

# **Diploma Thesis**

## **“Clavien-Dindo classification” of postoperative complications after abdominoplasty**

**A retrospective single centre analysis and comparison to international data**

Submitted by

**Fabian Heinz Tiefenbacher**

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under supervision of

**Dr. med. univ. Frederike Marie Josefine Reischies**

**Ass. Prof. Priv.-Doz. Dr. med. David Benjamin Lumenta**

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## Abstract

**Background:** According to the World Health Organisation, obesity rates have more than doubled since 1980. This result in an increased prevalence of tissue excess and laxness which has led to Abdominoplasty being the sixth most common surgical procedure in the United States. Abdominoplasty is according to literature associated with a higher risk for developing postoperative complications compared to other contouring procedures. This thesis aims to evaluate local complication rates and data from literature as well as the use of the Clavien-Dindo classification of surgical complications as a grading system for post-operative complications after abdominoplasty.

**Methods:** This retrospective analysis evaluated all patients admitted to the Department of Plastic, Aesthetic and Reconstructive Surgery at the Medical University Hospital Graz to receive abdominoplasty as part of weight loss associated tissue reduction or autologous breast-reconstruction between 01/2001-11/2016. All types and prevalence of complications associated with these procedures were identified from medical records, manually transferred into IBM SPSS Statistics Version 22.0 (IBM, Armonk, USA) for statistical analysis and then classified with the Clavien-Dindo classification. Source of the retrospective analysis was PubMed (U.S. National Library of Medicine, Bethesda, Maryland, USA) and seventeen articles evaluated published between 01/1994 and 12/2016.

**Results:** A total of (n=398/100%) patients between nineteen and seventy-eight, (n=355/89%) women and (n=43/11%) men, found eligible, were included in this study. All complications (n=387/100%) were recorded. The total complication rate was 47.7% and 27.4% after filtering with the six most common complications from the literature we reviewed. The evaluation with the Clavien-Dindo classification showed (n=85/44.7%) Grade I, (n=28/14.7%) Grade II and (n=55/28.9%) Grade III complications. Grade III showed (n=6/3.2%) Grade III-a and (n=16/8.4%) Grade III-b complications. Grade IV, and Grade V complications were fortunately not registered in this collective.

**Conclusion:** Depending on data analysis and definitions, complication rates can be reported in various modes. We demonstrated that the lack of standardized means can result in representing our own data among the highest or lowest published complication rates in the evaluated literature. We found the Clavien-Dindo classification to be a useful tool to

achieve an objective classification of complications, notably in the case of abdominoplasty, when using its contracted form.

## Zusammenfassung

**Hintergrund:** Von der Weltgesundheitsorganisation wurden Zahlen veröffentlicht, wonach sich die Rate an fettleibigen Personen seit 1980 mehr als verdoppelt hat. Diesem Trend folgend, steigt das Auftreten massiver Haut und Gewebsüberschüsse zunehmend. Dadurch ist die Abdominoplastik mittlerweile der sechst-häufigste chirurgische Eingriff in den Vereinigten Staaten von Amerika. Dies obwohl dieser Eingriff generell mit einem höheren Risiko, verglichen mit anderen ästhetischen Eingriffen, verbunden ist. Dennoch fehlt es an einer standardisierten Klassifikation für postoperative Komplikationen. Diese Diplomarbeit erhebt lokale Daten und vergleicht diese zu denen aus internationalen Publikationen um herauszufinden wie hoch Komplikationsraten tatsächlich sind und evaluiert die Clavien-Dindo Klassifikation auf ihre Anwendbarkeit und Zuverlässigkeit Komplikationen nach Abdominoplastik einzustufen.

**Methodik:** In dieser retrospektiven Studie wurden alle Patienten, die zwischen Januar 2001 und November 2016, an der Abteilung für plastische, ästhetische und rekonstruktive Chirurgie Graz, eine Abdominoplastik allein oder im Zuge einer Brustrekonstruktion erhalten haben auf Komplikationen überprüft. Die gesammelten Daten wurden hernach zur statistischen Auswertung in „IBM SPSS Statistics“ Version 22.0 übertragen und analysiert. Die Daten für den Literaturvergleich wurden mittels PubMed (U.S. National Library of Medicine, Bethesda, Maryland, USA) erhoben und insgesamt siebzehn Studien, publiziert zwischen 1996 und 2016, in die Diplomarbeit inkludiert.

**Ergebnisse:** Insgesamt wurden (n=398/100%) Patienten (n=43/11%) und Patientinnen (n=355/89%), zwischen neunzehn und achtundsiebzig Jahren zur Auswertung zugelassen und in die Studie integriert. Insgesamt wurden (n=387/100%) Komplikationen erfasst. Die allgemeine Komplikationsrate betrug 47,7% und 27,4% nach Filterung mit den sechs häufigsten Komplikationen in der von uns evaluierten Literatur. Die Einteilung der Komplikationen in die Clavien-Dindo Klassifikation ergab insgesamt (n=85/44.7%) Grad I, (n=28/14.7%) Grad II und (n=55/28.9%) Grad III Komplikationen. Auf die Untergrade III-a und III-b entfielen jeweils (n=6/3.2%) Grad III-a und (n=16/8.4%) Grad III-b Komplikationen. Grad IV und Grad V Komplikationen konnten in dieser Patientengruppe nicht gefunden werden.

**Schlussfolgerung:** In Abhängigkeit der Datenanalyse und –definition können Komplikationsraten in verschiedenen Formen dargestellt werden. Wir konnten zeigen, dass eine fehlende Standardisierung der eigenen Daten dazu führt, dass die eigenen Ergebnisse sowohl zu den höchsten als auch niedrigsten Komplikationsraten in der evaluierten Literatur eingereiht werden können. Die Clavien-Dindo Klassifikation ist ein nützliches Instrument um eine objektive Einordnung von Komplikationen zu erreichen, insbesondere bei Abdominoplastiken, wenn man die sogenannte “contracted form” der Clavien-Dindo Klassifikation verwendet.

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# 1 Introduction

Abdominoplasty is one of numerous surgical procedures which allows body-contouring or re-contouring for functional and aesthetic reasons. It is usually performed singly or in combination with other aesthetic as well as reconstructive procedures like autologous breast reconstruction. (1) The surgical goals of abdominoplasty are the removal of excess abdominal skin that cannot be removed through sport, workout or diet, the tightening of underlying muscles if required as well as the re-contouring and flattening of the abdomen. Necessary scars should not be more than a fine line concealable through patient's favoured type of swim- and underwear. It is usually performed after massive weight loss ([group A](#)) or as part of autologous breast reconstruction ([group B](#)). Nevertheless, it should never be considered as quick, easy or perfectly safe solution for losing weight and redundant tissue because the risks and complications should not be underestimated. Numbers show that abdominoplasty is associated to a higher complication rate compared with other contouring procedures and rates are even higher in combined procedures. (1–8)

According to the World Health Organisation, obesity rates have more than doubled since 1980. This means that nearly two billion adults were overweight in 2014, and 600 million were obese. (9) This leads to increased evidence of metabolic and cardiovascular diseases, as well as increased overall disability, morbidity and mortality. (10–13) Growing knowledge about side-effects, the spreading of daily new diet concepts in social medias and the advent of new fat-reduction technologies lead to an increased number of massive weight losses. This results in an increased prevalence of tissue excess and laxness. (14) This turn has led to abdominoplasty being the sixth most common cosmetic surgical procedure in the United States, according to the American Society for Aesthetic Plastic Surgery, with nearly 120,000 performed in 2013. Analyses indicate that just in the United States alone, the rate of abdominoplasty has increased by 79 percent since 2000 and additionally by 9% since 2014. (15,16) Europe may follow this trend since obesity is not just an American phenomenon. “In Europe, obesity prevalence has tripled over the last two decades and has reached epidemic proportions as the 4th most important risk factor for ill health and premature deaths in Europe”. (17)

Abdominoplasty as an elective procedure under general anesthesia demands a standardized risk evaluation and informed consent. Postoperative complications are well described in

literature but neither assigned to an objective classification or is it standardised what a complications actually is. There are various approaches to define what complications really are in literature but we decided to accept the definition after Clavien et al. as “any deviation from the normal postoperative course” (18). Common classifications in studies are major and minor complications whereas former require surgical intervention and minor complications mostly only pharmacological treatment. (19,20) A precise method of how to rate postoperative complications is still missing in a society where the evaluation of quality becomes more and more important. (18)

This study aimed to determine how high complications rates after abdominoplasty really are. Therefore we compared own data from the Medical University Hospital Graz to international data gathered from PubMed (U.S. National Library of Medicine, Bethesda, Maryland, USA). Furthermore, we evaluated the Clavien-Dindo Classification of Surgical Complications; an intervention based standardised grading system, for its usability to grade complications following abdominoplasty.

## ***1.1 Why Body Contouring is Necessary and Important***

Patients after massive weight loss, challenge plastic surgeons with a wide range of individual cases and problems. (20) “With an appreciation of the magnitude of the surface deformity, and altered metabolism, nutrition, and psychological makeup of these patients, innovative plastic surgeons have forged an organized approach to preparation, operative technique, and postoperative care.” (21) There is a great variety of surgical gender-specific procedures and techniques for body contouring. Most patients seek plastic surgery after massive weight loss, because slackening of the skin usually follows such a drastic physical change. (22) The main motivation for seeking surgery in 66% of cases is psychosocial problems, in contrast to only 10% for medical reasons. (23) Skin excess and laxity can be inconceivably incriminating for patients after achieving their desired weight, and not just for cosmetic reasons, as sport or even working can be extremely unsatisfying due to painful rubbing of skin. Imagine losing a quarter or more of your bodyweight through exercise or surgical interventions such as gastric banding, but still having to wear excessive clothing to hide sagging skin. The most common site of excess skin seems to be the abdomen in women and men as well as being reported as causing the most discomfort. The same study mentioned that women suffered significantly more from emotional distress. However, physical symptoms were the same in both genders. This may be caused by the enormous media presence and social pressures we are exposed to. It seems to be more tolerated if men do not have a shaped body contour or women are more likely to suffer from emotional distress. Nevertheless patients for abdominoplasty must be chosen wisely. (24) Suitable patients in general seem to be those who have achieved a stable Body Mass Index (BMI) of  $\leq 35$  and are mentally and physically healthy and show enough compliance to heal all kind of wounds caused by surgical interventions. (25)

“The individuals’ perception of their position in life in the context of the culture and value systems in which they live and in relation to their goals, expectations, standards and concern.” (26) This is the World Health Organisation definition of quality of life. Such an extensive concept considers patients personal beliefs, physical and psychological health as well as their social integration and independence. Studies show that body contouring surgeries are highly wanted by patients after massive weight loss. Approximately 74% of patients in the United States desire body contouring after massive weight loss supported by surgical interventions but only around 21% actually receive therapy. (22,27) Modarressi et

al. showed with a long-term follow-up study that despite unavoidable scar dissatisfaction, the Health-Related Quality of Life was much higher after surgical intervention and according to them, 84% of their patients treated by surgery would consider undergoing procedures again if needed. That is why treatment of morbid obesity cannot be considered as achieved unless plastic surgery has been well-thought-out. (27)

## ***1.2 History of Abdominoplasty***

Abdominoplasty has a long history of procedures developed and refined over generations. The first limited early stage form of dermolipectomy was reported by Demars and Marx. (28) Their early stage procedure included an umbilicus removal but no reconstruction. Similarly, a Professor at the John Hopkins Clinic in Baltimore, US, H Kelly, (29) described in 1899 a transverse incision across both spinous processes including the removal of the umbilicus, resulting in a linear scar across the abdomen. (30) Due to this, abdominoplasty former performed as part of general or gynaecological procedures became known from a pure plastic-esthetical point of view. That's why today some call Kelly, the father of abdominoplasty. It's his contribution that obstetrics got separated and established as own specialty from gynaecology and that lipectomy was inaugurated. (31) Inspired surgeons tried to improve his resection line, using singular or multiple, vertical as well as horizontal elliptical and straight incisions with some in- or excluding the navel. Thorek (32) established a wedge-shaped incision entirely below the navel and described it in 1939.

1967 was a turning point; until then were three main categories of abdominoplasty known and performed:

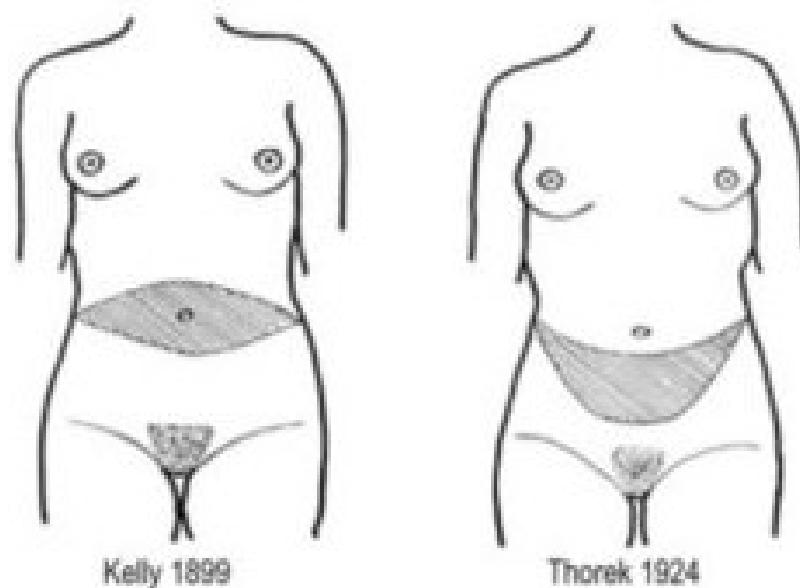
1. The transverse incision
2. The vertical incision
3. A combination of vertical and transverse incision

After 1967, many modifications were done over the next years. However, surgeons started to favour the low transverse incision with inconspicuous scarring. It was a technique considered to provide overall positive outcomes and was published in 1967 by Pitanguy. (33) He reported more than 500 cases between 1967 and 1975. His technique included a low transverse abdominal and groin incision as well as extensive undermining over the costal margins, muscle tightening and compression dressings. The "W" incision technique appeared first in 1972 and was modified in 1975. By starting within the pubic hairline, followed by a curved line around the mons pubis to the groin crease and laterally upwards, this technique allowed minimisation of the long-term mons-pubis-pull-up and the unappealing suprapubic scarring. (30) It was in 1995 when the traditional open W-type incision changed to a type called "bicycle handlebar". In this procedure the lateral limbs of the incision are in a high position while the pubic segment remains in a lower line at the level

of pubic hair while the anterior superior iliac spine is used as a reference. (34) The template of our known method for full abdominoplasty was first described by Baker (35) in 1977.

Mini-abdominoplasty was first introduced in 1971 and had its own development. The use was often limited due the fact that just small corrections of lower abdominal skin and fat were possible. This changed in 1975 with the birth of suction-assisted lipectomy. Liposuctioning set body contouring on a whole new level of plastic surgery including different variations of combined procedures.

Techniques have developed and full, as well as mini, abdominoplasty have taken different routes and are ingrained in our today's medicine. However, progress will never stop; new techniques will be found to decrease overall risk, morbidity and time of recovery and to enhance outcomes, satisfaction and quality of life. (30)



**Figure 1:** Early steps in the development of the abdominoplasty procedure today (35)

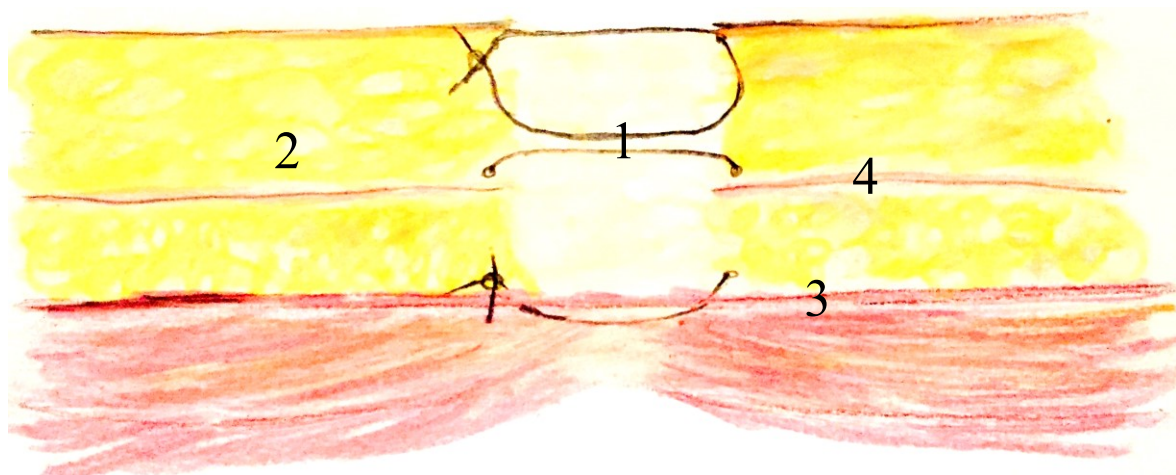
## 2 Abdominoplasty Techniques and Preparation

The traditional or classic abdominoplasty, with or without liposuction, is performed in two different variations regarding the different umbilicus management. Further variations include fleur-de-lis abdominoplasty, lower abdominoplasty and high lateral tension abdominoplasty. (36)

Nevertheless, the principles of all abdominoplasty techniques are the same;

- Do not remove too much tissue allowing a muscle-fascia-plastic
- Perform extensive liposuction in the non-undermined area
- Connect the superficial fascial system using non-absorbable sutures
- Reduce the suprapubic skin tension and allow sufficient lateral inguinal tissue tension

The incision should be as small as achievable. Liposuction in the epigastric area should only follow the vascular course. Even if all the fat tissue between mons pubis and the umbilicus seems removable, 3-4 centimetres should be spared after separating the navel to guaranty a tension free wound closure. The open resection of the subcutaneous fat tissue in the hypogastric region is less traumatic than liposuction and reduces the postoperative seroma. It is recommended to fixate the proximal mons-pubis area to the deep fascia after the muscle repair to avoid the risk of a mons pubis elevation.

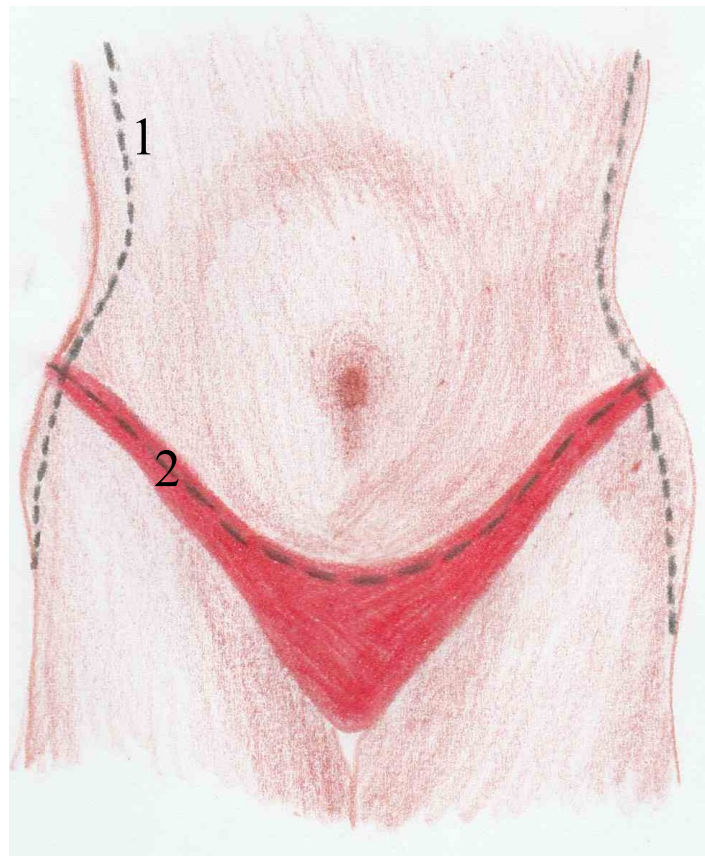


**Figure 2:** Fixation of the to the deep fascia, (1: sutures, 2: dermis and subcutaneous fat-layer, 3: rectus sheath, 4: Scarpa's fascia)

After the muscular myoaponeurotic-layer-plastic a flexion of the patient of 20-30° and the mobilisation of the cutaneous flap is recommended to guaranty a tension free wound closure. This improves nutrition of the aria and reduces the risk of hypertrophic scaring in the postoperative phase. (31)

## 2.1 Preoperative Markings

Examinations and markings should be made in assistance of a nurse making patients feel more comfortable, especially recommended for female patients. This should be done a day before surgery is scheduled. Therefore, the usually preferred style of underpants or/and swimsuit should be brought to the appointment. This helps to plan the needed incision. The goal is that resulting scars can be concealed by the patients preferred garments. Another positive effect is that patients can get a better understanding of the planned procedure regarding exact locations, incisions and resulting scars.



**Figure 3:** Surgical markings for the new body contour and estimated scar-line, adapted from (35), (1: New Contour-Line, 2: Incision-Line)

This should be followed by precise photo documentation regarding lighting, background and standardized positioning.

Surgical marking is best performed when patients are standing upright. The tissue to be excised is usually found horizontally between both superior iliac spines and vertically between navel and pubis. The midline serves as maximum excision border with lateral tapering. The clinical judgment should be made whether the supra-umbilical skin reaches

the pubis after removal of redundant skin or not. This can easily be achieved by bringing the proposed midline-points together. Special attention should be given to patients with a greater-than-usual distance between umbilicus and pubis as well as a short distance between the xiphoid process and umbilicus. Finally, on the next day on the operating table in a supine position, the periumbilical markings are made. This includes the vertical midline mark from the xiphoid process to the umbilicus and the estimated location of the new umbilicus site. (36)

## ***2.2 Different Types of the Abdominal Wall***

A classification of the abdominal wall was introduced in the 1980ties under the influence of liposuction. This classification was further developed to have more strategic options to plan treatments. Matarasso and Avelar were pioneering and their work led to the six types we know today. Nahas established additionally to the classification of Matarasso a separate one which consists of four different types (A, B, C, D) and is based on the muscular tension loss of the abdominal wall and determines the most adequate surgical treatment. (31)

### **2.2.1 Type I**

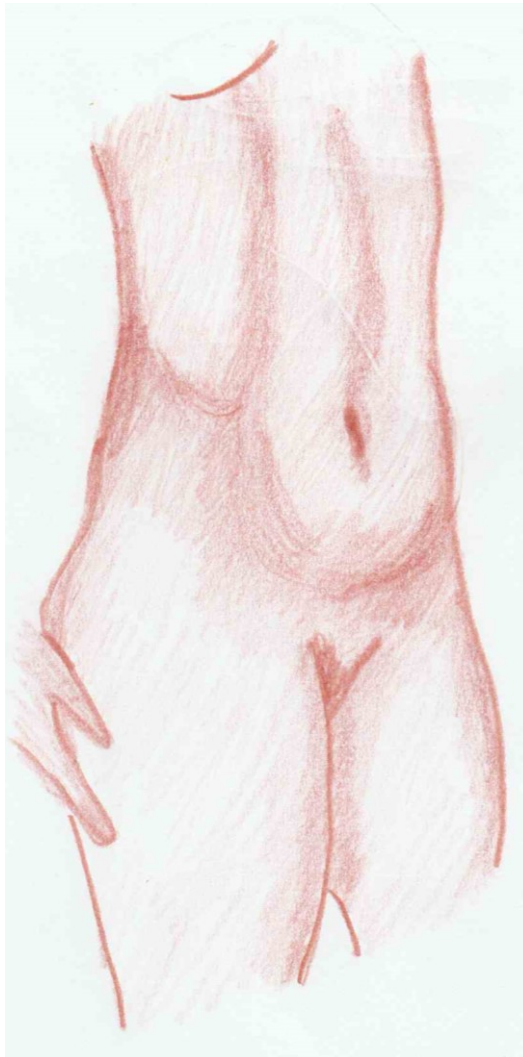
This type is typically found in young nulliparous patients with normal cutaneous and muscular tension but with excessive subcutaneous fat in the infraumbilical area. (31)



**Figure 4:** Type I, adapted from (31)

### 2.2.2 Type II

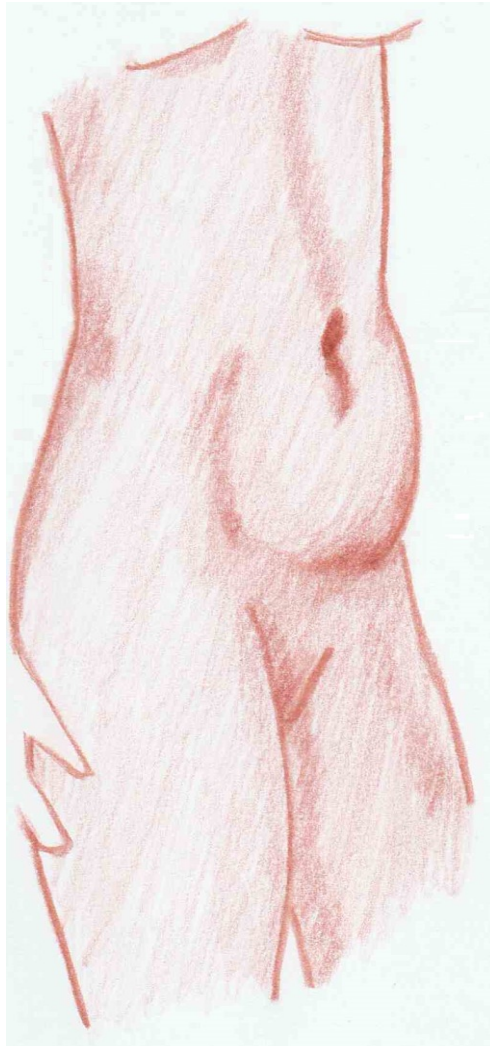
Usually patients who have no limpness of the myoaponeurotic-layer and only low levels of hypogastric excess tissue and tension loss but sometimes slight levels of increased suprapubic fat. (31)



**Figure 5:** Type II, adapted from (31)

### 2.2.3 Type III

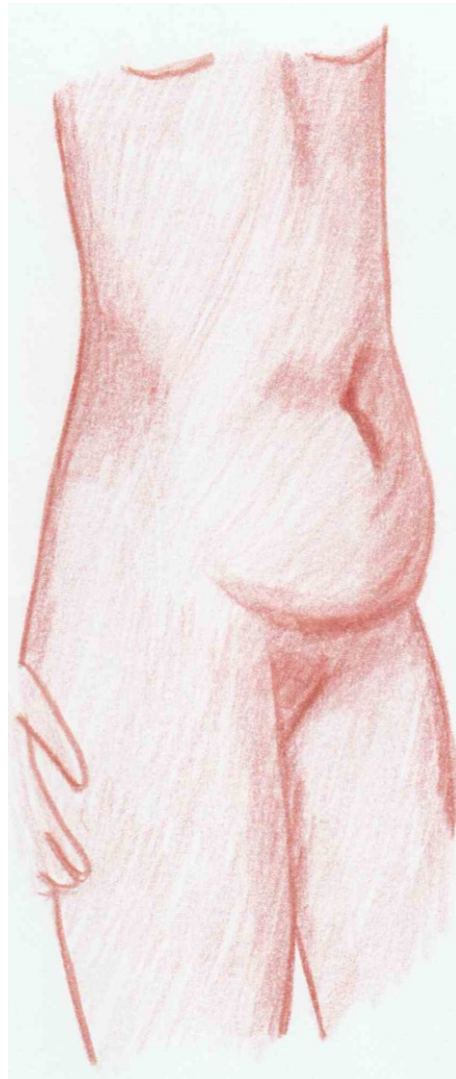
Type 3 is usually found in multiparous women. These patients are very similar to type two patients but show slight slackness of the myoaponeurotic-layer in the suprapubic area including loss of cutaneous tension.



**Figure 6:** Type III, adapted from (31)

## 2.2.4 Type IV

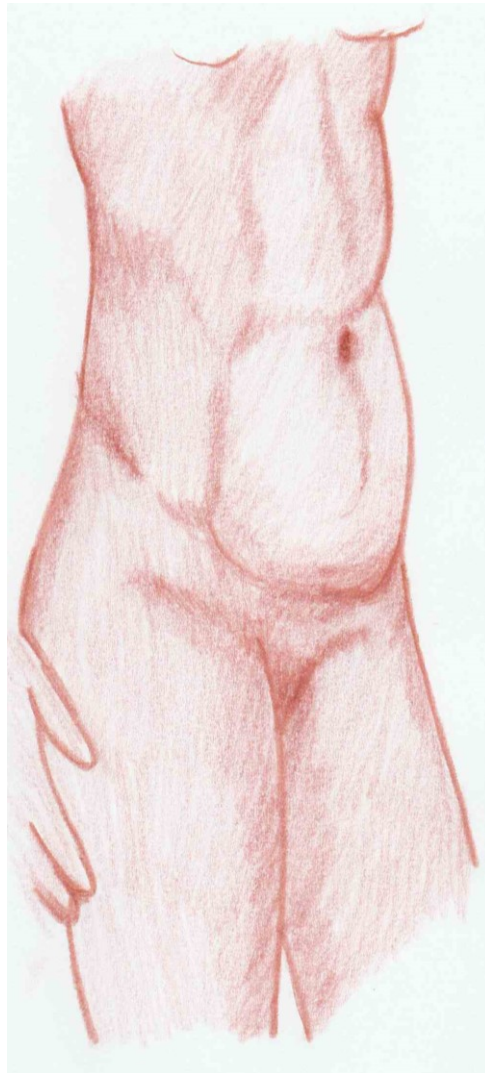
Patients of this group commonly show tension loss of the myoaponeurotic-layer between the xiphoid and the mons pubis, a moderate excess of hypogastric skin, moderate to high loss of skin tension, diverse accumulation of fat and an umbilicus-pubis distance of more than 14 cm. (31)



**Figure 7:** Type IV, adapted from (31)

### 2.2.5 Type V

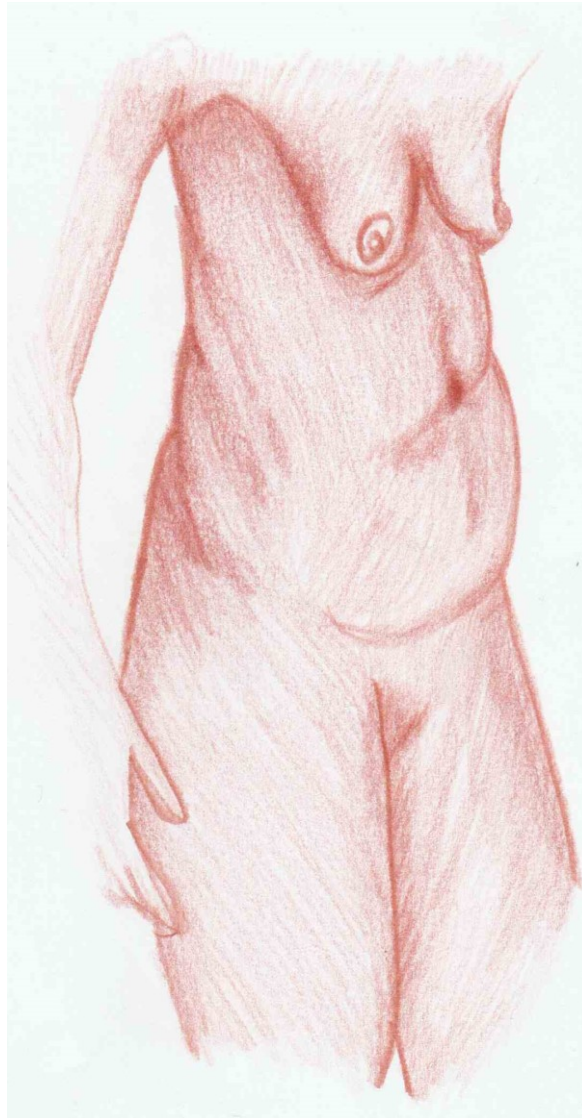
The patients of this classification are characterised by a significant muscular and cutaneous limpness with different fat accumulations above and below the umbilicus, loss of skin and muscular as well as myoaponeurotic-layer-tension. (31)



**Figure 8:** Type V, adapted from (31)

## 2.2.6 Type VI

These patients usually show large accumulations of excess skin and fat above the navel in the epigastrium. They frequently have the indication for mastopexy, breast augmentation or reduction and some show therefore submammary scars of past breast surgeries. (31)



**Figure 9:** Type VI, adapted from (31)

## **2.3 Same Techniques Different Nomenclatures**

A diverse range of different techniques regarding abdominoplasty can be found in the literature. All show slight differences, variations and nomenclatures but the essential components are similar. Incision, umbilicus repositioning, liposuction and direction of dissection are mostly the varieties shown. (37)

Hönig describes six types of abdominoplasty procedures based on six different types of the abdominal wall shown by patients (Figure 4-9). (31)

### **2.3.1 Type I Abdominoplasty**

This procedure is usually performed on patients of the Type 1 abdominal classification and only abdominal liposuction is done. (31)

### **2.3.2 Type II and III Abdominoplasty**

Patients are commonly Type II or III classified. They show a supra pubic excess of skin without noteworthy tension loss of the myoaponeurotic-layer-system. (31) This procedure is often called scarless abdominoplasty because the length of incision is generally much smaller compared to the traditional abdominoplasty but is still varying depending on the amount of removed skin. It is usually done under general anesthesia but also local anesthetic combined with a mild sedative is commonly performed.

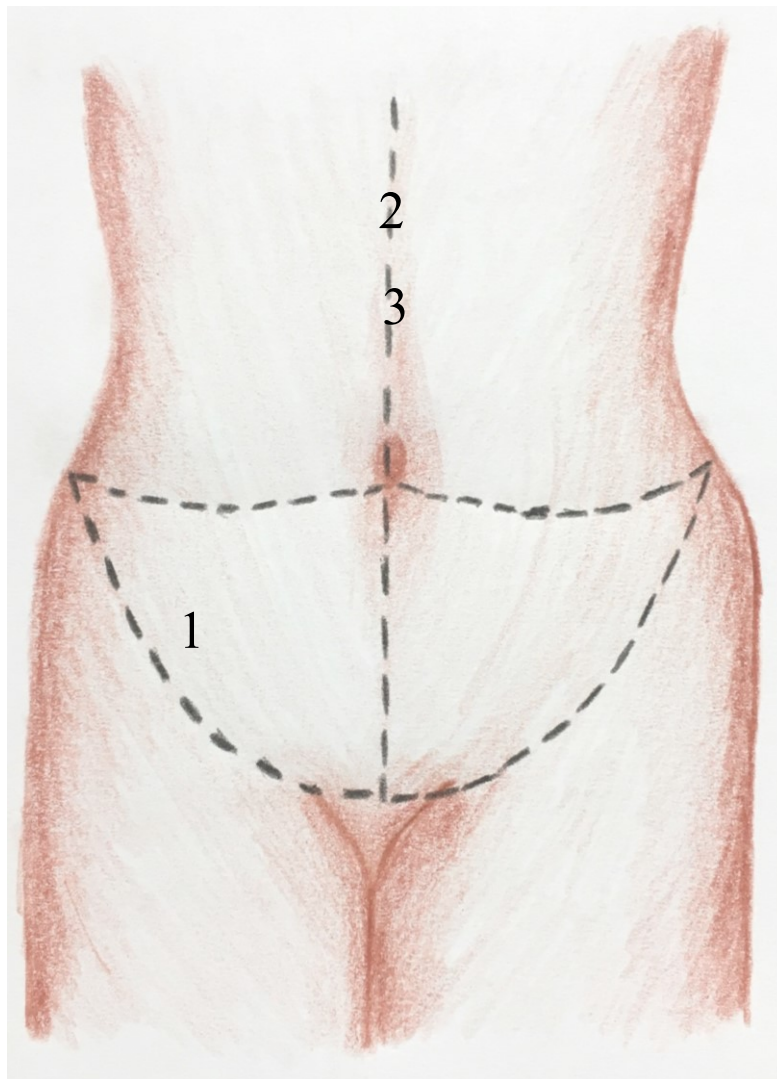
The umbilicus stays usually untouched but repositioning may be done in some cases as well as liposuction for better cosmetic results. (38)

### **2.3.3 Type IV Abdominoplasty**

This procedures should be seen as an extended version of the „Type III abdominoplasty in combination with a transfer of the umbilicus (floating Navel) and vertical closure of its old position (Slit Navel). (31)

### 2.3.4 Type V Abdominoplasty

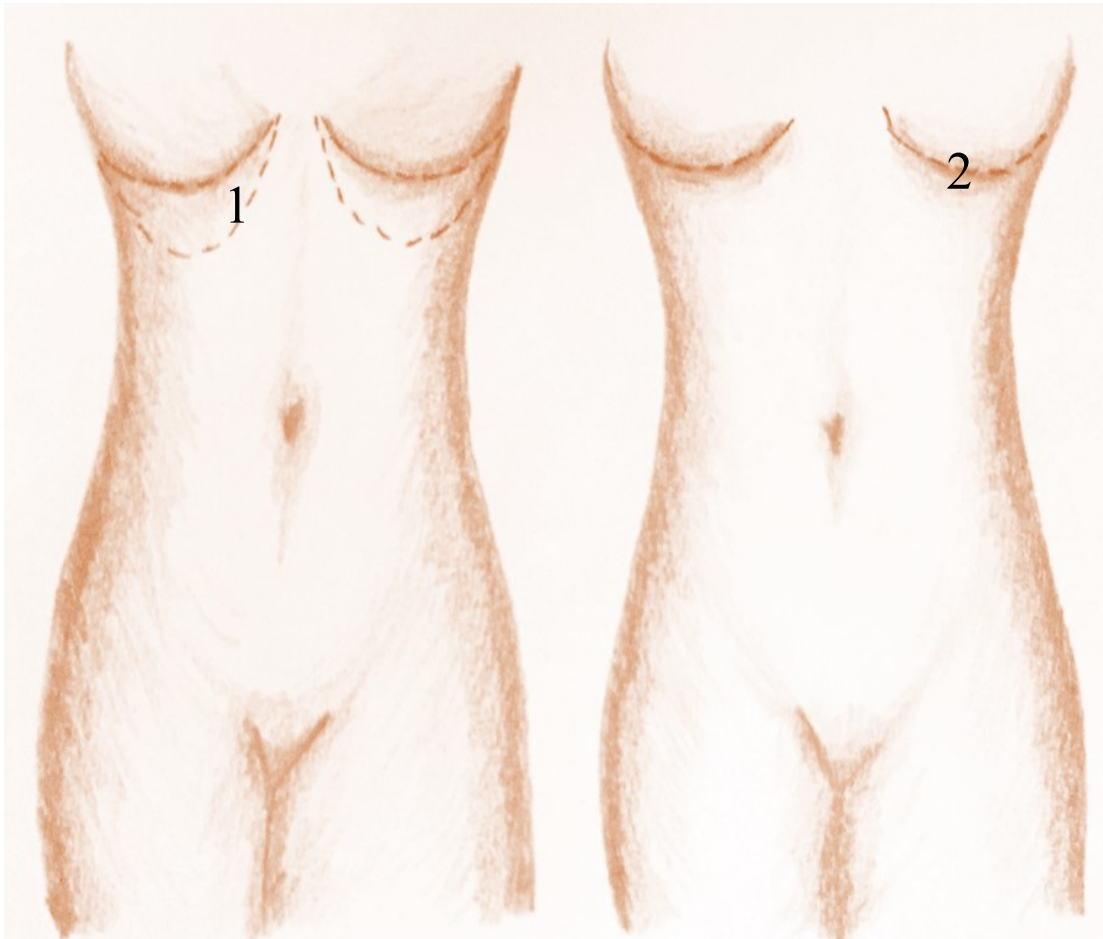
This is the classic full abdominoplasty and is typically indicated for Type V patients and aims for the correction of the myoaponeurotic-layer and cutaneous tension loss, the removal of unwanted epi- and hypogastric fat in combination with reduction of the excessive skin excess in the hypogastrium and an external oblique plication with the rectus abdominis muscle. (31)



**Figure 10:** Planned incision line and midline marking for classic abdominoplasty, adapted from (36), (1: planned skin incision, 2: midline marking, 3: proposed neoumbilical site)

### 2.3.5 Type VI Reverse-Abdominoplasty

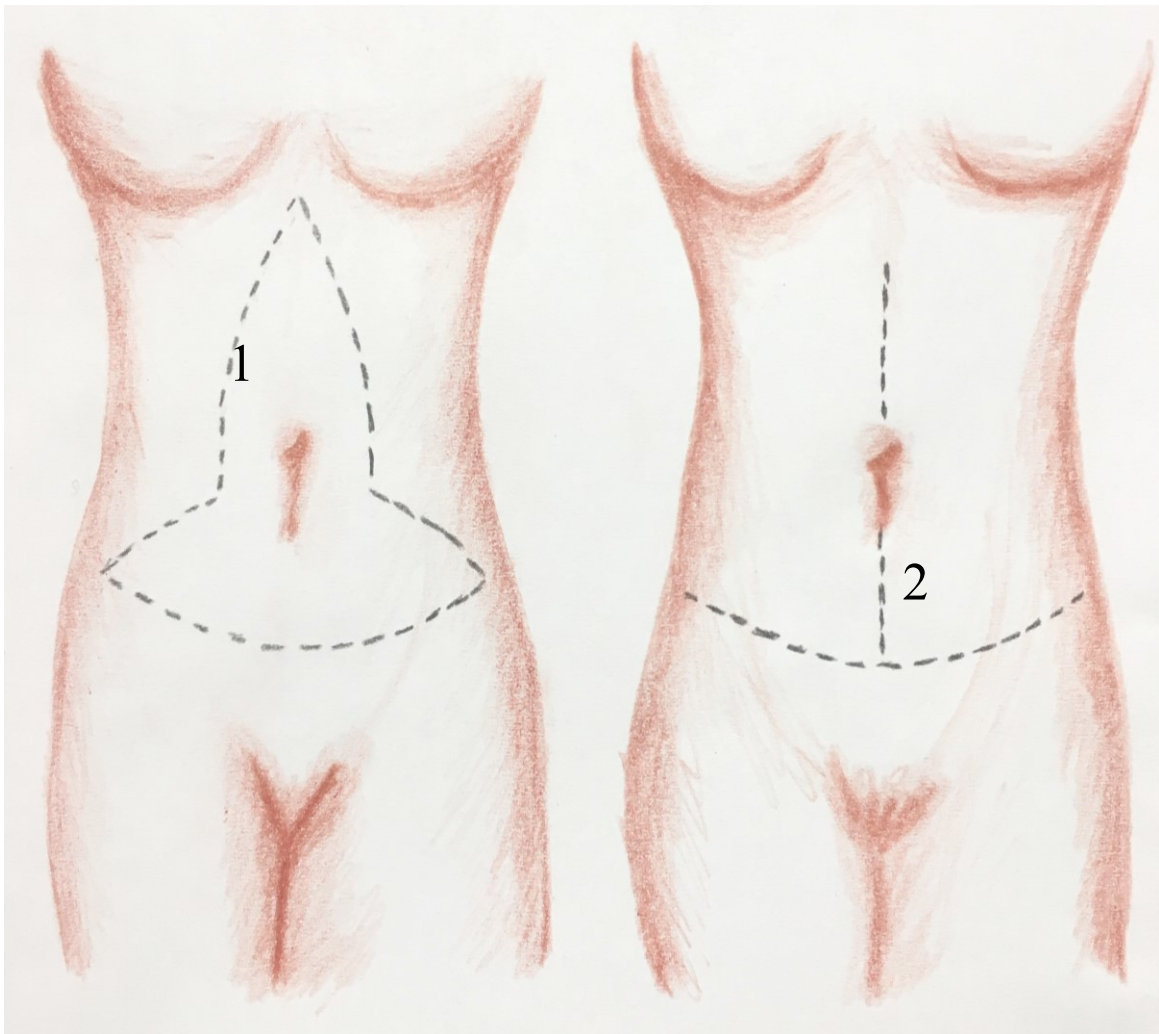
This procedure described by Rebello and Franco was established in 1972 and is rarely performed and is barely mentioned in the literature. (31,39,40) It is usually considered when patients show developed epigastric as well as submammary dermatochalasis and mastopexy, and when breast reduction or augmentation is indicated simultaneously or scars from previous breast surgeries are shown. (31) The difference in this technique lies within the access. Incision and dissection, similar to Baroudi's method, is performed reverse from the submammary fold and undermining is done downwards from the incision line to the umbilicus and lateral of it. (34)



**Figure 11:** Reversed abdominoplasty, adapted from (41), (1: planned incision line, 2: estimated scar line)

### 2.3.6 Fleur-De-Lis Abdominoplasty

This procedure shows additionally to the typical horizontal incision a second vertical one. Resulting scars are more difficult to hide and that's why this procedure should be reserved for patients who need the most amount of correction available. Sometimes a third incision is also necessary to remove skin between the umbilicus and the pubic region which adds another scar pub improves the overall contour. (42)



**Figure 12:** Fleur-de-lis abdominoplasty, adapted from (43) (1: planned incision line, 2: estimated scar lines)

## ***2.4 Postoperative Care***

The key aspects of post-operative care are comparable in all kinds of abdominoplasty. Postoperative nausea and vomiting should be minimized to avoid anxiety, discomfort, increased blood pressure, abdominal swelling and the risk of hematoma formation. The Binder should be inspected, released, smoothed and repositioned regularly as kinking or folding could result in ischemia and necrosis. It should be worn comfortably and not too tight during the early postoperative phase. From the second postoperative day onwards, showering is acceptable but intense activity and heavy lifting should be avoided for the first three weeks. (37)

The patient should be positioned with a slight flexion of 20° and bent knees. Antibiotics should be used until postoperative day two and anticoagulation, in combination with compression stockings, until discharge. Deep breathing, coughing and constipation should be avoided in the immediate postoperative period. (31)

High-vacuum wall suction is advised in the early postoperative period, and drains should remain until only 30-50 mL drainage is collected within 24hours. (37)

### **3 Anatomy**

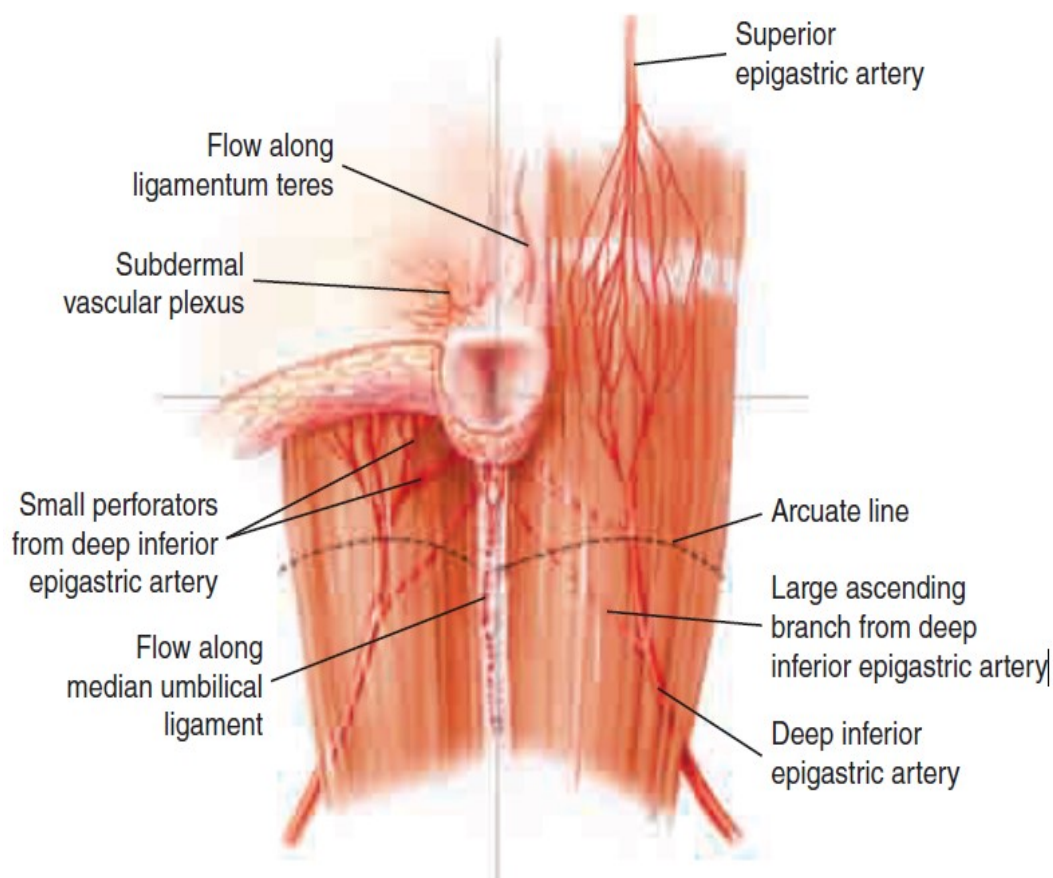
In order to avoid hideous scars, pain and other complications, a fundamental knowledge of the entire anatomy including the main perforating vessels, nerve courses, “Borgess lines” (44) (relaxed skin tension lines) (45) and their relationships is mandatory in order to predict individual occurrences and complications during surgical procedures. This is even more important as according to data from the United Kingdom, dissection of the body under personal tuition, as compared to literature based knowledge, becomes rarer in medical training for undergraduate medical students and medical graduates. (46)

#### **3.1.1 Superficial Tissue**

Skin, especially on the abdomen, is subject to many changes during life. Weight loss, weight gain, pregnancy, different surgical interventions and age have serious impacts on tissue composition and distribution. Progression of the dermal collagen rupture and separation results in consequent skin thinning. Especially patients after bariatric weight loss seem to have pre-damaged skin based on content and structure of collagen and elastin. “Zones of adherence” are areas of increased adhesion to the underlying fascia. These adhesions are found in the vertical midline area and usually in a horizontal direction above the navel called “supra-umbilical skin fold” as well as in a horizontal direction superior to the anterior superior iliac crest. The subcutaneous abdominal tissue contains two different fasciae. The first is Camper’s fascia which is superficial, in contrast to the deep Scarpa’s fascia, which is usually found as a strong fibrous layer of connective tissue and extends into the fascia lata. (45) Substantial scientific data shows that the abdominal wall be a three-coated structure. The middle layer is represented by the Scarpa’s fascia and the superior and deep layer of fat (note that regardless of adiposity level the superior is always the thicker one). Referring to Costa-Ferraira et al. “preservation of Scarpa’s fascia and the deep fat compartment during abdominoplasty carries several advantages. Lower drain volumes, earlier drain removal, avoidance of long drainers, shorter hospital stay are clinically very significant benefits.” Preservation also grants similar aesthetical results as to those usually obtained by classic full abdominoplasty. (47)

### 3.1.2 The Umbilicus

The navel drew less attention until 1917 when Beck published an article about integrating the umbilicus into the transversal scar to achieve better cosmetic results. Being usually situated in the centre of the torso on a line between the xiphoid and mons pubis the belly button has an enormous status for aesthetic reasons. (31) 9-12 cm above the upper edge of the mons pubis to be more precisely. This region shows further an increased risk forming hernias. (45) It is not hard to imagine that patient's satisfaction after abdominoplasty might not be great if a natural appealing navel is not part of their new, flat belly.

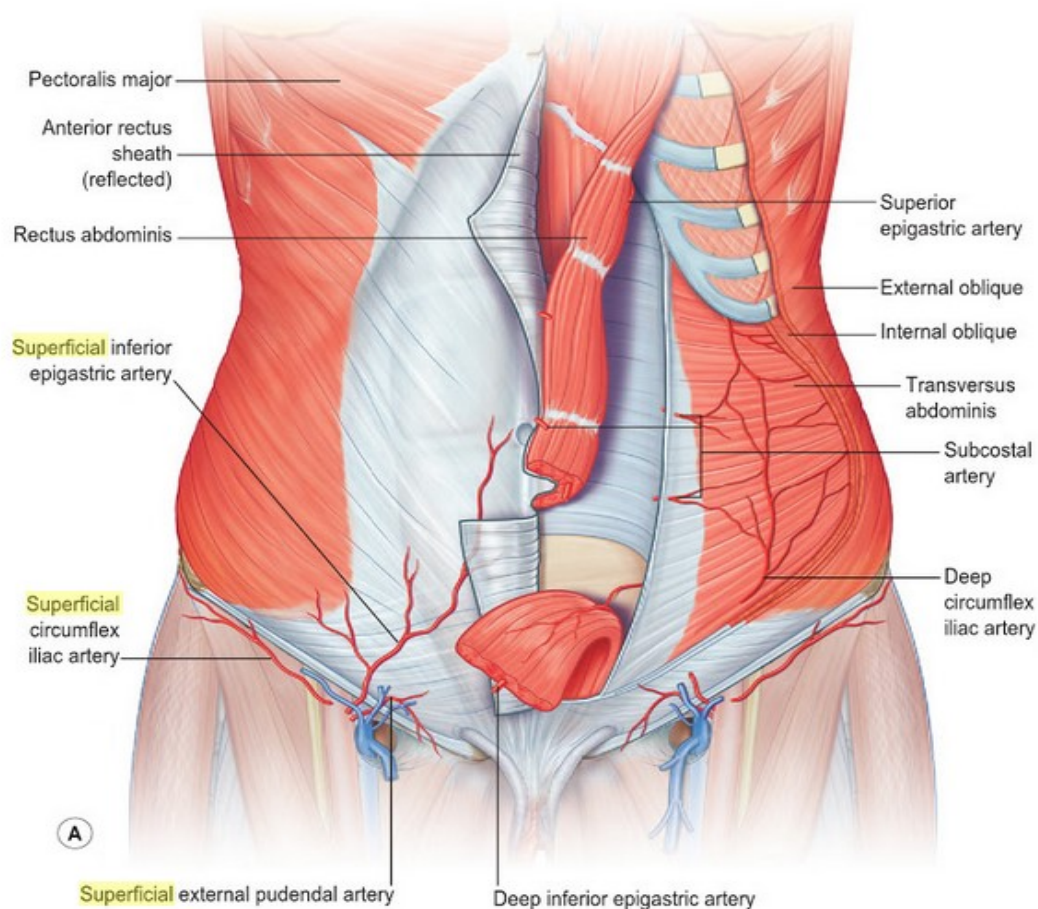


**Figure 13:** The umbilicus (36)

### 3.1.3 Blood Supply

Different systems which supply the abdominal region with blood are known. They include deep and superficial sources from thoracic and pelvic arteries communicating together. Superficial arteries mainly supply skin and near tissue while deep arteries are responsible for muscles and other deep structures. This knowledge will be especially important when it comes to surgeries after prior abdominal procedures. (48) Hunger described three different supply zones of the human abdomen. In depth knowledge of them can help to organise and plan procedures for an optimal outcome.

- Zone I is supplied by the epigastric arcade
- Zone II by the superficial inferior epigastric, superficial circumflex iliac and superficial external pudendal arteries
- Zone III represents the flanks which are supplied by six lateral intercostal and four lumbar arteries



**Figure 14:** Arteries of the abdominal wall (49)

Distinctive collateral arteries help to sustain a good overall circulation. Mobilising the flap in standard abdominoplasty normally cuts all zone I and nearly all branches of zone II, which makes arteries from the third zone essential. Lumbar and intercostal arteries are therefore decisive to provide optimal perfusion to the remaining skin. That's why previous surgeries or traumas should be investigated seriously. (45) Moon et al. published a radiographic study with special consideration of deep superior and inferior epigastric arteries and their anastomosis within the abdominal wall in 64 fresh cadavers. Showing that these arteries can be found in different variations:

- Type I: in 29 percent showed a single deep superior epigastric artery and deep inferior epigastric artery
- Type II: in 57 percent showed a double-branched system of each vessel
- Type III: in 14 percent showed a system of three or more major branches

Furthermore, it was shown that each variation of the superficial and inferior arteries shares connecting choke vessels in the segment of muscle above the navel. Referring to flap surgery, it was shown that vertical and the various transverse flaps seem to have the best blood supply while transverse rectus abdominis myocutaneous flaps (TRAM) have the most tenuous. (50) Knowledge of this is chiefly important for flap surgery in the context of abdominoplasty since this technique remains the most common method of autogenous breast reconstruction. (51)

### **3.1.4 Lymphatic System**

The Lymphatic drainage of the abdominal walls soft tissue is divided by the umbilicus which serves as a watershed point. As a result, the lymphatic network superior to the navel drains primarily into the axillary lymph node basin while the inferior drains mostly into the superficial ipsilateral inguinal lymph node basin. The importance of Scarpa's fascia preservation in abdominoplasty can be explained through the fact that the infraumbilical drainage runs through the subscarpal plane. (49)

### 3.1.5 Nerves of the Abdominal Wall

Cutaneous sensations from the abdominal area include dermatomes T4-L1 (37) but they often change following abdominoplasty. (31) The abdominal soft tissue is mostly innervated by anterior and lateral cutaneous branches of intercostal and subcostal nerves (37) (usually branches of T6-T12) as well as afferents(?) of ilioinguinal and iliohypogastric nerves. (31)

Anterior branches of intercostal and subcostal nerves deliver afferents of the midline abdomen. They travel between transverse and internal oblique muscles and further through the rectus abdominis muscles before emerging through the anterior rectus sheath to skin and soft tissue. Lateral branches of subcostal and intercostal nerves go through the oblique muscles near the midaxillary line and continue superficially to the external oblique muscles to supply sensations laterally. The hip and lateral thighs are supplied by subcostal and iliohypogastric nerves. The junction between the lateral one-third and the medial two-thirds of the inguinal ligament is the place where the lateral femoral cutaneous nerve typically emerges. (37)

## 4 Clavien-Dindo Classification of Surgical Complications

Clavien et al. established a classification for postoperative complications to encounter the lack of standardisation and uniformity in surgical literature. (52) Their classification (Table I) is simple, flexible and useful, regardless of the patients social, ethnic or cultural background. Their tests for general applicability in several centres familiar with this system showed results of more than 90% correct assignments for simple and complex cases over more than five years. They concluded that their classification has reached a status where it can be recommended in its current version for retro- and prospective studies. (53) This intervention-oriented classification system separates groups into five major grades regarding kind of complication and needed intervention. The full scale version provides, in contrast to the contracted form, four additional sub-grades; grade III-a/b and IV-a/b. Dindo et al. also published an evaluation of this classification in a cohort of more than six-thousand patients undergoing elective surgery. (18)

Full Scale		Contracted Form	
Grade	Intervention / Definition	Grade	Intervention / Definition
I	Any deviation from the normal postoperative course	I	Same as for full scale
II	Requiring pharmacological treatment	II	Same as for full scale
III	Requiring surgical, endoscopic or radiological intervention	III	Same as for full scale
III-a	Intervention not under general anesthesia		
III-b	Intervention under general anesthesia		
IV	Requiring IC/ICU-management	IV	Same as for full scale
IV-a	Single organ dysfunction (including dialysis)		
IV-b	Multi organ dysfunction		
V	Death of a patient	V	Same as for full scale

**Table 1:** Clavien-Dindo Classification of Surgical Complications (53)

## 5 Scientific Questions

Abdominoplasty is according to the American Society for Aesthetic Plastic Surgery one of the most common surgical procedures performed and associated with a higher complication rate than other contouring procedures. (1,15,16) However, complication rates vary in literature and therefore predictions are hard to make. (1,3,27,47,70–82)

Therefore, how high were local rates at the University Hospital Graz within the last fifteen years and how high are rates published in recent literature? Are there any differences between both rates and if so, why? Is the Clavien-Dindo classification for surgical complications a useful tool to rate complications following abdominoplasty?

## **6 Methods and Material**

### **6.1 Data Collection (Own Data)**

All data was collected retrospectively from the electronic data achieving system MEDOCS (SAP R/3, SAP, Walldorf, Germany) used by the Medical University Hospital Graz. All surgery reports, anesthesia reports, medical files, patient records and clinical records including follow up reports were read from preselected patients operated on between 01/2001-11/2016. All data was manually transferred into IBM SPSS Statistics Version 22.0 (IBM, Armonk, USA) for evaluation and further statistical analysis. The Completion of data was done using electronic individual case record review. No difference was made with regard to gender, political, social or ethnical background.

#### **6.1.1 Parameters Collected from Own Data**

- Total number of approved patients
  - Gender
  - Type of surgery
  - Group affiliation
- Age
- BMI
- Smoking habits
- Complication yes/no
  - Type of complications
  - Rate of complications

## **6.1.2 Literature Collected from Review**

Source of this analysis was the PubMed database (U.S. National Library of Medicine, Bethesda, Maryland, USA). Articles were included if published between 01/1994 and 12/2016 if the following data was included:

- Type of surgery
- Complication yes/no
  - Type of complications
  - Rate of complications
  - The most commonly defined complications
- Use of the Clavien-Dindo classification in literature yes/no?

### **6.1.2.1 Inclusion Criteria (Own Data)**

All patients were included who received abdominoplasty alone or as part of a autogenous breast reconstruction surgery between 01/2001 and 11/2016 at the Department of Plastic, Aesthetic and Reconstructive Surgery at the Medical University Hospital Graz and were at least eighteen years old.

### **6.1.2.2 Inclusion Criteria (Literature Review)**

Literature was identified and analysed if the following data was reported:

- Number of patients
- Study period
- Complication rate
- Detailed list of complications

## **6.2 Grouping**

We defined two groups, and assigned all eligible patients based on the therapy they received. This was either abdominoplasty as part of weight loss associated tissue reduction ([Group A](#)) or as part of autologous breast reconstruction ([Group B](#)).

## **6.3 Complications**

Only complications resulting from abdominoplasty were assessed. Meaning that complications resulting from upper arm lift or belt lift were not recorded and complications from autologous breast reconstruction other than located at the abdomen, were not logged.

## **6.4 Definition of Complications**

### **6.4.1 Wound Healing Disorder**

Wound healing disorders resulting from a disturbed sequence of the physiological healing phase's haemostasis, inflammation, proliferation and remodelling. (54)

### **6.4.2 Necrosis**

This is a detrimental or fatal pathological process resulting from irreparable injuries or severe hypoxia. It is a progressive, uncontrolled action which leads to death of cells and living tissue. It is the opposite from the normal, controlled and regulated process called apoptosis. (55)

### **6.4.3 Fistula**

Fistulas are abnormal communications between two epithelialized surfaces. They are most commonly seen between two internal organs, or between an internal organ and the surface of the body. They can result from disease, medical treatment (sutures) or trauma. (56)

#### **6.4.4 Seroma**

Seromas are serous fluid accumulations in a tissue, organ, or cavity. They can result from surgery when small blood vessels are severed and blood plasma escapes. Injury can also lead to these fluid formations which are usually reabsorbed over time but calcified tissue knots can remain. (57,58)

#### **6.4.5 Haematoma**

Haematomas are collections of blood outside of blood vessels resulting from disease or trauma such as injury and surgery. They can be localized in an organ, space, or tissue such as fat, skin and muscles. They can also be caused iatrogenic due to an overdose of anticoagulant. They can be visible in the skin or felt as lumps if they are deeper. (59)

#### **6.4.6 Increased Local Postoperative Pain**

Typically shown as increased pain during the period after surgery and requires additional pain management. Subjective to the patient and not assessed standardised.

#### **6.4.7 Scar Deformity**

Scar deformity can be present as any unpleasant, painful or unwanted deviation from the normal postoperative scarring (e.g. contracture, retraction, and hypertrophy). (60)

#### **6.4.8 Wound Dehiscence**

This is a pathological process consisting of a partial or complete disruption of the layers of a surgical wound with the possibility of bleeding, pain, fever, inflammation or spontaneous wound opening. (61)

### **6.4.9 Postoperative Infection**

These infections occur post operatively at sites of surgical incisions and can either be localised in the skin or subcutaneous tissue as well as deep in the muscle, fascia, bone or fascia. Staphylococcus aureus is the most common causative organism in adults whereas gram-negative organisms are more likely in immunosuppressed patients. (62)

### **6.4.10 Abdominal Wall Weakness**

No MRI or CT scans done, information gathered from patient's records.

### **6.4.11 Hyperalgesia**

Hyperalgesia results in an increased sensation of pain or discomfort resulting from stimuli that are not normally painful and normally painful stimuli are perceived even more strongly. (63)

### **6.4.12 Suture Granuloma**

Suture granulomas are benign lesions that result from foreign body reactions to non-absorbable suture material at a surgical site. (64)

### **6.4.13 Haemorrhage**

Reactive bleeding normally occurs within the 24 hours following surgery. Slipped ligatures or initially missed vessels are most commonly the cause. (65)

## **6.5 *Statistical Analysis***

### **6.5.1 Own Data**

The data collection was done using a prefilled Excel sheet which was manually completed (MS Excel 2010, Microsoft, Richmond, USA).

IBM SPSS Statistics Ver. 22.0 (International Business Machines Corporation IBM, Armonk, USA) was used for statistical analysis.

The Parametric distribution was tested using the Kolmogorov-Smirnov test. Descriptive statistics for parametric data was done using the mean $\pm$ standard deviation; nonparametric data were analysed using median [min-max].

### **6.5.2 Literature Review**

Descriptive statistics using the mean $\pm$ standard deviation for parametric and median [min-max] for non-parametric data.

## 7 Results

### 7.1 Own Data

#### 7.1.1 Patients

We identified a total of (n=398/100%) patients who were eligible for this thesis. We found (n=355/89%) women who received abdominoplasty alone or during breast reconstruction and (n=43/11%) men who received abdominoplasty alone. Autologous breast reconstruction (**group B**) was performed in (n=132/33.5%) of all eligible cases and abdominoplasty alone (**group A**) (n=266/66.5%) times.

#### 7.1.2 Gender Distribution in both groups

**Group A** had (n=43/100%) male and (n=223/62.8%) female patients whereas **Group B** (n=0/0.0%) men and (n=132/37.1%) women.

#### 7.1.3 Age

The youngest patient of the pure-abdominoplasty group was just 19 while the oldest was 78. Patients in the reconstruction group showed a slightly higher minimum age of 23 years and a higher maximum age of 78. The median was 39 in the pure-abdominoplasty and 46 in the reconstruction group. This resulted in an overall minimum age of 19, a median of 43 and a maximum age of 78 regarding all patients included in this study.

- **Group A**
  - 39 [19-78] years
  
- **Group B**
  - 46 [23-69] years

#### 7.1.4 BMI

The BMI was missing in the records of 12 patients records resulting in a total of (n=386/96.9%) patients included in the evaluation. One Patient in [group A](#) showed a BMI of 62 whilst all others of this group had values of 50 and below.

- [Group A](#)
  - 27.5 [18.73-62]
  
- [Group B](#)
  - 25.74 [18.4-44.64]

#### 7.1.5 Smoking Habits

Only (n=383/96.2%) patients had smoking/non-smoking records in their files and were included in this evaluation. We found a total of (n=171/44.6%) smokers and (n=212/55.4%) non-smokers.

- [Group A \(n=257\)](#)
  - Smokers (n=135/57.5%)
  - Non-smokers (n=122/42.5%)
  
- [Group B \(n=126\)](#)
  - Smokers (n=36/28.5%)
  - Non-smokers (n=90/71.4%)

## 7.2 Complications

A total of (n=387) complications were recorded and furthermore evaluated with the Clavien-Dindo classification of surgical complications. A total of (n=189/47.5%) patients were found who developed at least one postoperative complication. The total complication rate was of 47.7% within all (n=398/100%) patients. **Group A** showed a complication rate of 51.9% including (n=21/48.8%) male and (n=116/32.7%) female patients who developed postoperative complications. **Group B**, on the other hand had a complication rate of (n=52/39.4%) and consisted of only female patients.

- **Group A**
  - 51.9%
  - ♂ (n=21/48.8%)
  - ♀ (n=116/32.7%)
  
- **Group B**
  - 39.4%
  - ♂ (n=0/0.0%)
  - ♀ (n=52/39.4%)

### 7.2.1 All Complications, occurring in n=398 Patients (Own Data)

Following complications and numbers were recorded: disordered wound healing (n=116/30%), necrosis (n=49/13%), fistula (n=42/11%), seroma (n=32/8%), haematoma (n=33/9%), increased local postoperative pain (n=33/9%), wound dehiscence (n=24/6%), postoperative infection (n=22/6%), scar deformity (n=29/7%), allodynia (n=1/0.3%), suture granuloma (n=1/0.3%), pocket formation (n=2/1%), abdominal wall weakness (n=2/1%) and reactionary haemorrhage (n=1/0.3%).

Complications	Total
<b>Wound healing disorder (conservative management)</b>	116
<b>Necrosis</b>	49
<b>Fistula</b>	42
<b>Seroma</b>	32
<b>Haematoma</b>	33
<b>Increased local postoperative pain</b>	33
<b>Scar deformity</b>	29
<b>Wound dehiscence (either conservative or surgical management)</b>	24
<b>Postoperative infection</b>	22
<b>Pocket formation</b>	2
<b>Abdominal wall weakness</b>	2
<b>Hyperalgesia</b>	1
<b>Suture granuloma</b>	1
<b>Reactionary haemorrhage</b>	1
<b>Total</b>	387

**Table 2:** All complications recorded

## 7.2.2 Our Data Evaluated with the Clavien-Dindo Classification

The evaluation regarding the Clavien-Dindo classification showed following results: (n=85/44,7%) Grade I, (n=28/14,7%) Grade II and (n=55/28,9%) Grade III complications. Grade III showed (n=6/3,2%) Grade III-a and (n=16/8,4%) Grade III-b complications (Table 4, Figure 10).

Grade	Definition	Number
<b>Grade I</b>	Any deviation from the normal postoperative course without the need for pharmacological treatment or surgical, endoscopic and radiological interventions	85
<b>Grade II</b>	Requiring pharmacological treatment with drugs other than such allowed for grade I complications.	28
<b>Grade III</b>	Requiring surgical, endoscopic or radiological intervention	55
<b>Grade III-a</b>	intervention not under general anesthesia	6
<b>Grade III-b</b>	intervention under general anesthesia	16
<b>Grade IV</b>	Life-threatening complication	0
<b>Grade IV-a</b>	single organ dysfunction	0
<b>Grade IV-b</b>	multi organ dysfunction	0
<b>Grade V</b>	death of patient	0

**Table 3:** Complications graded using the Clavien-Dindo classification

### 7.2.2.1 Results after Grading with the Clavien-Dindo Classification

- (n=85/44.7%) Grade I
- (n=28/14.7%) Grade II
- (n=55/28.9%) Grade III
- (n=6/3.2%) Grade III-a
- (n=16/8.4%) Grade III-b

### 7.2.3 International Data (Literature Review)

Seventeen studies were identified, including a total of (n=15573/100%) patients who received abdominoplasty. The complication rate in literature was a parametric distribution with a mean of 31.18%±9.40.

The Clavien-Dindo classification was not used in any of the studies we evaluated (n=17) in this thesis to grade postoperative complications.

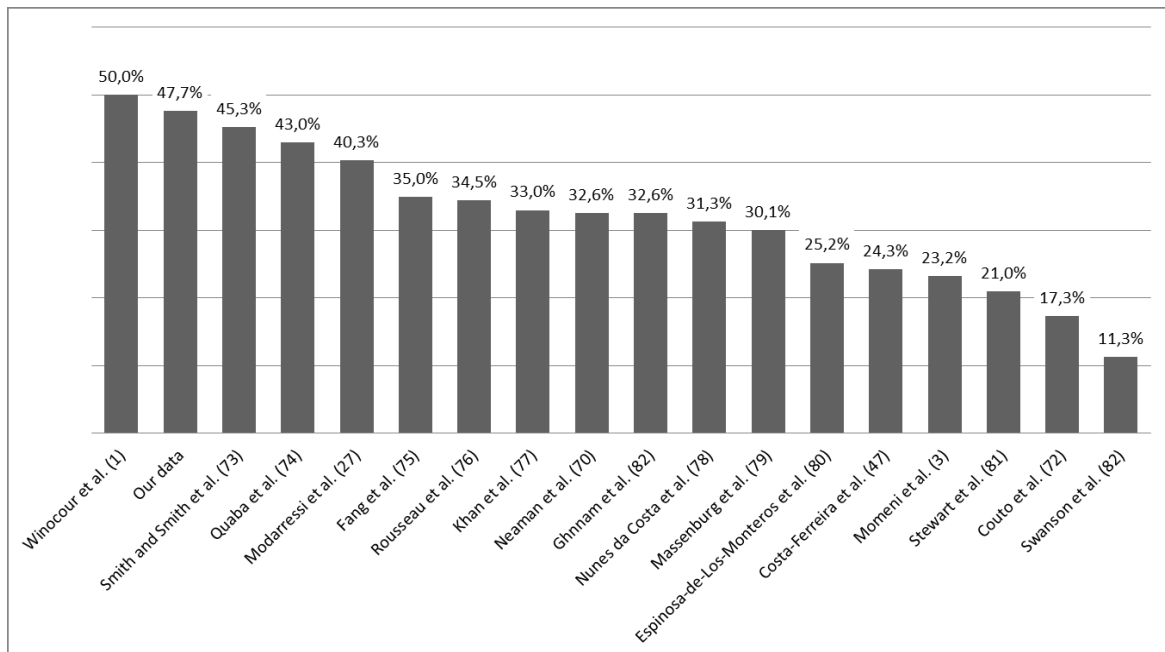


Figure 15: Complication rates (literature review)

Author	Time	Rate %	Minor	Major	Clavien-Dindo
Winocour et al. (1)	1994-2004	40,30%	28,80%	11,50%	no
Our data	1997-2001	43,00%	n.a.	n.a.	no
Smith and Smith et al. (87)	1998-2008	32,60%	31,90%	18,10%	no
Quaba et al. (86)	2000-2004	30,10%	n.a.	n.a.	no
Modarressi et al. (26)	2000-2008	25,20%	n.a.	n.a.	no
Fang et al. (85)	2001-2015	23,20%	n.a.	n.a.	no
Rousseau et al. (84)	2001-2016	47,7%	n.a.	n.a.	yes
Khan et al. (83)	2002-2006	50,00%	n.a.	n.a.	no
Neaman et al. (81)	2003-2012	21,00%	n.a.	n.a.	no
Ghnam et al. (82)	2004-2008	24,30%	24,30%	0,00%	no
Nunes da Costa et al. (80)	2005-2010	17,30%	16,00%	1,30%	no
Massenburg et al. (79)	2008-2013	11,30%	n.a.	n.a.	no
Espinosa-de-Los-Monteros et al. (78)	2009-2011	35,00%	n.a.	n.a.	no
Costa-Ferreira et al. (46)	2010-2014	34,50%	22,00%	45,00%	no
Momeni et al. (3)	2010-2015	45,30%	31,40%	23,20%	no
Stewart et al. (77)	2011-2012	33,00%	n.a.	n.a.	no
Couto et al. (76)	2011-2015	31,30%	14,90%	16,40%	no
Swanson et al. (75)	2015-2016	32,60%	n.a.	n.a.	no

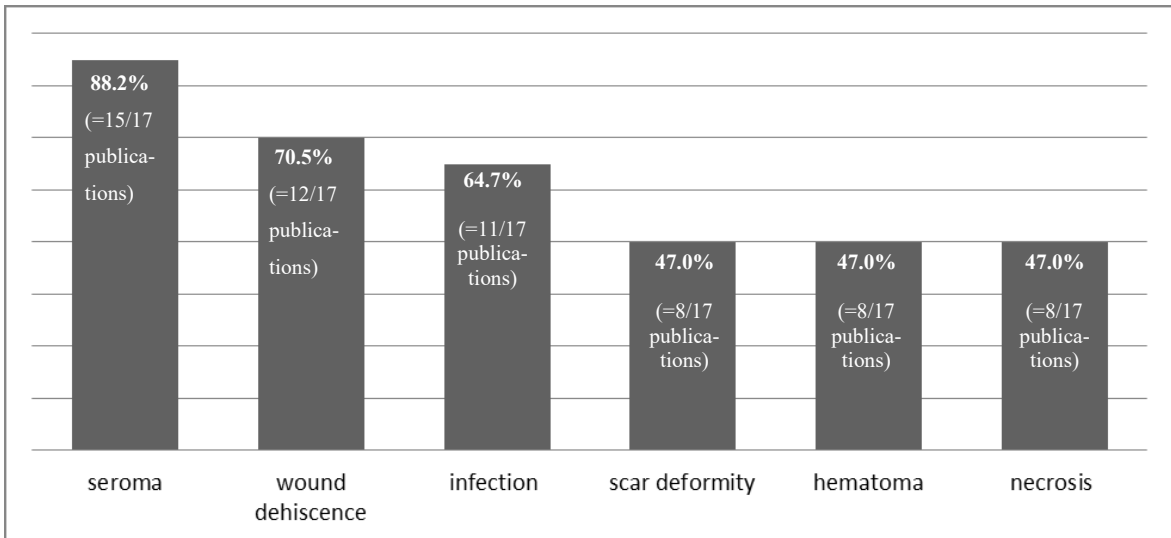
Table 4: Complication rates (literature review)

## 7.2.4 The Six Most Common Complications in Literature

We isolated the six most common postoperative complications from the literature (n=17) we reviewed to get additional comparison options.

These most common complications were:

1. Seroma 88.2% (15/17)
2. Wound dehiscence 70.5% (12/17)
3. Infection 64.7% (11/17)
4. Scar deformity 47.0% (8/17)
5. Haematoma 47.0% (8/17)
6. Necrosis 47.0% (8/17)



**Figure 16:** The six most common complications in literature (n=17)

### 7.2.5 Our Six Most Common Complications

Our six most common complications were: wound healing disorders ( $\neq$  dehiscence) with (n=116/29%) on the first place, followed by necrosis with (n=49/12%), fistulas with (n=42/11%), haematomas with (n=33/8%), increased local postoperative pain with (n=33/8%) and seromas with (n=32/8%).

1. **Wound healing disorder ( $\neq$  dehiscence)** 29% (116/387)
2. **Necrosis** 12% (49/387)
3. **Fistula** 11% (42/387)
4. **Haematoma** 8% (33/387)
5. **Increased local postoperative pain** 8% (33/387)
6. **Seroma** 8% (32/387)

### 7.2.6 The Six Most Common Complications in Literature Shown with the Numbers from Our Data

The six most common complications we identified in literature were used as a template to show if these numbers and distributions corresponded to our data. In this case necrosis was in the first place with (n=49/12%) followed by: seromas with (n=32/8%), haematoma with (n=33/8%), wound dehiscence with (n=24/6%), infection (postoperative) with (n=22/6%), scar deformity with (n=29/7%).

- 1. Necrosis 12% (49/387)
- 2. Seroma 8% (32/387)
- 3. Haematoma 8% (33/387)
- 4. Wound dehiscence 6% (24/387)
- 5. Infection 6% (22/387)
- 6. Scar deformity 7% (29/387)

The Six Most Common Complications in Literature
1. Seroma 88,%
2. Wound dehiscence 71%
3. Infection 65%
4. Scar deformity 47,%
5. Haematoma 47,%
6. Necrosis 47,%
<b>[% = mentioned complication(s) per 17 publications]</b>

**Table 5:** The six most common complications in literature

Own Data (Unfiltered)
1. Wound healing disorder 29% (≠ dehiscence)
2. Necrosis 12%
3. Fistula 11%
4. Seroma 8%
5. Haematoma 8%
6. increased local postoperative pain 8%
<b>[% = mentioned complication(s) per 398 cases]</b>

**Table 6:** Own data (unfiltered)

### 7.2.7 Our Complication Rate in Comparison to Rates from Literature

We compared our complication rate of 47.7% to the rates we gathered from literature and found out that our rate was consistent with the highest rate of 50.0% reported within the publications we evaluated.

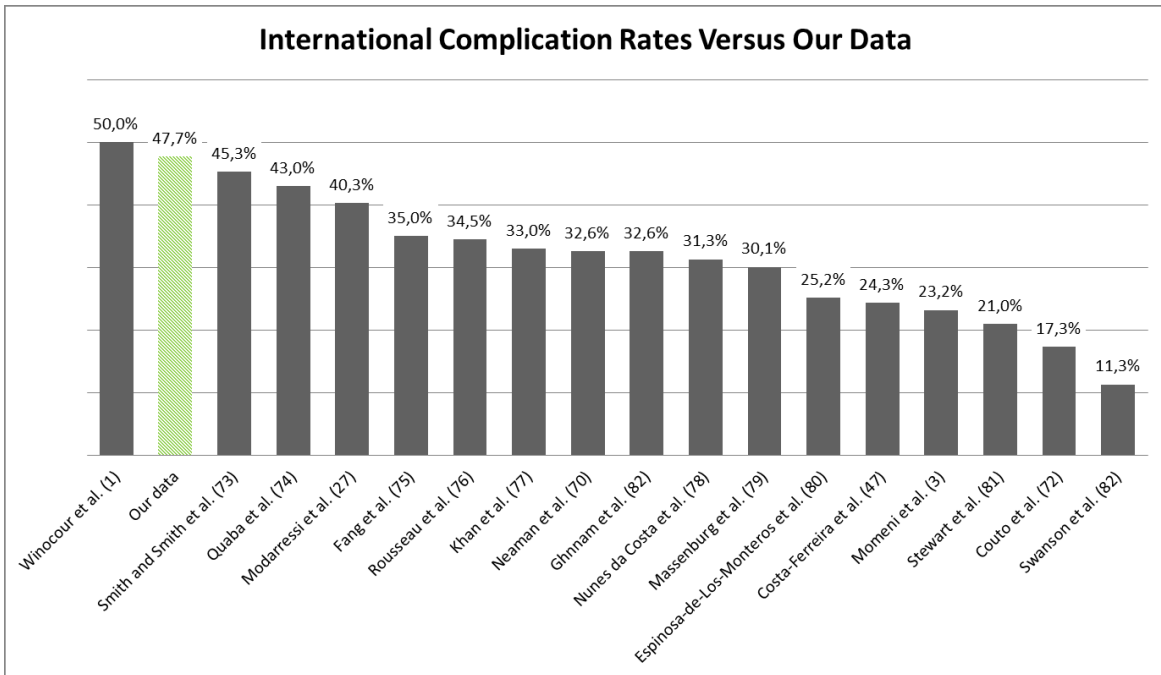


Figure 17: Our Data in Comparison to Literature

### 7.2.8 Comparison of the six most Common Complications in both Literature and Own Data

In an attempt to uncover similarities in both data sets, we only displayed the six most common complications in literature with numbers from our data and listed them according to their frequency. This comparison did not reveal any correlation or similarity.

Six Most Common Complications in Literature
1. Seroma 88,%
2. Wound dehiscence 71%
3. Infection 65%
4. Scar deformity 47,%
5. Haematoma 47,%
6. Necrosis 47,%
<b>[% = mentioned complication(s) per 17 publications]</b>

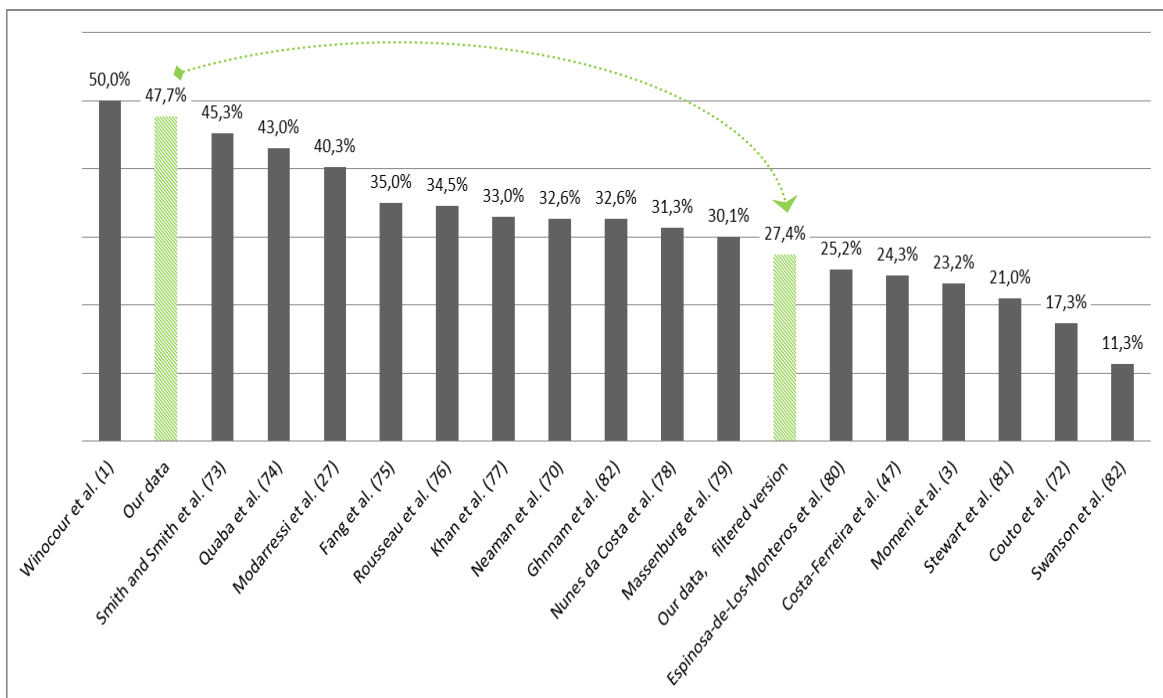
Table 7: Six most common complications in literature

Own Data (Filtered) Showing the Six Most Common Complications as Seen in Literature Only
1. Necrosis 12%
2. Seroma 8%
3. Haematoma 8%
4. Wound dehiscence 6%
5. Infection (postoperative) 6%
6. Scar deformity 7%
<b>[% = mentioned complication(s) per 398 cases]</b>

Table 8: Own data (filtered), showing the six most common complications as seen in literature only

## 7.2.9 Our Data Filtered with the six Most Common Complications

After getting our original rate of 47.7% in contrast to rates from literature, we wanted to see how our rate would change if we only display complications from literature. Therefore, only the six most common were rated, to get a new complication rate in accordance with literature. The result was a new, filtered complication rate of 27.7% which is almost half the initial rate and almost conjunction consistent with the lowest rates published.



**Figure 18:** Our Data Filtered with the six Most Common Complications

## 8 Discussion

According to literature abdominoplasty is associated with a higher complication rate compared to other contouring procedures and rates are even higher in combined procedures. (1–8)

The findings from our own data showed a corresponding high complication rate of 47.7% for **group A** and **B** combined.

A total of (n=387) complications affected only 189 patients, indicating that patients who developed postoperative complications were at higher risk of developing multiple complications. According to literature roughly 40% of patients suffered from multiple complications. The same study mentioned factors such as frailty and comorbidity as very predictive for the occurrence of multiple complications. (66)

The evaluation of our data showed a higher rate of complications in **Group A** (abdominoplasty) with 51.9% compared to **group B** (autologous breast reconstruction) with 39.4%. A possible reason for the difference between the two groups could be the share of smokers which was with 57.5% to 28.5% higher in **group A**. This corresponds to literature, listing smoking as a risk factor for postoperative complications such as wound healing disorders. (1,67)

It is possible that there are more smokers in **group A** because these patients received abdominoplasty after (massive) weight loss and many people believed that smoking helped to control their body weight. (68)

This has actually a long tradition; a commercial from the 1930s even recommended young women to “reach for a cigarette instead of a sweet”. (69)

Patients from **group B** in contrast received massive therapies such as mastectomy because of serious disease (e.g. breast cancer) or as preventive measure (BRCA mutation). The smoking prevalence in this particular group was lower.

Females were predominant in both groups with a share of 57.5% in **group A** and 28.5% in **group B** in contrast to a rate of 42.5% and 0% men. However, the male share of **group A** could have an impact on the increased complications rate following Neaman et al. who evaluated over one-thousand abdominoplasty procedures and reported the male sex as a risk factor for postoperative complications. (70) This was furthermore consistent with the evaluation by Momeni et al. but their data did not reach statistical significance. (3)

The BMI and age distribution was similar in both groups, even though the BMI was in contrast to age a risk factor for complications according to literature. (71,72)

However, the power of this study is greatly reduced by the purely descriptive analysis. A linear regression model would have been required to evaluate factors such as smoking, BMI, gender and age as risk factors for developing complications.

Another problem of this study is that the comparison of **group A** and **B** is like comparing “horses” with “zebras” due to the different underlying pathology in both groups.

This problem required the use of descriptive statistics with resultant statistical limitations (e.g. lack of group comparison by use of t-tests / Wilcoxon-Mann-Whitney tests). The lack of parameters which were not recorded or analysed is a further limiting factor. This includes the number of concurrent interventions per operation (e.g. by body region), duration of operations, pre-existing conditions (e.g. cardio vascular, diabetes, whether past surgeries were associated with postoperative complications).

Our literary research yielded a mean complication rate of 31.2%±9.4. (1,3,27,47,70–82) However, reporting of data was relatively incomplete and the list of complications in the cited literature was not comprehensive.

A reason for this inconsistency could be that complication rates were despite all disagreements an often used factor to represent the performance and quality of clinics, even without standardisation. (83) Thus implicating that no establishment has an actual interest in publishing such data.

At this point it has to be acknowledged that only seventeen studies were found to compare complication rates in literature. Further research projects are needed to clarify the issues as discussed above.

No standardised analysis was found in cited literature regarding definitions of complications, grading's of complications e.g. the Clavien-Dindo classification or simply which complications were published and which not. It is quite interesting that there was no standardised analysis of complications and their frequencies in the literature. This was surprising, because studies have established that the positive aspects of standardisation outweighed the negatives like limitation of creativity and is furthermore essential for structured comparison. (84)

Due to the lack of standardisation, comparison was very difficult to achieve. That is why, we introduced a parameter by selecting “the six most commonly reported complications” in cited studies (n=17). Those were compared to our six most common complications and

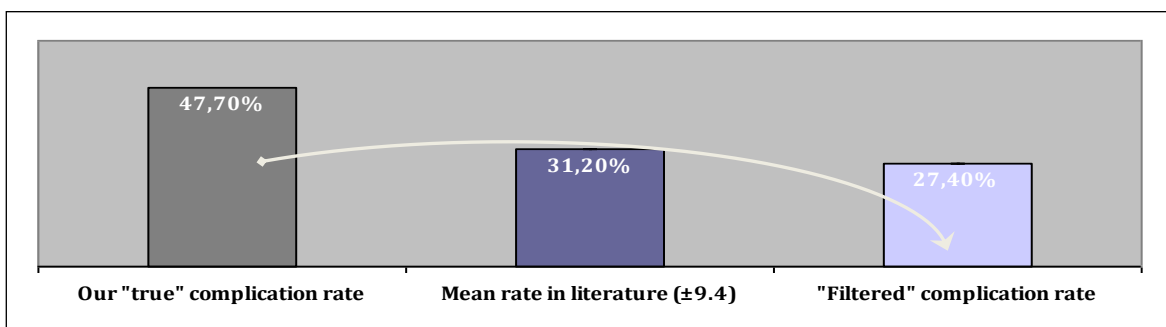
with our numbers only representing “the six most common” in literature as “filtered” complication rate. This actually did not represent the real complication rates and the comparison was therefore limited, but nevertheless it conveyed the message that currently literature lacks transparency. No direct correlation was found between our “filtered” version and the six most common complications from literature. The only close similarity was the seroma rate: ranked number 1 in literature and ranked number 2 in our data. This was quite interesting because seroma was only on the 4<sup>th</sup> place on our list although it is according to literature the most common complication after abdominoplasty. (85)

Six most common complications in literature	Own data (filtered version)
1. Seroma 88,%	1. Necrosis 12%
2. Wound dehiscence 71%	2. Seroma 8%
3. Infection 65%	3. Haematoma 8%
4. Scar deformity 47,%	4. Wound dehiscence 6%
5. Haematoma 47,%	5. Infection (postoperative) 6%
6. Necrosis 47,%	6. Scar deformity 7%
<b>[% = mentioned complication(s) per 17 publications]</b>	<b>[% = mentioned complication(s) per 398 cases]</b>

Figure 19: Comparison of “six most common complications” vs. our “filtered” version

Our “true” complication rate was with 47.7% consistent with the highest reported rates from the cited literature (about 50% and higher than the “mean”).

The results from our “filtered” rate on the other hand showed a rate of just 27.4% which is



lower than the mean and among the lowest published rates in the literature we cited.

Figure 20 Our “true” and “filtered” complication rate in contrast to the mean rate in literature

This shows once more how relative data can be and how easy it is to mend the numbers. The use of less stringent definitions of complications can result in biased reporting, rendering published rates “incomparable” and questioning published complication rates as “reliable and valid quality indicators” for hospitals.

The Clavien-Dindo classification of surgical complications was found to be a useful tool to grade complications following abdominoplasty and autologous breast reconstruction with some minor limitations.

It is important to take into consideration that only the contracted version of the classification was used. The reason for this is that the grading of a certain complication depends on the available therapeutic option. In case of different viable therapeutic options available for one complication (e.g. surgery or conservative), grading can be misleading because the same complications could be assigned to completely different grades (e.g. grade II or III). One option could be, that the treatment options resulting in the highest grade would always be used for grading, but that would perhaps distort the classification and its usage.

The majority of complications we assessed in our data were grade I. The question is whether the classification will still be viable in the future when risk factors for major complications such as grade III and above are identified and these complications can be avoided sufficiently. This could result in a vast majority of grade I and II complications which would on the other hand relativize the use and impact of this classification.

Another issue we were confronted with was that the Clavien-Dindo classification was actually not used in any of the publications we evaluated.

It would be great if more publications would acknowledge the CDC in the future to establish the classification in clinical routine. This would be a step towards standardisation and international comparability. A proposal for improvement would be that complications themselves would become associated with a certain grade oriented on the golden standard therapeutic option for that complication. Clavien. et al. did an evaluation of their classification and had a rate of more than 90% successful assignments over a period of five years. (53) However, this creates room for errors and that itself contradicts the idea of standardization.

## 9 Conclusion

Our data showed a relatively high risk compared to international data regarding post-operative complications associated with abdominoplasty. This may be due to the fact that we included every unwanted development which occurred during the postoperative course. However, further research requires a standardised analysis (e.g. the Clavien-Dindo classification) to make comparison of data possible in the future.

Future reviews/meta-analyses need to ask further questions: Were different kind of disease entities mingled (e.g. weight loss and breast reconstruction)? What were the inclusion criteria? Were concomitant interventions readily recorded in the current literature? Did reviews of publications screen for this?

This work illustrates in an open fashion the variability of how data on complications can be presented depending on the use of definitions. In the omnipresence of prefabricated or so-called “alternate facts”, it is essential for scientists and clinicians alike to foster open reporting based on reliable and valid parameters.

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