UNIVERSITÀ DEGLI STUDI DI MILANO

DOCTORAL PROGRAM IN CLINICAL RESEARCH

DEPARTMENT OF BIOMEDICAL, SURGICAL, AND DENTAL SCIENCES (DISBIOC)

Comparative Analysis of Dissection Techniques in Post-Bariatric Abdominoplasty

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2024/2025 – XXXVIII cycle

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1. Post-bariatric surgery

1.1. Obesity: a global health emergency

Obesity is recognized by the World Health Organization (WHO) as one of the main health challenges of the twenty-first century. It is a pathological condition characterized by an excessive accumulation of body fat, with systemic and multi-organ repercussions. In Italy, about 11.8% of the adult population is obese, with a growing trend that also affects adolescents and children. This phenomenon, unevenly distributed at the territorial level, is associated with environmental, socio-economic and cultural factors. The southern regions and islands have higher rates, with significant health and social implications. Obesity is a known risk factor for numerous chronic diseases, including cardiovascular disease, type 2 diabetes, metabolic syndrome, osteoarthritis, obstructive sleep apnea, and endocrine and metabolic malignancies. [1,2]

1.2. Bariatric Surgery: Indications and Benefits

Bariatric surgery is currently the most effective therapeutic strategy for the treatment of severe and morbid obesity. It includes several surgical techniques that act through restrictive, malabsorptive or mixed mechanisms, allowing a significant reduction in body weight and documented improvements in the main comorbidities. Surgical indications follow precise criteria: BMI > 40 kg/m² or > 35 kg/m² with associated comorbidities. The most popular techniques include sleeve gastrectomy, gastric bypass and mini-bypass, each with different profiles in terms of efficacy, risk and metabolic impact. The selected patients undergo an accurate multidisciplinary pre-operative pathway, aimed at ensuring compliance and reducing operative risks. The effectiveness of bariatric surgery also results in a significant reduction in long-term healthcare costs. [3]

1.3. The morphological consequences of weight loss

The rapid and substantial weight loss obtained through bariatric surgery inevitably leads to aesthetic-functional changes. The excess skin, devoid of adipose support, loses elasticity and tends to hang in the form of skin folds, generating discomfort, hygiene difficulties, maceration and

chronic intertrigo. The most frequently affected areas are the abdomen, arms, thighs, back and breasts. These conditions profoundly impair the patient's quality of life and self-perception, despite the success of the bariatric pathway. On a biomechanical level, residual dermo-adipose excess can also negatively affect posture and gait, making reconstructive surgical management necessary. [4]

1.4. Post-bariatric Plastic Surgery: Objectives and Procedures

Post-bariatric plastic surgery was born with the aim of resolving the morphological and functional alterations resulting from massive weight loss. Interventions such as abdominoplasty, brachioplasty, cruroplasty, mastopexy and body-lift allow the correction of excess tissues, improving the harmony of the body profile and restoring a positive perception of body image. To be a candidate, patients must have achieved weight stability (at least 6-12 months), have a BMI < 30 kg/m^2, be in the absence of active infections or nutritional deficiencies, and show good psychological motivation. These procedures are often complex, prolonged and involve non-negligible risks, including dehiscence, seromas, skin necrosis, and thromboembolic complications. Their management therefore requires advanced skills from the surgical and anesthesiological team. [4,5] [6] [7]

1.5. Psychological and Social Implications

The effects of post-bariatric plastic surgery are not limited to the physical level. Numerous studies have documented a significant improvement in self-esteem, body image and quality of life in patients who undergo these surgeries. Body perception plays a crucial role in social, sexual and work life. In many cases, body remodeling determines the end of the 'obese patient's journey', marking a symbolic and concrete rebirth. The psychological implications must be carefully evaluated in the pre-operative period to avoid post-operative disappointments and to strengthen the motivation to maintain weight. [6]

1.6. Conclusion

Post-bariatric plastic surgery is now an integral part of the treatment of morbid obesity. It represents not only a final phase of the surgical and rehabilitation process, but also a powerful

tool for psychological redemption, social reintegration and functional improvement. It is essential that this branch is recognized and supported within the clinical-care pathways for obesity, and that shared protocols are developed for the access, selection, execution and follow-up of reconstructive interventions, in order to ensure equity, safety and efficacy.

2. Anatomy of the abdomen and abdominoplasty surgery

2.1. Anatomy of the Abdominal Wall

The anterior abdominal wall represents a complex and stratified structure that performs multiple functions: containment of the viscera, participation in respiratory dynamics, support for posture and locomotion, and protection against mechanical trauma. Anatomically, it is made up of several layers: skin, subcutaneous tissue (composed of superficial and deep adipose layer), Scarpa's fascia, abdominal muscles (rectus abdominis, external oblique, internal and transverse oblique), and transverse fascia preceding the parietal peritoneum. [8–13]

The rectus abdominis muscle is the most important of the longitudinal muscles, extending from the pubic symphysis to the xiphoid process and the costal cartilages. The oblique and transverse muscles, with their aponeuroses, form the sheath of the rectus. The latter varies in its composition according to the region: in the supraumbilical portion, the sheath has an anterior and posterior trilaminar arrangement, while under the arched Douglas line, all the aponeurotic layers are carried anteriorly, leaving the rectus muscle directly in contact with the transverse fascia.

This arrangement has a direct impact in abdominal surgical procedures, especially in the evaluation of diastasis recti and the choice of plication technique during abdominoplasty. The abdominal subcutaneous adipose tissue has two layers: a superficial one (Camper), rich in lobules and poorly vascularized, and a deep one (Scarpa), more compact and with greater lymphatic drainage, an important element in the formation of post-operative seroma.

2.2. Surgical indications for abdominoplasty

Abdominoplasty is indicated in all those patients who have excess skin and abdominal adipose associated or not with diastasis rectus abdominis muscles. The most frequently treated conditions are those following major weight loss, multiple pregnancies, previous abdominal surgery or simple tissue aging. [14–17]

In the post-bariatric context, the abdominal wall is markedly ptotic, with skin pendules extending to the suprapubic region, frequently associated with rubbing dermatitis, limitations in movement and psycho-social discomfort. The ideal patient for abdominoplasty has stabilized his weight for at least 6-12 months, has no major nutritional deficiencies and has completed post-bariatric metabolic follow-up.

2.3. Classification of Abdominoplasty Techniques

Abdominoplasty techniques are many and must be adapted to the degree of ptosis, the distribution of excess tissue, the presence of previous scars and the condition of the underlying muscles. The most common classification includes: [14]

- Mini-abdominoplasty: indicated in cases of modest subumbilical skin excess, without involvement of the muscle fascia;
- Classic abdominoplasty: extensive removal of infraumbilical dermo-adipose excess, with transposition of the navel;
- Extensive or circumferential abdominoplasty (body-lift): it also involves the lumbar and gluteal regions;
- Fleur-de-Lys abdominoplasty: used in large weight loss, it includes an additional vertical incision to treat sagging even on the transverse plane.

The choice of technique depends on an accurate clinical evaluation and the functional and aesthetic expectation of the patient. The surgical approach must also be individualized based on the quality of the tissue, the presence of scars and the degree of muscle compromise.

2.4. Surgical Times and Operative Considerations

Abdominoplasty surgery involves different operative times: pre-operative marking in an upright position, transverse suprapubic skin incision, subcutaneous dissection up to the epigastric region,

possible plication of the rectus muscles, umbilical transposition, excision of the excess flap, accurate hemostasis, placement of suction drains and suture in several planes.

Intraoperative attention focuses on minimizing dead space, accurately managing thermal and mechanical trauma, and preventing complications such as hematomas, skin necrosis, and seromas. Dissection can be performed with a cold scalpel, electric scalpel, or advanced energy instruments: each modality has different impacts on tissue damage, hemostatic control, and post-operative inflammatory response.

2.5. The role of the multidisciplinary team

Abdominoplasty, particularly in ex-obese patients, requires the collaboration between plastic surgeon, nutritionist, psychologist and anesthesiologist. Nutritional evaluation is essential to correct any protein or vitamin deficits that may compromise healing. Psychological support helps the patient to cope with post-operative expectations, while the anesthesiologist must consider the history of obesity and any residual comorbidities. An integrated approach improves the safety and outcome of the intervention, reducing the risk of complications and optimizing long-term outcomes.

3. Surgical technique and use of electrosurgery

3.1. Physical-technical principles of electrosurgery

Electrosurgical is an electrosurgical instrument that uses high-frequency electric current to cut and coagulate tissues. The physical principle behind its operation is the Joule effect, according to which a current passing through a resistive body generates heat. The electrical energy produced by the generator is converted into thermal energy in contact with biological tissues, resulting in cell vaporization in the case of cutting, or protein denaturation and vascular coagulation in the case of hemostasis. [18]

The current used is alternating, at frequencies ranging between 300 kHz and 3 MHz, high enough to avoid neuromuscular stimulation and the risk of cardiac fibrillation. Modern devices allow intensity, pulse duration and waveform to be modulated, allowing extremely precise control of the desired surgical effect.

3.2. Operating modes: cutting vs coagulation

There are two main operating modes of electrosurgery: cutting and coagulation (coag). The 'cut' mode uses a direct, high-density current that causes rapid vaporization of the cell contents, allowing for a sharp and precise incision with minimal lateral thermal damage. It is particularly suitable for soft tissue dissection in vascularized areas.

The 'coag' mode, on the other hand, uses discontinuous pulses with low current density, generating a more diffuse heat that denatures proteins and induces thrombosis of the vessels. Although effective in achieving hemostasis, this modality results in greater tissue necrosis and a wider thermal side effect. The alternation or combination of the two modes (blend mode) allows you to balance precision and hemostatic control according to surgical needs.

3.3. Impact of coagulation on subcutaneous tissue

In the context of abdominal and post-bariatric surgery, the use of electrosurgery in coagulation mode has specific implications. The subcutaneous adipose tissue is poorly vascularized and rich in lipid lobules separated by fibrous septa: electrical coagulation in this site can cause superficial carbonization, lobular necrosis and loss of lymphatic integrity, factors associated with the formation of post-operative seromas. [19,20]

In addition, heat transmission in fat is less efficient than in muscle or connective tissue, requiring higher doses of energy to achieve a satisfactory clotting effect. This leads to increased thermal damage and an increased risk of tissue complications.

3.4. Role of gauze and contact medium

A technically relevant aspect during coagulation dissection is the use of gauze during the application of the electrosurgical unit. Dry gauze, being thermal insulators, can promote the accumulation of heat at the tip of the instrument, increasing the risk of burns and necrosis of adjacent tissues. On the contrary, the use of gauze moistened with cooled saline has been shown to dissipate heat more effectively, reducing the thermal side effect and improving operative comfort.

In particular, the use of cold gauze also contributes to local vasoconstriction, potentially useful in the control of post-operative edema and in the prevention of the formation of seroma. However, the variability of techniques makes it necessary to carry out a systematic study to rigorously compare the different approaches in terms of clinical efficacy and tissue safety.

3.5. Safety and complication considerations

The use of electrosurgery requires a deep knowledge of its physical properties, its biological effects and potential complications. The most common risks include: accidental burns, interference with implantable devices (e.g. pacemakers), electrode-patient contact malfunctions and capacitive discharges on tissues far from the operating site. [21]

Neutral plaque burns, in particular, are a rare but serious complication, preventable with correct application of the return electrode and the use of new generation generators equipped with impedance monitoring systems. The choice of appropriate operating methods, well-calibrated instruments and adjuvant techniques (such as the use of wet gauze) helps to significantly reduce the incidence of adverse events and optimize the overall surgical result.

4. The post-operative seroma

4.1. Definition and clinical relevance

Seroma is one of the most common complications in plastic and reconstructive surgery, particularly after surgeries with high tissue trauma such as abdominoplasty, mastectomy and post-bariatric body contouring. This is the accumulation of serous fluid in a newly formed cavity, generally in the residual dead space between the dissected tissues. This fluid, rich in proteins, lymph and inflammatory cells, can interfere with the healing process, increase the risk of infection and, in severe cases, lead to wound dehiscence or the need for reoperation. [22] [23]

4.2. Pathophysiological mechanisms

The formation of the seroma is the result of an acute inflammatory response to surgical dissection and vascular and lymphatic injury. Damage to capillaries and lymphatic vessels leads to an initial extravasation of fluids, to which is added the production of inflammatory mediators (cytokines, prostaglandins, histamine) that increase vascular permeability. In addition, the absence of contact between the detached planes prevents the reabsorption of the fluid, favoring its accumulation. The volume of the seroma depends on multiple factors: extent of dissection, dissection technique, patient's BMI, type of tissue treated, presence of undrained dead spaces, and degree of post-operative mobilization. Ex-obese patients, for example, have greater tissue fragility and hypovascularized adipose tissue, making them particularly vulnerable. [24–29]

4.3. Role of Surgical Drains

Suction drains are the main tool for preventing seroma. They allow excess fluid to be evacuated, promote adhesion between surgical planes and reduce local pressure. Drains can be active (negative pressure system) or passive (gravity or capillarity), and their management varies according to the type of intervention, the volume drained and the individual risk of the patient.

Although prolonged use of drains can reduce the incidence of seroma, it also carries an increased risk of infection and can delay discharge. Therefore, it is essential to balance draining effectiveness with patient safety and comfort. Many protocols provide for the removal of drains below a daily threshold (e.g. < 30 ml/24h), but there is no universal consensus.

4.4. Clinical Sieroma vs Subclinical Sieroma

Not all seromas are clinically evident. Subclinical seroma is often detectable only by ultrasound and can be completely asymptomatic. Clinical seromas, on the other hand, present with fluctuating swelling, skin tension, local pain and, sometimes, fever. Diagnosis is essentially clinical, but ultrasound is the most useful tool to confirm the presence of fluid and guide any aspirations. In some cases, chronic seromas may organize into pseudocysts with a fibrous wall, necessitating capsulotomy or surgical removal of the cavity.

4.5. Therapeutic strategies

Treatment of seroma varies based on volume, symptomatology and recurrence. Small, asymptomatic seromas can simply be monitored. Medium-sized seromas can be aspirated with a needle under ultrasound guidance, possibly repeating the procedure a few days later. In the case of recurrent seromas or fibrocystic organization, surgical drainage, revision of the wound or insertion of a new drain may be necessary. [30–32]

Local instillation of sclerosing substances (e.g. tetracycline, polidocanol) has been proposed in selected cases, but the risk of tissue necrosis limits their routine use. The optimal therapeutic approach therefore remains multimodal and personalized.

5. Materials and Methods

Our study stems from the need to evaluate the impact of the different ways of using electrosurgery on the incidence of post-operative seroma.

5.1. Study Design and PICO Criteria

The study was conducted according to an observational, prospective and comparative methodology, in order to analyze the effects of three different surgical dissection techniques during abdominoplasty operations on a sample of consecutive patients operated by the same surgical team at a single hospital center. The data were collected and recorded in a dedicated database, built on Excel support, containing personal, clinical, operative and post-operative variables.

The study design meets the PICO criteria, as follows:- Population (P): adult patients undergoing post-bariatric abdominoplasty surgery;- Intervention (I): use of electrosurgery in cutting mode (Group A) or coagulation with wet gauze (Group C);

- Comparison (C): use of the electrosurgical unit in coagulation mode with dry gauze (Technique B);

- Outcome (O): post-operative drainage volume (in ml), incidence and volume of seromas, need for treatment of seroma.

The sample consisted of 320 consecutive patients, divided into three homogeneous groups by surgical technique. All interventions were carried out by the same surgical team between 2023 and 2025. The patients were all stabilized for at least 6 months in body weight, had no nutritional deficiencies or severe comorbidities in the active phase, and were followed up for at least 30 days post-surgery. The exclusion concerned patients with incomplete data, early systemic complications unrelated to the technique, and those who had undergone other concomitant procedures.

5.2. Statistical analysis

Statistical analyses were carried out to compare the three surgical techniques with respect to the main outcomes: post-operative drainage volume, incidence and volume of seromas, associated complications and length of stay. Parametric and nonparametric tests were used depending on the distribution of the variables analyzed. The full details of the analyses conducted are reported in the attached document below.

This paper provides a detailed statistical analysis of a clinical dataset comparing three surgical techniques (A, B, C) employed during tummy tuck surgeries. The goal is to identify which technique is associated with lower serum production and lower incidence of seromas. Each statistical analysis is accompanied by a complete explanation of the test used, the reasons for its choice and the alternatives excluded.

1. Descriptive statistics

The following table shows the descriptive values (mean, standard deviation, median, min and max) of the most relevant clinical variables in the three groups. This initial step allows you to highlight any preliminary differences between groups that could influence post-operative outcomes.

	ETÀ	SESSO	BMI	FUMATORE	DIABETE	IPERTENSIONE
A	50	22	30,05	32	16	32
B	47	17	28,5	36	12	32
C	49	13	29,6	35	11	28
DS / %	12,13	21%	3,25	30%	15%	30%
DS / %	13,00	16%	3,11	34%	11%	30%
DS / %	13,20	12%	3,08	32%	10%	26%

2. Analysis of Variance (ANOVA)

The ANOVA (Analysis of Variance) is a statistical test used to compare the means of a continuous variable between more than two independent groups. It was chosen in this case to compare the post-operative drainage volume between techniques A, B and C. The ANOVA assumes that the data are roughly distributed normally and that the variances between the groups are homogeneous.

Student's t-test was not used because it compares only two groups. In addition, the Kruskal-Wallis test was not used, as the distribution of the drainage volume in this dataset is close to normal (verifiable with Shapiro-Wilk test or QQ plot).

ANOVA results for Drenaggio_24h_ml:

INDEX	SUM_SQ	DF	F	PR(>F)
C(TIPO_TECNICA)	65627.83351022015	2.0	69.5216427477358	9.234887916503 23E-26
RESIDUAL	149622.63836477988	317.0	In	In

ANOVA results for Drenaggio_48h_ml:

INDEX	SUM_SQ	DF	F	PR(>F)
C(TIPO_TECNICA)	86947.03338792792	2.0	143.66808920391225	3.8480076103999 08E-45
RESIDUAL	95923.21348707197	317.0	In	In

ANOVA results for Totale_Drenaggio_ml:

INDEX	SUM_SQ	DF	F	PR(>F)

C(TIPO_TECNICA)	303337.85787037	2.0	182.40806597995518	1.91262735737573 38E-53
RESIDUAL	263579.62962962966	317.0	In	In

3. Chi-square test

The Chi-square (χ^2) test is used to assess the association between two categorical variables. In this case, it was used to analyze whether the frequency of post-operative seromas differs between groups A, B, and C. This test is appropriate because all the expected frequencies in the cells of the contingency table are greater than 5.

The Fisher exact test was not used because the latter is indicated for very small samples or when the expected frequencies are less than 5.

TIPO_TECNICA	**0**	**1**
A	85	21
B	72	34
C	96	12

p-value: 0.0008 - Significant

4. Logistic regression

Logistic regression is used to predict the probability of a binary event (e.g., presence or absence of seroma) based on one or more independent variables. In this case, it was used to assess whether the surgical technique, together with other factors such as BMI, duration of surgery, smoking and diabetes, is a significant predictor of seroma.

A linear regression was not used because the dependent variable is categorical binary (0 = absent, 1 = present), and a linear regression would lead to estimates that cannot be interpreted in probability.

INDEX	COEF.	STD.ERR.	WITH	P>|Z|	[0.025	0.975]
INTERCEPT	-3.269815374785494	1.5538781387614 39	-2.1042933118241 75	0.035352869118 00036	-6.3153605631220 47	-0.2242701864489 4092
C(TIPO_TECNICA)[T.B]	0.6395390718585 776	0.3223532942770 14	1.9839694000737 909	0.0472592512832 76585	0.0077382247777 88738	1.2713399189393 666
C(TIPO_TECNICA)[T.C]	-0.6860143937893	0.4004375774011 7775	-1.7131618821627 66	0.0866827620598 2053	-1.4708576235520 785	0.0988288359734 7869
BMI	0.0345735372811 9139	0.0326525511397 1166	1.0588311196041 111	0.2896766983655 694	-0.0294242869559 95763	0.0985713615183 7854
DURATA_INTERVENTO_MIN	0.0077181593826 499105	0.0093161414506 61982	0.8284716825656 911	0.4074034254152 5376	-0.0105411423355 28306	0.0259774611008 28127
SMOKER	-0.0557115681601 8456	0.3038255276293 687	-0.1833669757603 321	0.8545100860405 359	-0.6511986598976 263	0.5397755235772 572
DIABETES	0.1241002969652 6431	0.4212984714779 0717	0.2945662169860 7827	0.7683252725607 802	-0.7016295338732 09	0.9498301278037 375

5. Summary of Outcomes

The following table summarizes the main clinical outcomes in the three groups: mean total drainage volume, seroma incidence and mean seroma volume. Techniques A and C show lower values than technique B, supporting the initial hypothesis of the study.

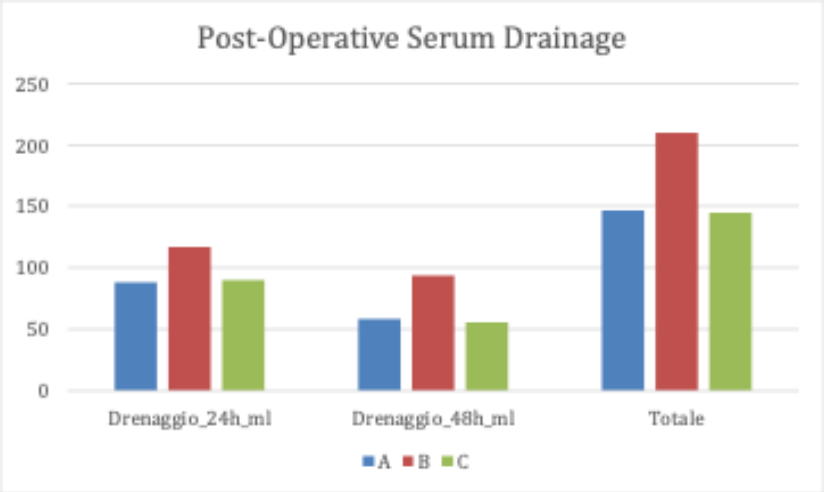
TIPO_TECNICA	TOTALE_DRENAGGIO_ML	SIEROMA	VOLUME_SIEROMA_ML	% SIEROMA
A	146,5	21	41	20%
B	210	34	58	32%
C	145	12	45	11%

6. Results

This chapter presents the results of the analyses conducted on the sample of 320 patients, divided equally into three groups based on the surgical technique used for dissection during abdominoplasty. The focus was on three main post-operative outcomes: total drainage volume, incidence of clinically relevant seromas, and mean seroma volume in affected patients.

6.1. Post-operative drainage volume

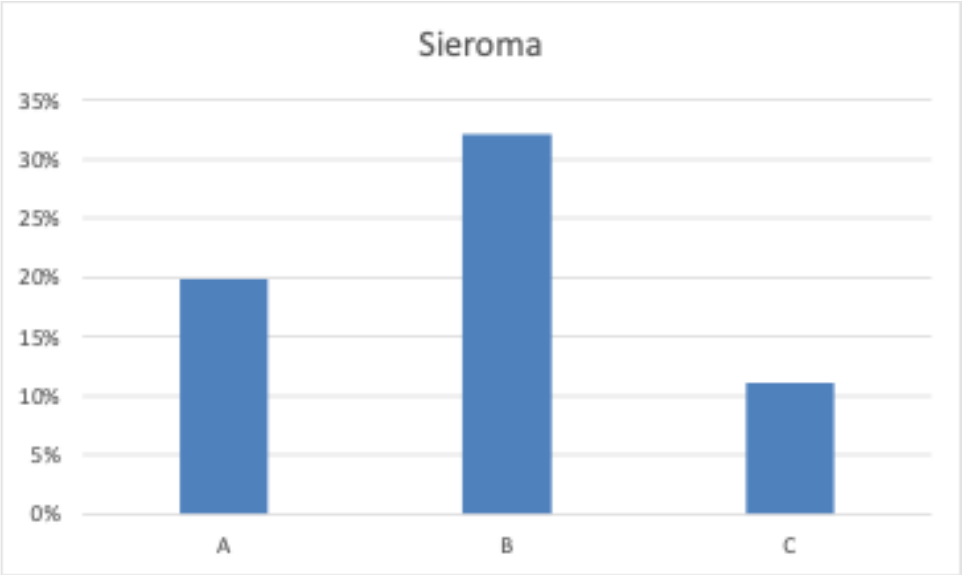
Drainage volume was measured cumulatively over the first 48 hours post-operatively. The results showed a statistically significant difference between the three groups. In particular, patients treated with technique B (coagulation with dry gauze) showed a higher average drainage volume than groups A and C. This difference is consistent with the initial hypothesis that the aggressive coagulation mode can generate greater thermal trauma and therefore greater tissue exudation. The following boxplot represents the distribution of drainage volumes in the three surgical groups:



6.2. Incidence of Clinical Seromas

The incidence of clinically relevant seroma was defined as the presence of clinically or ultrasoundly confirmed symptomatic fluid collection, such as to require treatment (aspiration or drainage). Again, group B recorded the highest incidence, with a rate of 32%, compared to 20% in group A and 11% in group C. Chi-square testing confirmed the statistical significance of this

difference, supporting the hypothesis that the mode of dissection influences post-operative seroma risk. The following graph shows the percentage incidence of seromas in the three groups:

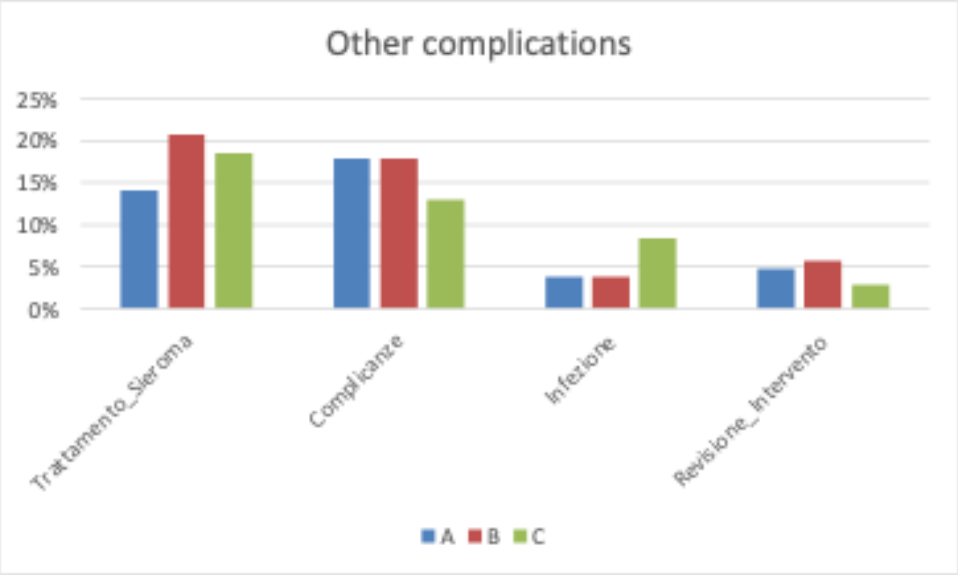


6.3. Mean seroma volume in affected patients

In patients in whom seroma formation occurred, the volume of fluid collected was analyzed. Again, technique B was associated with higher average seroma volumes, with values ranging from 50 to over 200 ml in some cases. Groups A and C showed smaller volumes and less extreme distributions. This supports the idea that the non-thermally mediated coagulation mode can promote local lymphatic destruction with persistent accumulation of exudate.

6.4 Other complications

The incidence rate of other complications, including infections and reinterventions, did not differ among the three techniques. This demonstrates how the different electrical dissection techniques impact mainly on the heat damage of the adipose tissue, and the consequent inflammation and production of serum.


Other complications
25%
20%
15%
10%
5%
0%
Trattamento_Sieroma
Complicanze
Infezione
Revisione_ Intervento
A
B
C

7. Conclusions

7.1. Summary of results

The study made it possible to analyze, on a clinically homogeneous sample of 320 patients, the effect of three different surgical dissection techniques during post-bariatric abdominoplasty, with particular attention to post-operative serum production and clinically relevant seroma formation. The results have consistently shown that the use of electrosurgery in coagulation mode with dry gauze (Technique B) is associated with greater drainage production, a higher incidence of seromas and more important seromic volumes than use in cutting mode (Technique A) or coagulation mediated by gauze wet with cold saline solution (Technique C).

7.2. Clinical implications

From a clinical point of view, these data support the adoption of dissection techniques that minimize the destructive thermal effect on the subcutaneous tissue. The use of wet gauze and cold solutions during coagulation can represent a simple, reproducible and inexpensive strategy to reduce tissue inflammation and prevent post-operative complications. The cutting mode of the electrosurgical unit, while requiring greater manual hemostasis, has proven to be safe and less invasive from an inflammatory point of view.

7.3. Limitations of the study

Being a retrospective study, it has the limitations of this methodological design, including the risk of bias in data collection and the impossibility of prospectively controlling confounding variables. Furthermore, although the groups were managed by the same surgical team, subjective technical variations in daily operative practice cannot be completely excluded. The duration of follow-up, although sufficient to identify clinically relevant seromas, does not allow the evaluation of other late complications.

7.4. Future perspectives and recommendations

In light of the results obtained, it is recommended to standardize the dissection techniques adopted in post-bariatric abdominoplasty, favoring approaches that reduce thermal diffusion and preserve lymphatic tissue. It would be desirable to carry out randomized controlled trials, with a more extensive follow-up and the integration of systematic ultrasound evaluations, to further validate the effectiveness of the proposed techniques. In addition, the inclusion of shared and individualized post-operative management protocols could reduce the incidence of complications and optimize recovery times.

8. Acknowledgements

Many people must be thanked for the help and the sustainment given to me.

First of all, I must thank my parents, without whom none of this would have been possible.

Thank you, Marta, the love of my life and the column upon which I am building our future.

Thank you very much, Matteo, for all the guidance and encouragement which you entrusted me with. Without you, I would have been a migrant surgeon around Europe and the world.

A final recognition goes to all my colleagues who participated to my career with proximity, support, furtherance and encouragement.

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