast cancer the disease with the highest prevalence among other cancer types (1). Overall survival rates (over 90%) are also increasing day by day (2).

The decrease in breast cancer-related deaths with early diagnosis and technological developments has led to more efforts to improve cosmetic results and increase the quality of life. Therefore, instead of focusing only on the oncological results of the surgery, surgeons have preferred to apply oncoplastic breast surgery (OPBS) methods, skin or nipple sparing mastectomy, considering the psychosocial status of the patients (2-8).

The definition of oncoplastic surgery includes the combination of oncological resection with improved aesthetic results (7) (2).

In the published consensus results to establish a universal language for describing OPBS including volume replacement, and volume displacement methods including autologous flap or implant-based reconstruction, the OPBS classification is as follows: Level 1 (up to 20% of the breast tissue removal) and Level 2 (up to 50% of the breast tissue removal) OPBS techniques are used for volume displacement. Furthermore, for Level 2 OPBSs, symmetrization with mastopexy or breast reduction is generally recommended for the contralateral

breast and nipple. If the tumor:breast ratio exceeds 1:2, volume replacement is recommended (2).

Compared to standard breast-conserving surgery (BCS), the surgeon can be more liberal in resection of the tumor and surrounding tissue (7, 9, 10), as the wide reconstruction option is planned from the beginning in OPBS, which explains the less positive surgical margins and reexcision rates (8, 11) and greater patient satisfaction reported in studies (3, 8). As with any surgical technique, complications are a scourge in OPBS. The overall complications of OPBS vary between 15-30% (10).

The most troubling result of the studies is the delay of adjuvant oncological treatments by 1.9-6% due to complications in both BCS and OPBS (9), (12-15).

Variables belonging to the patient that increase the complication rates include age (>50 years), (16-19) presence of comorbidities (like obesity, chronic obstructive pulmonary disease (COPD), hypertension (HT) and diabetes mellitus (DM)), radiotherapy (RT) history of the region, and smoking (16, 19-21).

Complications can be classified as “early and late complications”. Complications of sentinel lymph node biopsy will not be mentioned in this section, these complications are discussed in the section titled “Complications of breast surgery”.

## **2. Early complications**

Early complications are those that occur in a short time postoperatively and affect wound healing, and include “seroma, hematoma, wound infection, wound dehiscence, and necrosis”.

### **2.1. Seroma**

Seroma is one of the most common early complications characterized by serous fluid accumulating in the dead space formed during OPBS or BCS (22) and usually occurs after drains are removed (21).

In addition, seroma may occur in the donor and recipient site in reconstructions with autologous tissues (21, 23) or in implant-based reconstructions (24). In addition, the formation of seroma can cause the implant to change its position or become infected. There are previous studies showing that this situation is more evident in the use of acellular dermal matrix (ADM) (25, 26). It is recommended to drain the fluid by puncture in the presence of symptomatic seroma, to perform a microbiological evaluation of the fluid to

identify the infectious agent in the presence of signs of inflammation, and to wait until it drops below 30 cc/day by placing a drain in cases where the amount is high (21).

In previous studies, it has been determined that there are certain risk factors for the formation of seroma, such as advanced age, high body mass index (BMI), and large size of the removed breast tissue (23).

For persistent seroma in the near postoperative period, waiting for spontaneous resolution may be an option, as well as puncture followed by triamcinolone injection, pressure dressing, seromadesis and/or sclerotherapy (27).

In addition, the presence of persistent seroma after the 1st year postoperatively with pain, breast mass, swelling or asymmetry in implant-based reconstructions should be a warning for physicians and patients about Breast implant-associated anaplastic large celloma (BI-ALCL) (21, 27, 28).

## ***2.2. Hematoma***

Hematoma is a complication of OPBS and BCS that occurs due to accumulation of blood clot in the surgical field due to intraoperative or postoperative bleeding (21). The hematoma, which usually develops in the first 24 hours postoperatively (21), manifests itself with swelling and ecchymosis in the affected area (9). Late-onset hematoma usually develops due to bleeding diathesis, use of anticoagulant/antiaggregant agents, HT, trauma, or excessive movement of the area (21, 23). It can be prevented by being vigilant about the factors that will cause bleeding during the preoperative evaluation and by a detailed and meticulous intraoperative hemostasis (16). Follow-up is very important in terms of hematoma in the postoperative period (16). In the postoperative period, follow-up is very important in terms of hematoma (16) and if hematoma is detected, it should be evacuated at the bedside or operating room, hemostasis should be ensured, and a drain that will provide aspiration of the area should be placed (23).

## ***2.3. Wound infection***

The presence of local infection (especially abscess formation in the breast) adversely affects the cosmetic result. Infection, which manifests itself with the cardinal symptoms and signs of inflammation, can sometimes be accompanied by purulent discharge. Removal of devitalized tissue, drainage of the abscess, and empirical i.v. It is recommended to start antibiotic therapy (23). It is

known that Staphylococci are mostly detected as microbiological agents. Yet, antibioticotherapy should be rearranged according to the culture result. (23, 29).

In the presence of a superficial infection such as a mild cellulitis after implant-based reconstruction, a conservative approach with debridements is recommended instead of removing the implant, while in deeper infections, it is recommended to excise the implant, take a wound culture, irrigate the soft tissue pocket, and provide appropriate drainage; however, capsulotomy should be avoided as much as possible due to the risk of bleeding in the infected tissue. For re-implant-based reconstruction, the infection should pass completely, it is recommended to wait 3-6 months. (30).

It is known that Staphylococci are mostly detected as microbiological agents. Antibioticotherapy should be rearranged according to the culture result (23, 29).

#### **2.4. Wound dehiscence**

Wound dehiscence is mostly due to impaired wound healing because of the frequent and tight suturing and poor perfusion of the skin. Smoking and the presence of comorbid diseases also makes the patient prone to this complication. (16, 31). It is more common in the T junction area, where reduction mammoplasty is used, especially the inferior pedicle. (16, 31). While a conservative approach with topical treatments is recommended in superficial dehiscence, skin grafting can be applied after debridement in cases exceeding 3 weeks, thus delaying adjuvant treatment is prevented (31).

#### **2.5. Necrosis**

Necrosis in circulatory compromised skin or NAC not only affects cosmetic results, but also delays adjuvant treatments.

##### **2.5.1. Skin flap necrosis**

Tension, frequent sutures, radiotherapy history, smoking, presence of hematoma, comorbidities are risk factors for skin necrosis. Improvement can be seen with debridements after limitation with topical antibiotics (23).

Risk factors for skin flap necrosis include the location of the incision, the retractors' position, pressure and duration of the pressure applied, during surgery, the thickness of the skin flaps, and surgical experience (32).

To elaborate on the location of the incision, the risk of skin necrosis increases in reverse T, J or V mammoplasty because it is close to the intramammary fold (IMF) (23).

Skin necrosis in the presence of implants is covered in “Implant based reconstruction” under “Other complications of specific applications”.

### **2.5.2. NAC necrosis**

Currently, nipple-sparing mastectomy is recommended for selected patients with hormone-positive, her2-negative early-stage invasive breast cancer and DCIS, with peripheral localization less than 5 cm, located more than 2 cm from the NAC (33).

NAC necrosis is one of the serious wound complications seen after OPBS. It is mostly due to deficiencies in surgical technique (thickness of the tissue behind the NAC, excessive undermining (33), thin, long and superficial pedicles and their surrounding compression to these pedicles, distance between the sternal notch/clavicle and the NAC) (16, 23 but also patient-related factors ( like smoking, and presence of comorbidities (23, 33) can lead to loss of NAC. Symptoms and signs of classical arterial insufficiency (pale, no capillary circulation) or venous congestion (edema, varicose veins, bruising) are seen. In such cases, the sutures should be loosened and tension and pressure should be reduced. Anticoagulants or antiaggregants are preferred in ischemia of arterial origin, but it is necessary to be alert to bleeding when using these drugs. In venous problems, hyperbaric oxygen and hydrotherapy can be used together with heparin (23).

In a recent review, it was noted that the incidence of total NAC necrosis was 3.5%, and the incidence of partial NAC necrosis was 12.1% (33).

### **2.5.3. Fat necrosis**

Fat necrosis is an early (31).or late (7) complication of OPBS and BCS, causing false alarm of malignancy, poor cosmetic results, pain and palpable breast masses. Since it mimics local recurrence, it increases the anxiety of physicians and patients with frequent follow-up and repeated core biopsies. (7, 23, 31) . It usually disappears spontaneously within a few months during postoperative follow-up (7, 31), but if pain is present, sometimes excision of the area may be required (31).

Although RT can cause fat necrosis, this complication and its late results can be avoided if sensitive about the circulation of adipose tissue in the intraoperative period (34).

### 3. Late complications

Late complications consist of varieties of necrosis, asymmetry and deformities, scar formation and late complications of RT.

Any dead space created during BCS or OPBS will eventually cause dimples and deformities, RT will further progress these deformities (5).

Patients who are prone to hypertrophic scar and kelody formation should be identified in the preoperative questioning, especially if reduction mammoplasty is planned, these patients should be promptly intervened (with silicon gel pads, corticosteroid injection, 5-FU) as soon as abnormal scar formation is noticed with close follow-up postoperatively (30).

#### ***3.5.1. RT-related late complications***

In OPBS, RT is used to destroy multicentric disease and neoplastic foci left behind in the surgical bed or remaining breast (35). Thus, RT is an important treatment modality as it has been found to reduce the local recurrence rate of breast cancer. (7, 9, 33). After all, previous prospective randomized studies have found that the overall survival of BCS/OPBS after neoadjuvant RT is equivalent to mastectomy (7). Currently, there is no consensus on the optimal time to radiation from surgery for patients undergoing BCT. usually postop 4-10 weeks (9) Moreover, studies have found that there is an increased risk of local recurrence when the onset of adjuvant RT following OPBS/BCS exceeds 8 weeks postoperatively (7).

Currently, there is no consensus on an appropriate time to start adjuvant RT after BCS/OPBS, but 4-10 weeks postoperatively are generally recommended (36).

RT causes complications such as fat necrosis and volume loss in autologous flap-based reconstruction, and capsular contracture in implant-based reconstructions. Yet, studies conducted for NAC necrosis indicate that RT does not increase the risk (33).

Moreover, it is very difficult to reconstruct a irradiated tissue because its complications reach 50% (37).

#### ***3.1. Asymmetry***

Since glandular atrophy due to RT is an expected outcome, leaving the malignant breast approximately 10% larger when sudden contralateral symmetry is planned will help prevent asymmetry (31).

In previous studies, it is recommended to perform bilateral breast reduction in patients with complications associated with gigantomastia. It is emphasized that additional morbidities related to RT will also decrease with breast reduction (5). If the desired cosmetic cannot be obtained after these procedures or if a 2-stage reconstruction is planned, both breasts can be manipulated for symmetry after the wound remodeling is completed (38).

However, recommendation of contralateral symmetry operations in patients who have undergone mastopexy or partial mastectomy is still a matter of debate due to the additional burden of complications that may arise from intervention in a healthy organ (6).

#### **4. Other complications of specific applications**

##### **4.1. NAC sensation loss**

The innervation of the NAC (cutaneous branches of the 2nd-5th intercostal nerves) may be damaged during OPBS, resulting in temporary or permanent loss of NAC sensation (23).

##### **4.2. Autologous flap-based reconstruction**

Complications of donor and recipient sites are seen in breast reconstruction with autologous flaps (30).

###### **4.2.1. Flap necrosis**

DIEP flap, (30), pedicled TRAM flap, and latissimus dorsi myocutaneous flaps are commonly used for reconstruction with autologous flaps (39). Necrosis may occur as a result of circulation problems in any flaps used for reconstruction. If the flap has an island of skin, it can be used to monitor the entire flap, otherwise close clinical follow-up is required. If a symptom or sign of infection and necrosis is encountered, antibiotic therapy should be started, and reconstruction should be planned after the problem is taken under control with debridement (24).

Although fat necrosis, a complication of autologous breast reconstruction, is quite common, it is very worrying because it mimics recurrent breast cancer. Fat necrosis rates after DIEP flap reconstruction are 6-17.4%. When fat necrosis, which usually regresses spontaneously with manual massage, covers a larger area or causes symptoms such as pain, it is treated with minimally invasive methods or surgical excision (30).

#### ***4.2.2. Donor site complications***

Donor site complications are more common in free flaps or distant pedicle flaps in reconstructions with autologous flaps. Shoulder movements can be restored with effective physiotherapy in latissimus dorsi flap necrosis (23).

Contour defects and incisional hernias in the donor area in TRAM occur due to failure of the anatomical folds to be properly restored after sacrificing the rectus muscle. If the suspicion of their occurrence is high despite a meticulous surgical technique, it is recommended to strengthen the area with prophylactic mesh (30). Donor site complications are more common in those with a history of previous abdominal operations, particularly the presence of a subcostal incision (30). These complications are extremely rare since the muscle is not removed in perforator flaps such as DIEP (23). Nevertheless, contour abnormalities in DIEP are mostly due to denervation of the muscle during flap elevation. This problem could be prevented if attention is paid to the nerve anatomy during DIEP flap harvesting (30).

#### ***4.3. Implant based reconstruction***

Complications such as wrinkling, wound healing problems and necrosis, rotation or displacement of the implant, capsule contracture, infection and asymmetry are encountered in implant-based reconstructions (23, 30, 40). Capsular contracture, which is graded according to the Baker classification, is more common in smooth-surfaced implants (23,40) with an incidence of 8–15% (40).

In addition, the use of betadine in the irrigation of the pocket increases the risk of contracture. Partial and total capsulectomy may be required in its treatment (23, 30). When inflammatory findings occur, infection should be suspected, prophylactic antibiotic therapy should be started, uncontrolled infections result in implant excision (23, 30). The rates of infection following implant based reconstruction is 1.8 to 35.4% (30).

Revision surgeries may be required if the implant is not in the place and position it should be. In the presence of skin necrosis and implant exposure, serial debridements and a tension-free closure method can be tried as mentioned before (23).

Complications may also vary depending on the area where the implant is placed. For example, submuscularly placed breast implants may cause animation deformity. In this case, this deformity can be corrected by taking the implant into the prepectoral area or by injection of botox or surgically selective nerve ablation (23).

Implant rupture can progress insidiously, especially in silicone implants, so regular scans with MRI are recommended in the postoperative period (30).

Excessive medial dissection, creating an incorrect soft tissue pocket, or using an implant larger than 400 cc or bigger than 14 cm in diameter may cause webbing in the chest which leads to simmasty (30).

Exposure of implants genelde cilt nekrozuna sekonder veya enfeksiyona bağlı olarak oluşabilir. Geleneksel olarak ekspoze olan implantın çıkarılması önerilse de bazı çalışmalarla neredeyse yarısı ekspoze olmuş olan implantın bile daha küçük hacimlisi ile değiştirilerek kurtarılabilceğini savunmaktadır. İmplant salvage edilecekse de genelde latissimus dorsi flapları ile rekonstrüksiyon uygulanmaktadır (30).

#### **4.3.1. BIA-ALCL**

BIA-ALCL has anaplastic morphology; It is a T-cell lymphoma with CD15-/CD30+/CD40+ expression. BIA-ALCL is characterized by seroma between the implant and the fibrotic capsule after 1 year postoperatively (40, 41).

The current risk of BIA-ALCL in the use of silicone implants is 1/30,000-50,000, although it is mostly seen in textured implants, cases of flat implants have also been reported (40).

The presence of CD-30+ immunohistochemical staining in the fluid sampling performed from the seroma with imaging is diagnostic. PET-CT scan is recommended for staging, Stages I and II are completely curable (40).

When diagnosed early, it is possible to treat with implant excision and capsulectomy, but systemic chemotherapy is required in cases where it exceeds the capsule (42). Positive results have been obtained with targeted treatment methods in resistant cases (40).

#### **4.4. Lipotransfer (*fat grafting, lipomodelling or lipofilling*)**

Lipotransfer can be used either for correcting the sequelae of the previous mastectomies/BCS/OPBS, or for immediate reconstruction of patients with unfavorable tumour to breast volume in order to get good cosmetic results (41).

The fat layer obtained by centrifugation of the fat tissue harvested by liposuction from the peripheral donor area is grafted to areas with asymmetry or volume loss, sometimes during the primary operation and sometimes in the late periods (41).

Although there are equivocal results regarding the oncological safety of lipotransfer (41, 42) most studies have not found any association between disease recurrence and delayed lipotransfer (42).

Although some studies suggest waiting for the post-RT 6th month or the first annual mammogram for the application of “delayed lipotransfer” and concomitant adipose-derived regenerative cell (ADRCs), current studies generally show that this reconstruction method is safe from an oncological safety (27, 41).

It has been reported that lipotransfer causes a “false” malignant appearance in the clinical and postoperative imaging follow-up leading to repeated biopsies from suspicious masses and cysts (41). Also, it has been shown that ADRCs used together with fat grafting can induce tumor angiogenesis (41). In addition, some previous studies have shown that lipotransfer, especially in patients with DCIS or LCIS, increases local recurrence (43).

## 5. Conclusion

It should be kept in mind that every complication seen after both classical and partial mastectomies and OPBS has a more or less effect on the cosmetic result and may cause a delay in the onset of adjuvant therapy in the postoperative period. Complication rates can be reduced with proper evaluation of the predisposing factors of the patient in the preoperative period, ptosis of the breast, general skin quality and neoadjuvant radiotherapy history, a surgical method suitable for the biology and size of the tumor, and a meticulous surgical technique.

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## CHAPTER XII

# COMPLICATIONS AND MANAGEMENT OF GASTRIC SURGERY

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### 1. Introduction

Gastrectomy is being used for a range of gastric pathologies, both benign and malignant. As in every operation, postoperative complications can happen following gastrectomy.

Thanks to advanced techniques we see fewer postoperative complications today. Among patients who had a partial or total gastrectomy, %25 of them present with significant symptoms due to complications, and in %2-5 of them, these symptoms affect their day-to-day life (1).

#### 1.1 Postgastrectomy Anatomy

Impairments of gastrointestinal functions after gastric resection can vary by the resected part, volume, and type of reconstruction.

Reconstruction techniques:

- Billroth I
- Billroth II
- Roux-en-Y
- Esophagogastrostomy

## ***1.2 Diagnosis of Postgastrectomy Complications***

The possibility of complications should be considered when patients who had gastrectomy present with epigastric pain, nausea-vomiting, early satiety, bloating, diarrhea, or weight loss.

Abdominal CT is necessary for most patients with gastrointestinal symptoms following surgery.

### ***1.2a Acute abdomen:***

In the early postoperative period, patients may present with acute abdomen symptoms (peritonitis, fever, tachycardia, or hypotension) due to anastomosis or stump leak. These patients should undergo abdominal CT. Upper GI imaging studies with water-soluble contrasts may be the second choice but is usually unnecessary.

Although they are therapeutic rather than diagnostic, endoscopic approaches may also be used.

### ***1.2b Obstructive symptoms:***

Patients who present with acute obstructive symptoms such as epigastric pain and nausea-vomiting should also undergo abdominal CT as it is diagnostic for complications that may cause upper GI complications such as afferent or efferent loop syndrome, jejunal intussusception, or internal hernia. Patients who experience chronic or intermittent obstructive symptoms should undergo upper GI imaging studies with barium contrast.

### ***1.2c Dumping syndrome:***

Patients with dumping syndrome may present with gastrointestinal symptoms like nausea-vomiting, abdominal pain, and diarrhea as well as vasomotor symptoms such as perspiration, palpitation, and flushing 15-30 minutes after meals. The diagnosis of dumping syndrome is made clinically and confirmed with upper GI imaging studies and solid food gastric emptying studies.

### ***1.2d Chronic dysmotility:***

Patients who present with symptoms suggestive of motility problems such as early satiety, bloating, postprandial vomiting/diarrhea, and weight loss should undergo abdominal CT and upper GI endoscopy to rule out mechanical complications such as obstruction. Also, solid food gastric emptying study is

diagnostic of gastroparesis and roux stasis syndrome. Technetium biliary scan can be used to identify alkaline gastritis.

## 2. Anastomotic Complications

Anastomotic complications such as leak, stricture, or ulceration can develop following gastrectomy. Also, postgastrectomy obstructions can be seen at the level of the gastrointestinal anastomosis or near it (afferent or efferent loop syndrome etc).

### 2.1 *Leak:*

Postoperative leak can happen at any of the suture or staple lines including the jejunoojejunal anastomosis of a Roux-en-Y (2). An anastomosis leak occurs most commonly on 7-10th days after surgery. Patients present with fever, unexplained tachycardia and/or hypotension, abdominal pain, and/or acute abdomen symptoms. If anastomosis leak is suspected, the patient should undergo abdominal CT as it can show indirect signs of pneumoperitoneum, extraluminal contrast, inflammatory strandings, fluid collections, and/or abscess. Upper GI imaging studies with gastrografin can show the leak directly.

Broad-spectrum antibiotics are commenced once the diagnosis of anastomotic leak is made. Further treatment options depend on the patient's state and access to an interventional radiologist to perform percutaneous drainage. Percutaneous drainage aims to build a controlled enterocutaneous fistula to allow the leak to heal over time (3).

If medical treatments fail to control the leak, the patient is hemodynamically unstable, or widespread intra-abdominal contamination is suspected, surgical intervention is necessary for exploration, drainage, and anastomosis revision to avoid or control intra-abdominal sepsis. After the leak is taken under control, antibiotic therapy can be rearranged according to the antibiotic susceptibility of the culture obtained during percutaneous drainage or surgical intervention.

### 2.2 *Duodenal stump leak:*

The most feared complication of partial gastrectomy is the breakdown of the duodenal stump closure or duodenal stump leak following a Billroth II or a Roux-en-Y procedure. The aim of the management of the duodenal stump leak is to take sepsis under control and the drainage of the area. In addition to the routine surgical treatment of anastomosis leak, insertion of a tube duodenostomy can be performed if feasible.

### **2.3 *Stricture:***

The Billroth II reconstruction is susceptible to postoperative damaging of the gastrojejunostomy site that can lead to gastric outlet obstruction which is presented with non-bilious vomiting and chronic or intermittent bloating. The diagnosis of stricture is mostly made with upper GI imaging studies with attention to the lateral views. If a stricture is seen on fluoroscopy, biopsy with endoscopy is essential to rule out the possibility of recurrent cancer. Benign strictures can be treated with dilatation, which may need to be repeated. Also, stenting can be considered for the treatment of strictures.

Stricture of the anastomosis can be seen in %6-20 of the patients who had Roux-en-Y gastric bypass operation (4). These patients can be treated with endoscopic dilatation like the ones after Billroth II reconstruction.

### **2.4 *Obstruction:***

Obstruction can happen at any level from gastrointestinal anastomosis following gastrectomy. Despite the level of obstruction, the patients present with progressive intolerance to oral intake, nausea-vomiting, early satiety, and/or epigastric pain. Obstruction may be suspected based upon clinical presentation and examination but the diagnosis is made by radiological imaging and/or endoscopy.

### **2.5 *Afferent and efferent loop syndrome:***

Afferent and efferent loop syndromes may develop following Billroth II reconstruction with a gastrojejunostomy. They develop due to mechanical obstructions such as entanglement of loops, anastomotic narrowing, adhesions, or rarely seen, anastomotic ulcers (5). Afferent loop syndrome has been associated with a very long loop, so it can be prevented by maintaining a distance of <12-15 cm between the ligament of Treitz and the gastrojejunostomy.

A patient with acute afferent loop obstruction presents with acute onset of severe abdominal pain and vomiting and requires emergency surgery to prevent intestinal necrosis and duodenal blowout (6). Chronic afferent loop syndrome usually presents with postprandial epigastric pain and intermittent projectile bilious vomiting followed by a period of temporary relief that may last for several days. In patients with suspected afferent loop syndrome, the presence of a stretched afferent loop on abdominal CT is diagnostic. In order to treat this problem, it is necessary to revise the gastrojejunostomy or conversion to a Roux-en-Y anastomosis. Performing Braun's enteroenterostomy between

the afferent and efferent loops can also reduce the pressure of the afferent loop (5).

The distal jejunal segment of the gastrojejunostomy that removes the succus entericus from the stomach is called the efferent loop. Obstruction of the efferent loop leads to gastric outlet obstruction presenting with epigastric pain, distention, and biliary vomiting. Surgical correction is the treatment of choice when efferent loop syndrome is detected by abdominal CT or upper GI imaging studies.

### **2.6 *Marginal ulcers:***

Ulcers may form on gastric remnant, duodenum, or jejunum following gastric surgeries (2,5). The most common type of ulcers, marginal ulcers form at the distal of gastrojejunal anastomosis in the jejunum.

### **2.7 *Jejunal intussusception:***

Although it is pretty rare, the afferent or efferent loop of the Billroth II reconstruction may intussuscept to the gastric remnant through gastrojejunal anastomosis (jejunogastric intussusception). This rare cause of gastric outlet obstruction may lead to acute-onset bloating and bloody vomiting following gastrectomy (2). Intussusception can be seen on abdominal CT, upper GI imaging studies, and endoscopy. Stricture on the distal of gastric remnant and non-opaque coil-like distention on proximal jejunum can be seen in upper GI imaging studies. Jejunal intussusception is usually irreversible so it is essential to resect the intussuscepting part of the small bowel and revision of the gastrojejunostomy or conversion to a Roux-en-Y reconstruction.

### **2.8 *Internal hernia:***

Internal hernia can cause gastrointestinal obstruction following Billroth II or Roux-en-Y gastrectomy. Patients with an internal hernia usually present with acute abdominal pain with/without abdominal distension or vomiting. Diagnosis of internal hernia is made by abdominal CT. To avoid small bowel necrosis, early surgical intervention is essential as internal hernias may frequently lead to closed-loop small bowel obstruction. Internal hernias can be avoided by carefully closing all the mesenteric defects during gastric surgeries. In particular, during gastrojejunostomy, mesocolon should be sutured to the stomach and the distance between the mesentery of the retrocolic jejunal piece and mesocolon (Peterson's defect) should be closed.

### **3. Motility Complications**

#### ***3.1 Rapid transit:***

The most common symptom of rapid transit in patients who had gastrectomy is diarrhea.

#### ***3.2 Dumping syndrome:***

Dumping is usually seen as a result of the destruction or bypass of the pyloric sphincter. Clinically important symptoms of dumping are seen in %20 of the patients who had pyloroplasty or distal gastrectomy (7). Although the mechanism of dumping syndrome remains unexplained, it is associated with the fast passage of hyperosmolar gastric fluid (especially carbohydrates) to the small bowel (8). It is thought that the osmotic gradient draws fluid into the small intestine, resulting in the secretion of one or more vasoactive hormones such as serotonin and vasoactive intestinal polypeptides.

#### ***3.3 Early dumping:***

Patients present with gastrointestinal symptoms such as nausea- vomiting, epigastric pain, and diarrhea as well as vasomotor symptoms such as perspiration, palpitation, and flushing 15-30 minutes after meals (9,10). These symptoms are referred to as early dumping or dumping syndrome.

#### ***3.4 Late dumping:***

Although it is seen less often, dumping symptoms may present hours after meals. It is thought that this situation is not due to the osmotic gradient changes seen throughout the gastrointestinal tract, but to the hypoglycemia observed after the postprandial insulin peak.

#### ***3.4a Diagnosis:***

The diagnosis of dumping syndrome is made clinically (11). Monitored glucose challenge, upper GI imaging, or gastric emptying studies can be used to confirm the diagnosis.

#### ***3.4b Treatment:***

Most patients with dumping syndrome can be treated with only lifestyle changes (Less but frequent consumption of foods that are rich in fiber and protein and low in carbohydrates, not mixing liquids and solids in meals, etc) (9,10). In

some cases, Octreotide can be used but it's usually unnecessary (8). In a study conducted with 30 patients with dumping syndrome who were given either 3x1 SC or extended-release octreotide (octreotide LAR), it was shown that both reduced dumping symptoms significantly and improved the quality of life (12). In rare cases that cannot be controlled by lifestyle changes or medical treatment, surgical intervention may be required (9,10). For patients who had distal gastrectomy, the treatment of choice is the conversion of the loop gastrojejunostomy to a Roux-en-Y. This method slows gastric emptying by damaging the motility of the Roux loop. Less than %25 gastric remnant should be left behind to avoid postoperative Roux stasis syndrome.

#### **4. Postvagotomy diarrhea:**

After truncal vagotomy, %30 of the patients present with diarrhea (7). The pathogenesis has not been fully elucidated, but it is thought to be related to the rapid passage of unconjugated bile salts in the denervated biliary system to the colon, where they stimulate secretion. In most cases it is self-limiting. Oral cholestyramine, which binds bile salts, is effective in severe cases. In the past, 10 cm antiperistaltic jejunal loop placement was performed at 100 cm distal to the ligament of Treitz when medical treatment failed, but this procedure is rarely needed today.

#### **5. Slow transit:**

Patients who developed slow passage after gastrectomy usually present with nausea-vomiting (bilious / non-bilious) which leads to weight loss over time, epigastric pain or bloating, and early satiety. The differential diagnosis includes gastric stasis, alkaline gastritis, and Roux-stasis syndrome.

#### **6. Gastric stasis:**

Gastric emptying may be impaired following gastric operations due to atony, vagal denervation, or small gastric remnant (5). The symptoms of this condition include early satiety and subsequent vomiting of undigested food, abdominal pain, and weight loss.

Assessment of the patient with suspected gastric stasis syndrome after gastrectomy is done with upper GI series and small bowel series to evaluate the post-surgical anatomy and rule out the possibility of mechanical obstruction. Upper GI endoscopy is also usually performed to rule out the possibility of anastomotic strictures or marginal ulcers as they may cause or exacerbate gastric

stasis. Upper GI endoscopy can also treat bezoars which can be commonly found in patients with chronic gastric stasis (13).

Symptoms associated with a small gastric remnant can improve by eating frequently but less, and giving the residual stomach time to adjust. Postoperative gastric atony can benefit from prokinetic agents such as metoclopramide and erythromycin. Although there are some studies that show gastric pacing improves the symptoms of primary gastroparesis, it has not yet been widely used in clinical practice. Repeat gastrectomy may be performed if lifestyle changes and medical treatment fail. Subtotal gastrectomy (75%) should be performed in patients who have not previously undergone partial gastrectomy, and near-total (95%) or total gastrectomy with esophagojejunostomy should be performed in patients who have previously undergone partial gastrectomy (14). Billroth II reconstruction with Braun enterenterostomy may be preferred instead of Roux-en-Y reconstruction as it can cause Roux stasis syndrome.

## **7. Alkaline gastritis:**

Bile reflux to the stomach is common after operations in which the pylorus is removed or bypassed. In most cases, there are no serious clinical sequelae (5,15). But ~2% of the patients can develop alkaline gastritis which presents with persistent burning epigastric pain and chronic nausea which is aggravated by eating. Endoscopy can confirm gastritis and technetium biliary system imaging can show excess bile reflux into the stomach, but the diagnosis is usually made by excluding other diagnoses that may be causing the symptoms.

Surgical interventions aim to separate the residual stomach and duodenal contents by placing the jejunum loop between them. Roux-en-Y reconstruction (45-60 cm Roux loop), Henley loop (40 cm isoperistaltic jejunal loop placement between stomach remnant and duodenum), Braun enterenterostomy (45-60 cm distance from gastrojejunal anastomosis) with Billroth II reconstruction can be counted among the examples. The reoperative procedure is chosen based upon the amount of remnant stomach left (5).

## **8. Roux stasis syndrome:**

Roux-en-Y reconstruction is the preferred reconstruction method after near-total or total gastrectomy. It can also be used in the re-operative treatment of non-self resolving dumping syndrome, severe alkaline gastritis, or afferent loop syndrome. Some patients may present with symptoms of vomiting, epigastric pain, and weight loss (Roux stasis syndrome, etc) following Roux-en-Y

reconstruction. Upper GI imaging studies, upper GI endoscopy, and nuclear gastric emptying studies should be performed in patients with suspected Roux stasis syndrome (16). The obtained findings are similar to those of gastric stasis, with the only significant difference being the appearance of a dilated and often loose Roux loop.

Medical treatment of Roux stasis syndrome is prokinetic agents such as metoclopramide and erythromycin. If medical treatment fails, the needed surgical treatment is to remove the existing Roux loop and perform a new Roux-en-Y reconstruction. Near-total or 95% resection of the residual stomach is also performed to prevent the reoccurrence of Roux stasis. Billroth II reconstruction +/- Braun enterostomy can also be used, if possible, to prevent Roux stasis, as Roux stasis syndrome is more common in patients with a residual stomach greater than 50% and in patients undergoing truncal vagotomy (5).

## **9. Gallstones:**

Gallstones may be seen after gastrectomy in cancer patients due to cholestasis as a result of decreased contraction of the gallbladder by various mechanisms such as weight loss, vagotomy, and lymph node dissection in the hepatogastric ligament, and non-physiological reconstruction (17).

## **10. Long-Term Complications of the Remnant Stomach**

Gastric remnant after partial gastrectomy is predisposed to the development of ulcerative disease or cancer. Depending on the reason for the operation, these ulcers or cancers may be de novo or recurrent.

### ***10.1 Peptic ulcer:***

Gastric or duodenal ulcers may occur as a result of surgical or medical reasons (18). Residual gastric antrum and incomplete vagotomy are the two most important surgical causes of peptic ulcer disease in patients who had gastrectomy. In patients who underwent Billroth II gastrectomy, gastric antrum may be left behind at the duodenal margin. Being out of the acid flow, the residual gastric antrum secretes large amounts of gastrin, which stimulates excess stomach acid production, causing ulcers. Vagal stimulation of gastric acid production is not completely interrupted in patients undergoing incomplete vagotomy, resulting in hyperacidity and recurrent peptic ulcers. The fasting serum gastrin level is usually measured to rule out the possibility of a gastric antrum being left behind. High levels of gastrin can stimulate excessive secretion of stomach acid. Then,

a secretin test is performed to differentiate between residual gastric antrum and Zollinger-Ellison syndrome, which are both causes of hypergastrinemia. The diagnosis of the residual gastric antrum is made by the high fasting gastrin level, which is controlled by the administration of IV secretin. On the contrary, in Zollinger-Ellison syndrome (gastrinoma) administration of secretin further increases serum gastrin levels. The treatment of residual gastric antrum is surgical resection. Patients who have undergone gastrectomy presenting with peptic ulcer disease should also be evaluated for medical reasons. These causes include drugs (NSAIDs etc), H.pylori infection, Zollinger-Ellison syndrome, and residual stomach cancer.

### **10.2 Remnant cancer:**

Patients who have undergone partial gastrectomy for benign reasons are in the high-risk group for gastric cancer (19). These residual or stump gastric carcinomas usually develop in the distal portion of the remnant, close to the gastrojejunral anastomosis. It is thought that chronic bile reflux and pancreatic secretions play a role in this by causing chronic inflammation. The incidence of residual gastric carcinomas has been reported as 0.8-0.9% (25,26). Studies have shown that the increased risk of residual gastric cancer increases 15-20 years after the first operation (21-27). Endoscopic observation of patients who have undergone gastrectomy is not yet performed because its benefit has not been demonstrated (32,33). If observation is still considered, it should be started 15-20 years after gastric surgery.

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## CHAPTER XIII

# BILE DUCT INJURIES

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### 1. Introduction

Bile Duct Injuries occur during laparoscopic cholecystectomy (0.4-1.5% of cases) more than open cholecystectomy (0.2-0.3% of cases). (1)

Today, the rate of injury during laparoscopic cholecystectomy is decreasing. However, injuries currently seen tend to be more severe, with the most severe biliary and hepatic artery or portal vein injuries often occurring after conversion from laparoscopy to open cholecystectomy. (2) Leaks are more common than strictures. Most injuries during laparoscopic cholecystectomy result from basic technical problems and misinterpretations, not from inexperience. (3)

Bile duct injuries are encountered as a complication with high mortality and morbidity, which are difficult in both diagnosis and treatment, and the most common causes are laparoscopic cholecystectomies, open cholecystectomies, common bile duct exploration, liver hydatid cyst, and hydatid cyst operation, bile duct malignancy surgery, cholelithiasis and reported as abdominal trauma. Today, laparoscopic cholecystectomy is shown as the most common cause of bile duct injuries and significantly increases morbidity and mortality rates in patients. While 51% of biliary tract injuries are noticed in the postoperative period, 49% are noticed intraoperatively, and most of these problems are resolved in the intraoperative period with advanced laparoscopic surgical manipulations. Although many studies have shown that endoscopic retrograde cholangiopancreatography (ERCP) findings of bile duct injuries after open cholecystectomy and laparoscopic cholecystectomy are similar and can

be successfully treated endoscopically, when the time to diagnosis after complication is evaluated, it is seen that the duration is similar in biliary tract injuries after laparoscopic cholecystectomy reported to be significantly shorter. The most common signs of bile duct injuries are present signs of either bile duct obstruction or bile leakage in the early period. The majority of patients who have undergone laparoscopic cholecystectomy are discharged immediately after the operation or within 24 hours. Progressive abdominal pain, nausea, vomiting, abdominal distention, and fever that may develop in these patients should be considered and evaluated very carefully. In patients with bile leakage, serum bilirubin values, liver function tests and cholestatic enzyme levels may be normal in the early period, but later increase due to absorption from the peritoneal cavity and generally remains at the level of 2-6 mg/dl. In case of occlusion, postoperative 2-3 days. Even in the early days, liver function tests, total bilirubin, and alkaline phosphatase levels show a progressive increase.

The delay that may occur in the diagnosis and the postponement of the solution to the current problem also cause higher morbidity and mortality rates. Therefore, early diagnosis and minimally invasive treatment will reduce these patients' high mortality and morbidity rates.

Table 1: Amsterdam classification used in the evaluation of biliary tract injuries

<b>AMSTERDAM classification used in the evaluation of biliary tract injuries</b>	
Type	Results
<b>A</b>	Bile leaks from the cystic duct or connection points
<b>B</b>	Bile leakage due to bile duct injury
<b>C</b>	Common bile duct stenosis without bile leakage
<b>D</b>	Complete incision or excision of the common bile duct

Table 2: Strasberg classification used in the evaluation of biliary tract injuries

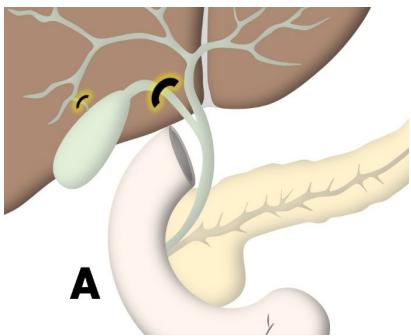
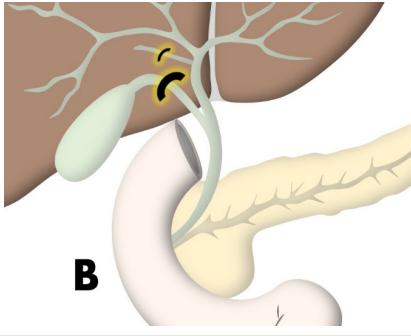
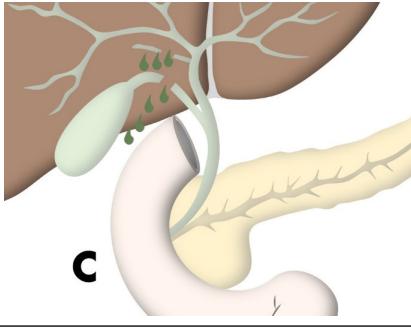
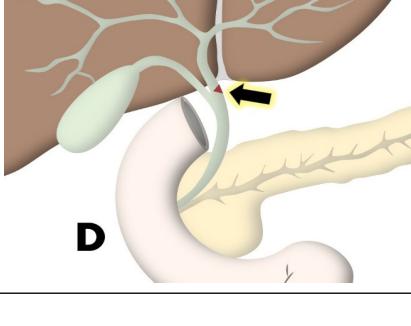
<b>STRASBERG classification used in the evaluation of biliary tract injuries (4)</b>	
Type	Results
Type A	Main bile ducts intact, leaks from connected minor ducts (cystic stump, Luschka)
	 A diagram of the liver, gallbladder, and bile ducts. A yellow arrow points to a small tear in the cystic duct where it joins the common hepatic duct. The bile ducts are shown in green, and the liver is brown.
Type B	Injury of aberrant right sectoral branch
	 A diagram similar to diagram A, but the yellow arrow points to a tear in an aberrant right sectoral branch of the bile duct system.
Type C	Fistula form of type B
	 A diagram similar to diagram B, but green dots represent bile leaking from the injured duct into the surrounding tissue.
Type D	Lateral injury in extrahepatic ducts
	 A diagram showing the extrahepatic bile ducts. A yellow arrow points to a tear in one of the larger bile ducts.
Type E1–E5	Bismuth type injuries

Table 3: Bismuth classification used in the evaluation of bile duct injuries

<b>BISMUTH classification used in the evaluation of bile duct injuries</b>	
<b>Medicine</b>	<b>Results</b>
Type E1	Biliary tract below the bifurcation > 2 cm
Type E2	Biliary tract below the bifurcation < 2 cm
Type E3	Main hepatic duct absent, bifurcation open
Type E4	No participation between right-left channels
Type E5	Injury of the right hepatic branch and a segmental duct of the right lobe alone or together with the main hepatic duct

The critical safety vision technique was defined as the recognition of gallbladder elements, particularly the hepatocystic triangle (consisting of the cystic duct, common bile duct, and liver), the safest approach in laparoscopic cholecystectomy in 1995. The use of critical safety vision (obtaining all 3 components) during laparoscopic cholecystectomy is the recommended approach to minimize the risk of bile duct injury.

The lateral traction of the infundibulum and the Calot's triangle, the cystic duct and the perpendicular position of the cystic artery to the common bile duct should be seen. Dissection should be started not over the tubular structures associated with the gallbladder, but right next to the gallbladder infundibulum. The peritoneal leaf over the infundibulum should be opened both medially and laterally. Lateral dissection is generally safer and facilitates medial dissection. No tubular structure should be cut until the distal 1/3 of the gallbladder bed has been separated from the liver. Again, no tubular structure should be clipped or cut before turning 360 degrees. It should always be ensured that there are only two tubular structures connected to the gallbladder. Depending on the anatomy and convenience, the artery or cystic duct may be clipped first. Cauter must be used very carefully to avoid thermal damage. Laparoscopic cholecystectomy should not be performed if, for any reason, a "critical view for safety" cannot be obtained (5-6)

A salvage procedure such as subtotal cholecystectomy should be considered if critical safety vision is not achieved during a difficult laparoscopic cholecystectomy. If partial cholecystectomy is to be performed, the cystic duct or the remaining gallbladder section can be closed by suturing. (7-9)

During a difficult laparoscopic cholecystectomy, conversion to open should be considered when the operating surgeon can't manage the situation as laparoscopically. (10-11)

Intraoperative cholangiography can be perform if there is recognizing bile duct anatomy, choledocholithiasis in cases of suspected intraoperative bile duct injury, misunderstanding of biliary anatomy, or lack of critical safety vision, but routine use is not yet recommended to reduce the rate of bile duct injury. Intraoperative indocyanine green fluorescence cholangiography is a noninvasive technique for describe bile duct anatomy and vascular structures, but routine use is not yet recommended. For acute cholecystitis patients, cholecystectomy should be perform within 48 hours and up to 10 days from the onset of symptoms for optimal timing. In cases at risk (eg, scleroatrophic cholecystitis, Mirizzi syndrome), a comprehensive preoperative study before cholecystectomy is a must for evaluation the risk/benefit ratio of the procedure. (12)

## 2. Treatment Of Bile Duct Injuries

- 2.1. *Simple leaks (Luschka, cystic stump leaks): Stent application, Percutaneous drainage*
- 2.2. *Incomplete bile duct lacerations: primary repair via T-tube, stent, Roux-Y choledochojejunostomy*
- 2.3. *Biliary incisions (Strasberg E type injuries) : Roux-N-Y Hepaticojejunostomy*
- 2.4. *Late operative strictures: Balloon dilatation & stent, surgery*

If damage is noticed during surgery, repair surgery should be performed immediately. However, if the damage is noticed in the postoperative period, patients should be placed with a transhepatic biliary catheter for biliary decompression and drainage for intra-abdominal collections. After the acute inflammation is resolved, approximately 6-8 weeks later, definitive treatment is performed with surgery.

## 3. Biliary Tract Injuries Management

Management of bile duct injuries is related to the type, extent, level, and time of diagnosis of the injury. Appropriate initial treatment of bile duct injuries during cholecystectomy prevents the development of biliary stricture. When there is a major injury and there is no experienced bile duct surgeon, an external drain should be placed and, if necessary, a transhepatic biliary catheter should be placed and the patient referred to a reference center. If the cut bile duct is  $<3$  mm or drains a single hepatic segment, it can be safely ligated. Reimplantation of this duct is required if the injured segment is  $\geq 4$  mm and is a biliary tract that drains multiple segments or an entire lobe.

If lateral injuries of the main hepatic duct or common bile duct occur during the surgery, the best treatment is T-tube application. If the injury is in the form of a small incision on the canal, a T tube is placed through this incision, as in classical choledochotomy, such as T tube placement. If there is a wider lateral injury, the T-tube should be placed through a separate incision, and then the injury should be repaired on the T-tube to prevent stenosis.

Major injuries, such as a complete incision of the common hepatic duct or common bile duct, should be best recognized and treated at the time of injury. In many of these injuries, there is not only a complete incision but also a canal excision of different lengths. This type of injury usually requires

a bilioenteric anastomosis using the jejunum. It may be necessary to perform an end-side Roux'Y choledochojejunostomy or, more frequently, a Roux'Y hepaticojejunostomy. A transhepatic biliary catheter is then placed to visualize and drain the anastomosis. If there is a rare distal injury, choledochoduodenostomy can be performed. If possible, end-to-end anastomosis can also be performed over a T tube inserted through another incision. A tension-free anastomosis is critical to avoid the high risk of postoperative stricture formation. Cystic duct leaks can usually be treated with endoscopic stenting after percutaneous drainage of intra-abdominal collections.

Major bile duct injuries detected after surgery require percutaneous transhepatic biliary drainage for decompression and, if available, percutaneous drainage for intra-abdominal collection. After the acute inflammation subsides within 6–8 weeks, surgical repair is performed. Patients with stenosis developed as sequelae of injury or previous repair usually present with progressively deteriorating liver function tests and cholangitis. The initial approach includes decompression as well as percutaneous drainage to define the anatomy and determine the extent and localization of the injury. These catheters also provide technical assistance in subsequent bilioenteric anastomosis. The anastomosis is made between the proximal canal of the injury and the Roux arm of the jejunum.

Balloon dilation of the stricture usually requires multiple procedures and rarely provides long-term benefits. Self-expanding metallic or plastic stents placed percutaneously or endoscopically may provide temporary drainage and may be permanent in high-risk patients.

Antibiotic therapy using broad-spectrum antibiotics may be considered in cases of suspected biliary tract injuries with no previous history of biliary drainage during elective laparoscopic cholecystectomy. Broad-spectrum antibiotics(4th generation cephalosporins) are recommended for the patients with pre-existing biliary infection and patients at risk of developing local and systemic sepsis, in patients with preoperative endoscopic nasobiliary drainage or percutaneous transhepatic biliary drainage/cholangiography and endoscopic stenting. Further adjustments are made to this according to the antibiograms. Antibiotics should be started immediately (within 1 hour) in patients with biliary fistula, biloma, or biliary peritonitis. In case of shock, choice of antibiotic should be piperacillin/tazobactam, imipenem/cilastatin, meropenem, ertapenem, or amikacin-associated aztreonam. The open abdomen may be consider as an option in patients with severe complicated intra-abdominal sepsis with organ failure and gross contamination.

#### 4. Conclusion

Good results can be obtained in 70–90% of bile duct injury cases. The best results are obtained with repairs detected at the time of cholecystectomy and performed by an experienced biliary surgeon. Operative mortality has been reported between 0 and 30% in different series. However, it is generally between 5 and 8%.

Common complications specific to bile duct repair are cholangitis, external bile fistula, bile leakage, subhepatic and suprahepatic abscess, and hemobilia. Bilioenteric anastomotic stenosis is usually seen in 10% of patients and may develop up to 20 years after repair. About 2/3 of recurrent strictures become symptomatic within 2 years. The success rate in proximal stenosis is lower than in distal ones. The worst outcomes are those requiring multiple revisions and those with signs of liver failure and portal hypertension. However, a previous repair surgery does not prevent the success of the next repair, especially in patients with good liver function.

Patients whose liver function continues to deteriorate are candidates for liver transplantation.

##### ***4.1. Treatment goals of iatrogenic bile duct injury***

###### ***4.1.1. Infection control***

- Intavenous antibiotics
- Drainage of periportal fluid collections

###### ***4.1.2. Clear and complete description of the entire biliary anatomy***

- Magnetic resonance cholangiopancreatography or percutaneous transhepatic cholangiography
- Endoscopic retrograde cholangiopancreatography (especially if cystic duct stump leakage is suspected)

###### ***4.1.3. Ensuring biliary-enteric continuity***

- Tension-free, mucosa-to-mucosa anastomosis
- Roux-en-Y hepaticojjunostomy
- Long-term transanastomotic stents in case of bifurcation or more severe injury

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