Scientific
Research
Publishing

Modern Plastic Surgery

Journal Editorial Board

Table of Contents

Volume 13　　Number 1　　　　　　　　　　　January 2023

Modern Plastic Surgery (MPS)
Journal Information

COPYRIGHT

Clinical Outcome of Abdominoplasty Cases—A Five-Year Retrospective Study

Omar Alameri, Medhat Emil*, Dalal Al Mansoori, Anoud Al Qaydi, Aysha Al Naqbi, Ibrahim Al Marzooqi, Dalia Medhat Habib, Shamsa Alameri

Department of Plastic and Reconstructive Surgery, Zayed Military Hospital, Abu Dhabi, United Arab of Emirates
Email: *medhatemil1@hotmail.com

Abstract

Aim: The aim of this study is to analyze the outcome of cases who underwent abdominoplasty surgery in our facility for the last five years. **Patients and Methods:** This is a retrospective study analyzing the outcome of patients who underwent abdominoplasty from the beginning of January 2015 till the end of December 2019 in Zayed Military Hospital, Abu Dhabi, United Arab of Emirates. Postoperative complications were recorded. The effects of risk factors including age, sex, smoking, body mass index, associated comorbidity, previous bariatric surgery and combined procedures were evaluated. **Results:** 213 patients were included in this five-year study. Majority of the patients were females 161 cases (75.6%) while males presented 52 cases (24.4%). The mean age was 38.3 years. The mean BMI was 27 Kg/m^2. 127 patients had previous bariatric surgery (59.6%) while 86 patients had not (40.4%). There were no major systemic complications in the cases as deep venous thrombosis, pulmonary embolism or paralytic ileus. There was no mortality in the study cases. Out of the 213 cases included in the study, 23 patients developed haematoma (10.8%), 8 patients developed seroma formation (3.8%), 3 patients had wound infection (1.4%) and one patient had tissue necrosis (0.5%). The complication rate was higher in males 36.4% compared to females 9.9% ($p < 0.001$). The patients who were 40 years old and above had less complications rate than those who were below 40 years 9.6% and 21% respectively ($p < 0.005$). The patients with BMI of 28 Kg/m^2 or less had less complications 14.3% compared to those above that level 21.2% although it was not a significant difference ($p = 0.231$). 55.7% of the smokers had complications while the incidence among non smokers was 8.5% ($p < 0.005$). Those who underwent previous bariatric surgery had more complications 19.7% compared to those who had not undergone this surgery 11.6% but it was not statistically significant ($p = 0.372$). Those who had liposuction, plication of the recti muscles or both in combination with the abdominoplasty procedure had 8% complica-

tion rate compared to those who had not these combined procedures done 23.9% (p < 0.005). Associated comorbidity did not have statistical significance in the complication rate. Conclusion: Although abdominoplasty is a safe operative procedure, still it has its complications which are mostly haematoma, seroma, wound infection and tissue necrosis. The risk of developing these complications is higher among smokers and male patients. Although complication rate is higher among patients who have elevated BMI above 28 Kg/m² and in those who underwent previous bariatric surgery, this was not statistically significant. Doing abdominoplasty for cases above the age of 40 years can be a safe procedure. Judicious liposuction and plication of the recti muscles do not carry higher risk of complications as well as associated comorbidity as long as it is well controlled along the perioperative period.

Keywords

Abdominoplasty, Outcome, Complications, Risk Factors

1. Introduction

Abdominoplasty is a commonly performed surgical procedure to reshape the body contour by reduction of redundant fat and skin tissue to improve quality of life and functional status of patients. [1] Like any other surgical procedure, it has a range of complications which vary from one center to another. These complications can be divided into systemic complications such as deep venous thrombosis, pulmonary embolism, paralytic ileus or even death and local complications as haematoma, seroma, wound infection and tissue necrosis. [2] Reviewing the literature shows that there are certain factors which can increase the risk of occurrence of these complications as age, male sex, smoking, elevated body mass index, comorbidity, history of previous bariatric surgery and combining other procedure to the abdominoplasty surgery as liposuction and plication of the recti muscles. In this study we will analyze our results in view of the postoperative complications and the effect of these risk factors on their incidence.

2. Patients and Methods

This is a 5 years retrospective study performed on patients who underwent abdominoplasty in Zayed Military Hospital, Abu Dhabi, United Arab of Emirates from the beginning of January 2015 till the end of December 2019. The data of the patients were analyzed retrospectively from the patients' files and through the computer system and kept in Excel sheet. The patients who underwent full abdominoplasty procedure in the classical way during the selected period were included in the study. Those who underwent dermatolipectomy or Fleur-de-Lis technique were excluded. The patients who had preexisting medical issues as haematological diseases were also excluded from the study.

The retrospective analysis included demographic data of patients, such as age, sex and body mass index (BMI). The increased risk factors for the patients were assessed according to increase of age, gender, smoking, history of bariatric surgery and combining other procedures to abdominoplasty as liposuction and plication of the recti muscles.

The minimum follow up period was determined to be 30 days postoperatively for the assessment of development of postoperative complications.

The complications were divided into systemic and local complications. Systemic complications included deep venous thrombosis (DVT), pulmonary embolism, paralytic ileus and death. The local complications were either major complications which required surgical intervention e.g. haematoma evacuation, wound debridement and secondary repair or minor complications which were managed as outpatient cases as aspiration of seroma or haematoma and treating infection or discharge.

2.1. Statistical Analysis

The data collected from January 2015 to December 2019 was compiled into Microsoft Excel using a customized matrix. This allowed for the participant's details to be entered and stored in a simple manner for comparison. Initially, descriptive and frequency statistics were performed to understand the population. Then, a series of statistic tests were conducted using SSPS to determine if an association between complications and the relevant risk factors were evident. Fischer's exact test was used for independent variables. Finally, the alpha was set at $\alpha = 0.05$.

2.2. Operative Technique

The surgical marking is done in the standing, sitting and supine positions. The marking starts in the lying position from a midline point 7 cm cephalic to the vulvar commissure in females or the root of the penis in males and extends laterally in a concave line on each side as much as required for removal of the sagging skin. This point is easily assessed in the sitting position. Confirmation of the proper measurements is assured in the standing position. The patient is taken to the operation theatre and the operation is done under general anaesthesia for all the cases. The skin is incised with a scalpel and the wound is deepened using the monopolar diathermy till the fascia superficialis and the anterior rectus sheath preserving the overlying thin lymphatic tissue layer. The superficial inferior epigastric vessels are cauterized or even ligated. The dissection is continued in a cephalic direction to the umbilicus. The umbilical stalk is preserved. Dissection is continued circumferentially around the umbilicus from the elevated abdominal flap. From this level, the dissection is continued in about 10 cm width in the midline region in the cephalic direction till the xiphisternum.

Liposuction of the flank region is done if required. If there is muscular diastasis, repair of the recti muscles is done in 2 layers using non absorbable sutures.

The lower part of the skin flap is excised. Haemostasis is ensured. The umbilicus is extruded through the advanced overlying skin and sutured with half horizontal mattress non absorbable sutures to its new location about 9 - 11 cm from the incision line. The Scarpa's fascia is repaired with 2/0 inverted absorbable sutures. The skin is sutured in two layers using 3/0 absorbable inverted interrupted dermal sutures and continuous subcuticular absorbable sutures. The wound is drained using two negative pressure drains; one kept at the epigastric region and the other one at the lower part of the wound. Dressing is applied with overlying compressive garment. (Figure 1)

2.3. Postoperative Care

The patient is kept postoperatively in the bed in the modified Fowler's position. Mobilization is started on the first postoperative day. Subcutaneous low molecular weight heparin 40 mg is started 6 hours postoperatively and continued once daily for 7 days. Antithrombotic pneumatic compression stockings are started in the operation theatre and continued till the patient is discharged. The drains are kept on negative pressure and removed when the drainage is less than 20 ml of fluid in 24 hours for each drain. The patient is usually discharged by the fifth postoperative day. The umbilical sutures are removed after 2 weeks. The patient continues to wear the abdominal pressure garment after the abdominoplasty surgery for a period of one month. If plication of the recti muscles is done during the abdominoplasty procedure, the duration of the pressure garment is extended to 3 months postoperatively.

3. Results

During the 5 years period from the beginning of January 2015 till the end of December 2019, 230 patients underwent abdominoplasty surgery.

Seventeen patients were excluded from the study. Thirteen of them did not undergo the classic form of abdominoplasty (11 patients had miniabdominoplasty and 2 had Fleur-de-Lis abdominoplasty). In addition, four patients were excluded; one had repeated abdominoplasty procedure, one had scar revision, one had haematological disorder that can mislead as haematoma complication and the last one had missing data in the records. (Table 1 shows the exclusion criteria from the study).
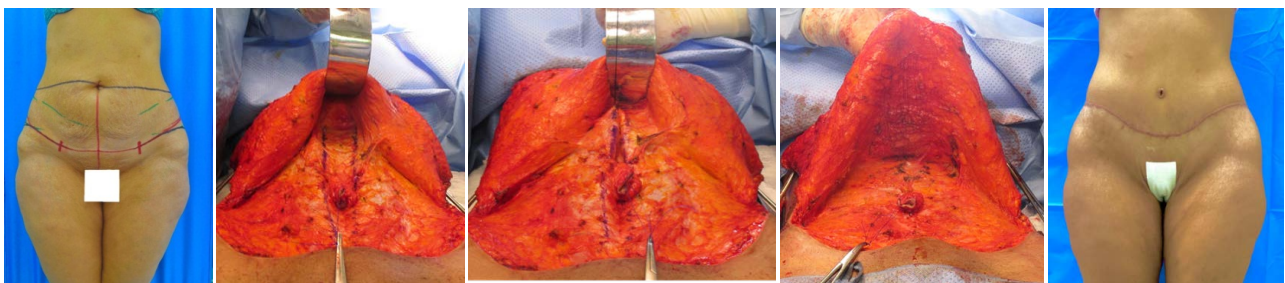
Figure 1. Abdominoplasty with plication of the recti muscles.

Table 1. Exclusion criteria from the study.

Cause of Exclusion	Number (Out of Total 17)
Miniabdominoplasty	11
Fleur-de-Lis	2
Redo Abdominoplasty	1
Scar revision post abdominoplasty	1
Haematological disorder	1
Missing data	1

This resulted in only 213 patients included in the study; 52 patients were males (24.4%) and 161 were females (75.6%).

The mean age of the patients included in the study was 38.3 (18 - 60 years). Those who were 40 years old or above were 84 patients (39.4%) and those who were below 40 years were 129 patients (60.6% of the total number of patients).

The mean BMI was 27 kg/m² (21 - 41.2 Kg/m²). It was decided during the last 3 years of the study to limit abdominoplasty surgery to patients whom BMI is 28 Kg/m² or less. The patients who had BMI above 28 Kg/m² constituted 66 patients in the study (31%). Those who had BMI of 28 Kg/m² or less were 147 patients (69%).

The mean hospital stay was 6.6 days (4 - 19 days). The patient who stayed for 19 days developed postoperative haematoma with complications. (Table 2)

127 patients included in the study had undergone bariatric surgery before (59.6%) while 86 patients underwent abdominoplasty with no history of previous bariatric surgery (40.4%).

Out of the 213 patients included in the study, 100 patients had liposuction, plication of the recti muscles or both in combination with the abdominoplasty procedure.

36 patients included in the study were smokers while 177 patients were non smokers.

31 of the patients included in the study were found having pre-existing diseases. Nine patients were diabetic, eight were hypertensive patients while two other patients were having history of being both hypertensive and diabetic. Five patients were having history of treatment from asthma, two were getting iron supplementation for chronic anaemia, four had history of getting psycahtric medications and one patient was having treatment for rheumatoid arthritis. All the patients included in the study had their medical conditions well controlled before embarking on the abdominoplasty operation.

No patients in the study got major systemic complications as Deep Venous Thrombosis, pulmonary embolism or paralytic ileus. There was no mortality in the study cases.

35 patients developed local complications (16.4% of the cases). Complications were classified as major or minor according to the need to take the patient back

Table 2. Demographic data of the patients.

Demographic Data	Mean Value	Range	Total No. of Patients	Percentage %
Age				
>40	38.3 years	18 - 60	84	39.4%
<40			129	60.6%
BMI				
>28	27 Kg/m^2	21 - 41.2	66	31%
<28			147	69%
Male			52	24.4%
Female			161	75.6%
Post Bariatric			127	59.6%
Traditional Cosmetic			86	40.4%

to the operation theater or to be managed conservatively at bed side respectively. The commonest complication was haematoma formation (23 patients; 10.8%); 11 of them had to be evacuated surgically (5.2%) and 12 were managed conservatively by repeated aspirations in the OPD (5.6%).

8 patients developed seroma formation (3.8%); all were managed by repeated aspiration in the OPD except one case which had to be operated on by debridement, curettage of the seroma sac wall and quilting sutures application to close the space.

Three patients had wound infection (1.4%); one of them had to be taken to the operation theatre for drainage and two were managed bed side with antibiotics and dressings. One patient had tissue necrosis (0.5%) which required debridement and Vaccuum Assisted Closure of the wound. (Table 3 and Figure 2)

Analysis was done for the risk factors which can increase postoperative complications, as male sex, increased age, elevated BMI, smoking, postbariatric surgery, combining liposuction and/or plication of the recti muscles with abdominoplasty and pre-existing co-morbidity.

Among the 52 male patients included in the study, 15 had haematoma formation (28.8%), one had seroma (1.9%), two had wound infection (3.8%) and one had tissue necrosis (1.9%) with total complications of 36.4%. On the other hand among the 161 female patients included in the study, 8 patients developed haematoma formation (5%), 7 had seroma collection (4.3%), one had wound infection (0.6%) and no patient had tissue necrosis (0%) with total complications of 9.9% (Figure 3). There was a statistically significant difference in scores for Male and Hematoma (p < 0.001). There was no significant statistical difference of Seroma occurrence between males and females (p = 0.898). The number of wound infections and tissue necrosis cases were low to be statistically compared.

84 patients were 40 years old and above while 129 patients in the study were younger than 40 years. Three patients above 40 years had haematoma (3.6%), four had seroma (4.8%), one had wound infection (1.2%) and no one had tissue

Table 3. Complications and their percentage to each other and to the total number of the patients.

Complication	No. of Cases			Percentage of Complications (35 Patients)	Percentage to Total No. of Cases (213 Cases)
	Major	Minor	Total		
Haematoma	11	12	23	65.71%	10.8%
Seroma	1	7	8	22.86%	3.8%
Wound Infection	1	2	3	8.57%	1.4%
Tissue Necrosis	1	0	1	2.86%	0.5%
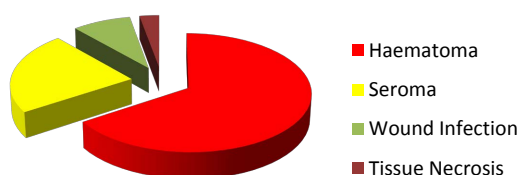
Figure 2. Percentage of complications to each other.
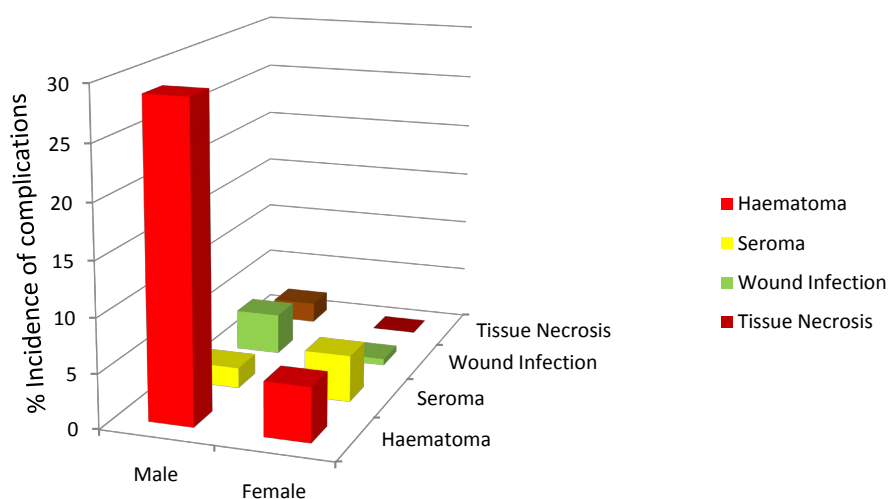
Figure 3. Relation between gender and incidence of complications.

necrosis (0%) with total complications of 9.6%. In the younger age < 40 years, 20 patients out of the 129 patients had haematoma (15.5%), 4 had seroma (3.1%), 2 had wound infection (1.6%) and one had tissue necrosis (0.8%) with total complications of 21%. (Figure 4) Statistic significance was found for patients under 40 and Hematoma ($p < 0.005$) suggesting patients under 40 have more risk in developing hematoma. While in comparing seroma cases with the two group ages, no statistical significance was found ($p = 0.715$). As for wound infection and tissue necrosis, the number of cases was low to be compared.

The patients who had BMI of 28 Kg/m² or less were 147 cases. Thirteen of them developed haematoma formation (8.8%), 7 developed seroma (4.8%), one case had wound infection (0.7%) and there was no tissue necrosis in this category with total complications of 14.3%. Sixty six patients had BMI above 28 Kg/m²,
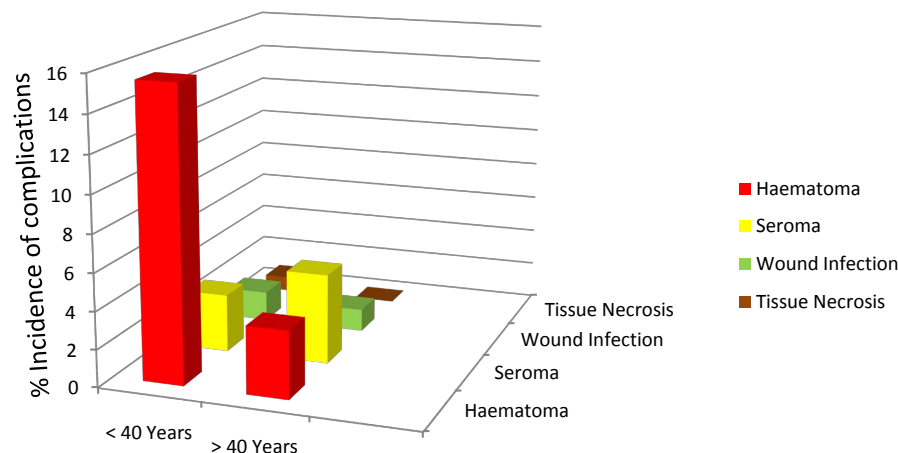
Figure 4. Incidence of complications according to age.

ten of them had haematoma formation (15.2%), one had sermoa formation (1.5%), two had wound infection (3%) and one had tissue necrosis (1.5%) with total complications of 21.2% (**Figure 5**). The two study groups did not have statistically significance in Hematoma development (p = 0.231). Similarly with Seroma development, no statistically significance difference was found (p = 0.440).

Among the 213 patients included in the study, 36 were smokers. Fifteen of the smoker patients had haematoma formation (41.7%), two had seroma formation (5.6%), two had wound infection (5.6%) and one had tissue necrosis (2.8%) with total complications of 55.7%. One hundred and seventy seven patients in the study were non smokers. Eight of them had haematoma (4.5%), Six had seroma formation (3.4%), one had wound infection (0.6%) and no one had tissue necrosis (0%) with total complications of 8.5%. (**Figure 6**) For Hematoma formation, there was a statistically significance in the smokers group (p < 0.001) suggesting smoking as a significant risk to developing hematoma. While in Seroma formation, no statistical significant difference was found between the two groups (p = 0.621)

In the study 127 patients underwent bariatric surgery prior to the abdominoplasty operation. Sixteen of these patients had haematoma formation (12.6%), five had seroma formation (3.9%), three had wound infection (2.4%) and one had tissue necrosis (0.8%) with total complications of 19.7%. Those who did not undergo bariatric surgery before the abdominoplasty operation were 86 patients. Seven of them had haematoma formation (8.1%), three had seroma formation (3.5%) and no one had wound infection or tissue necrosis (0%) with total complications of 11.6%. (**Figure 7**) No Statistic significance was found for all complications in comparison with the two study groups; hematoma development (p = 0.372), seroma formation (p = 0.586) and wound infection (p = 0.274)

Out of the 213 patients included in the study, 100 patients had liposuction, plication of the recti muscles or both in combination with the abdominoplasty procedure. Three of these patients developed haematoma formation (3%), four had seroma formation (4%), one had wound infection (1%) and no one had tissue
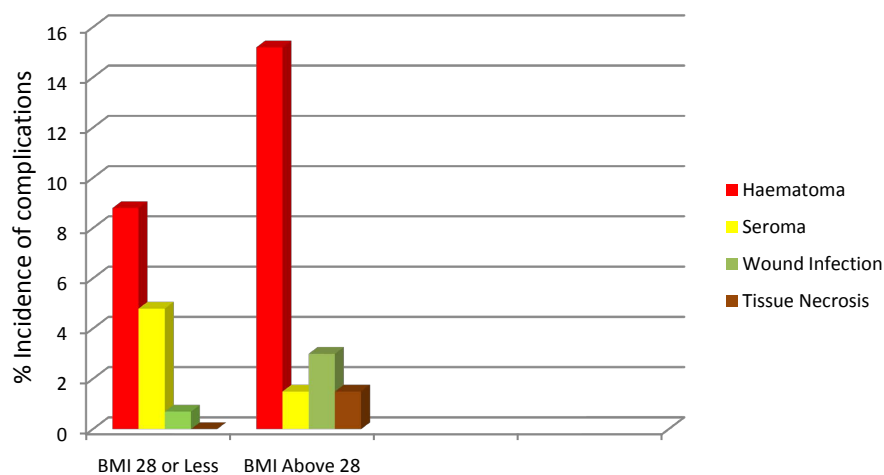
Figure 5. Relation between the Body Mass Index (BMI) and the complication rate.
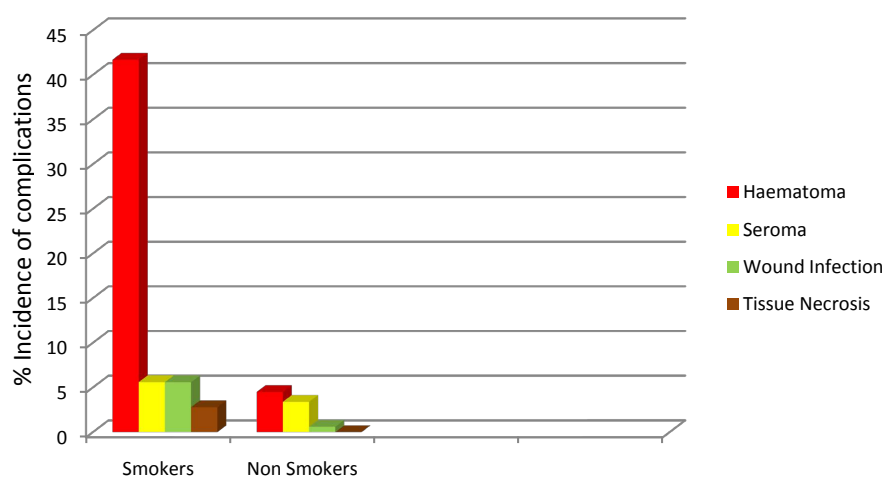
Figure 6. Effect of smoking on the incidence of complications.
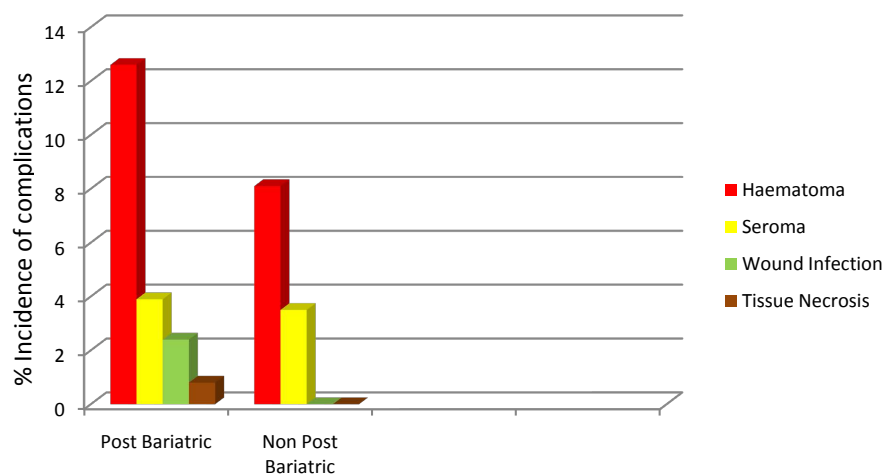
Figure 7. Relation between post bariatric surgery and the incidence of complications.

necrosis (0%) with total complications of 8%. The 113 patients who underwent abdominoplasty surgery without plication of the recti muscles or liposuction had

haematoma formation in 20 patients of them (17.7%), four of them had seroma formation (3.5%), two had wound infection (1.8%) and one patient had tissue necrosis (0.9%) with total complications of 23.9%. (Figure 8) The patients who underwent abdominoplasty surgery alone had a statistically significant score in developing hematoma (p < 0.001) while statistical tests showed no significant differences between the two groups in seroma formation (p = 0.570)

Thirty one patients had associated co-morbidity. Only one of the eleven diabetic patients had wound infection which was drained. Two patients with history of asthma had haematoma formation which was clinically irrelevant.

4. Discussion

Abdominoplasty is one of the most popular cosmetic procedures performed in plastic surgery. As with any surgical procedure, it is associated with complications which are assessed by many studies in the first 30 days following the abdominoplasty surgery. [3] [4] The complications can be classified as systemic complications like deep venous thrombosis, pulmonary embolism, paralytic ileus or even death and local complications as haematoma, seroma, wound infection and tissue necrosis. These local complications can be major requiring surgical intervention or minor which can be managed conservatively at the bed side. In our study we did not encounter systemic complications but we had 35 patients who sustained local complications which represented 16.4% of the patients included in the study. These complications were mostly haematoma 10.8%, seroma 3.8%, wound infection 1.4% and tissue necrosis 0.5%. There is a lot of variation of the complication rate and the incidence of each one between different centers. While some studies reported low incidence of complications of 4% with the majority haematoma followed by wound infection, [5] others reported high incidence of 32.6% which were mostly seroma formation followed by other complications. [6]
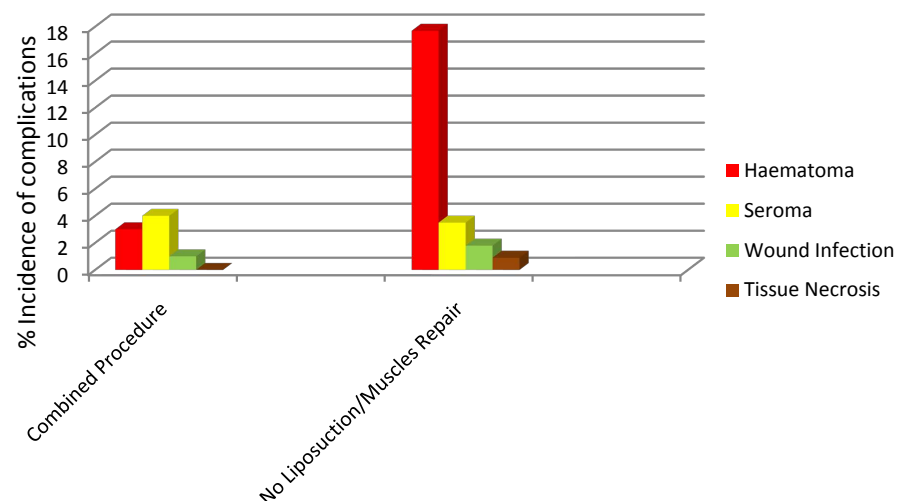
Figure 8. Complication rates of abdominoplasty either combined with liposuction and/or plication of the recti muscles or not.

There is a relation between possible risk factors and the occurrence of wound complications. These risk factors can be age, sex, body mass index, smoking, history of undergoing bariatric surgery, history of associated comorbidities and combining other procedures as liposuction or plication of the recti muscles with the abdominoplasty surgery. [7]

Chong *et al.* found on their retrospective study on 481 patients that males are at an increased risk of post abdominoplasty complications mostly hematoma and seroma formation compared to females. [8] Our study also showed that haematoma, wound infection and tissue necrosis were more in males than females. The exact cause of that is not known but there is a possibility that genetic factor can have a role. Additional possibility is that the number of smokers among men is higher than that among women.

Smoking is known to be associated with an increased risk of postoperative complications. This fact was confirmed by Grønkjær, M. *et al.*, on their meta-analysis of 107 studies [9] and was also stated before by Sørensen, L. T. on his review and meta-analysis of 140 cohort studies including 479,150 patients. [10] More than half of the smokers in our study (55.7%) developed complications of haematoma, seroma, wound infection and tissue necrosis while the complication rate among the non smokers was only 8.5%.

Christodoulos *et al.*; in their study showed that the incidence of complications in aesthetic surgery increases with the advancing age. [11] This was also stated by Dutot *et al.*; on their retrospective review of 1128 Cases who underwent abdominoplasty and found that an age of 40 years and older was associated with a higher rate of immediate complications and an elevated risk of seroma formation in particular. [12] Other studies which compared the complication rate in young and elder age groups who underwent abdominoplasty surgery did not find significant difference in either major or minor complications between the two groups. [13] Our study on the contrary showed that the complications were more in those who were younger than 40 years when compared to those who were 40 years of age and above. This could be explained by the fact that smoking is commoner among the younger age group and also most of the male patients in our study (72%) of them were below 40 years of age with higher incidence of complications among these both categories.

In contrary to the studies which related the increased incidence of complications in the elderly people to increase of comorbidities among them, [14] we did not find in our study a significant increase in the complication rate among the patients who were 40 years of age and above and had associated comorbidities. This could be due to proper patient selection, preoperative evaluation and control of the comorbidity conditions and continuation of monitoring and follow up of the patients intra and post operatively.

Many studies showed that Abdominoplasty in overweight and obese patients is associated with an elevated complication rate. [15] Hammond *et al.* performed abdominoplasty on patient with an average BMI of 32 kg/m^2 and had major and minor complications in 47.8% of the cases. [16] In the first 2 years of our study

we were performing abdominoplasty in patients with BMI above 28 Kg/m^2 and we had complication rate of 21.2% in these patients. We decided in the last 3 years of the study to restrict the abdominoplasty procedure to those who have BMI of 28 Kg/m^2 or less and the incidence of complications reduced to 14.3% in this category.

Grignaffini *et al.*, found that the risk of complications in postbariatric abdominoplasty is higher compared to cosmetic abdominoplasty. [17] Our study also showed 19.7% complication rate among those who had bariatric surgery before undergoing abdominoplasty compared to 11.6% among those who had not undergone that procedure before but the difference was statistically insignificant. Haematoma was the commonest complication noted. The possible causes for that can be due to deficiency of vitamin K with other malabsorption deficiencies in post bariatric cases which can predispose to more bleeding. [18] Baptista *et al.*; found that ex-obese patients have a higher number of small and large blood vessels, when compared to control patients and they related that to the excessive bleeding observed during their plastic surgery procedures. [19] Other studies related the increased incidence of haematoma in postbariatric abdominoplasty cases to the longer operative time and to the larger size of the surgical specimen removed in comparison to that in cosmetic abdominoplasty. [20]

Neaman *et al.*; found on their retrospective study of 1008 patients that concomitant liposuction of the flanks and abdomen with the addition of aggressive undermining leads to higher seroma rates. They related that to the increased resorptive demands placed on the abdominal lymphatics in the setting of greater dead space and larger fluid shifts as a result of liposuction. [6] We do not do aggressive undermining in our abdominoplasty cases especially if liposuction is done at the same time. We did not have significant difference in seroma formation between those who had abdominoplasty only and those who had abdominoplasty combined with liposuction or plication of the recti muscles. There was a significant difference in the formation of haematoma which was commoner in those who had abdominoplasty alone. Heller *et al.*; who performed similar technique of abdominoplasty combined with extensive liposuction and limited paramedian supraumbilical dissection had fewer complications and less dissatisfaction than in those who had traditional abdominoplasty. They attributed this to a reduced tension midline closure in the suprapubic region, less lateral undermining in the upper abdomen, and greater preservation of intercostal artery blood flow to the flap. [21] Swanson on his review of 360 cases found that combined procedure of liposuction and abdominoplasty is similar in discomfort level to abdominoplasty alone and produces the highest level of patient satisfaction. [22]

Further studies and meta-analysis research may be needed for evaluation of more factors and possible complications with their outcome.

5. Conclusion

The commonest complications of abdominoplasty surgery are haematoma, se-

roma, wound infection and tissue necrosis. Proper identification of the risk factors that can predispose to these complications should be considered in order to obtain the best outcome.

Compliance with Ethical Standards

This study was approved by Abu Dhabi Region Ethics and research Committed, Zayed Military Hospital Abu Dhabi.

Disclosure

The authors have no commercial associations that might be a conflict of interest in relation to this article.

Conflicts of Interest

The authors declare no conflicts of interest regarding the publication of this paper.

References

[1] Hunecke, P., Toll, M., Mann, O., Izbicki, R.J., Blessmann, M. and Grupp, K. (2019) Clinical Outcome of Patients Undergoing Abdominoplasty after Massive Weight Loss. *Surgery for Obesity and Related Diseases*, **15**, 1362-1366. https://doi.org/10.1016/j.soard.2019.06.001

[2] Jeroen, H., Van, U., Werker, P.M.N. and Kon, M. (2001) Complications of Abdominoplasty in 86 Patients. *Plastic and Reconstructive Surgery*, **107**, 1869-1873. https://doi.org/10.1097/00006534-200106000-00037

[3] Vu, M., Ellis, M.F., Blough, J.T., Gutowski, K.A. and Kim, J.Y. (2018) Development and Internal Validation of the Abdominoplasty Risk Calculator. *Plastic and Reconstructive Surgery*, **141**, 34e-45e. https://doi.org/10.1097/PRS.0000000000003922

[4] Massenburg, B.B., Sanati-Mehrizy, P., Jablonka, E.M. and Taub, P.J. (2015) Risk Factors for Readmission and Adverse Outcomes in Abdominoplasty. *Plastic and Reconstructive Surgery*, **36**, 968-977. https://doi.org/10.1097/PRS.0000000000001680

[5] Winocour, J., Gupta, V., Ramirez J.R., Shack, R.B., Grotting, J.C. and Higdon, K.K. (2015) Abdominoplasty Risk Factors, Complication Rates, and Safety of Combined Procedures. *Plastic and Reconstructive Surgery*, **136**, 597e-606e. https://doi.org/10.1097/PRS.0000000000001700

[6] Neaman, K.C., Armstrong, S.D., Baca, M.E., Albert, M., Vander Woude, D.L. and Renucci, J.D. (2013) Outcomes of Traditional Cosmetic Abdominoplasty in a Community Setting. A Retrospective Analysis of 1008 Patients. *Plastic and Reconstructive Surgery*, **131**, 403e-410e. https://doi.org/10.1097/PRS.0b013e31827c6fc3

[7] Samir, K.J. (2009) Risk Factors for Wound Complications Following Abdominoplasty. *American Journal of Applied Sciences*, **6**, 897-901. https://doi.org/10.3844/ajassp.2009.897.901

[8] Chong, T., Coon, D., Toy, J., Purnell, C., Michaels, J. and Rubin, J.P. (2012) Body Contouring in the Male Weight Loss Population: Assessing Gender as a Factor in Outcomes. *Plastic and Reconstructive Surgery*, **130**, 325-330.

https://doi.org/10.1097/PRS.0b013e3182589adb

[9] Grønkjær, M., Eliasen, M., Skov-Ettrup, L.S., Tolstrup, J.S., Christiansen, A.H., Mikkelsen, S.S. Becker, U. and Flensborg-Madsen, T. (2014). Preoperative Smoking Status and Postoperative Complications: A Systematic Review and Meta-Analysis. *Annals of Surgery*, **259**, 52-71. https://doi.org/10.1097/SLA.0b013e3182911913

[10] Sørensen, L.T. (2012) Wound Healing and Infection in Surgery: The Clinical Impact of Smoking and Smoking Cessation a Systematic Review and Meta-Analysis. *Archives of Surgery*, **147**, 373-383. https://doi.org/10.1001/archsurg.2012.5

[11] Kaoutzanis, C., Winocour, J., Gupta, V., Kumar, N.G., Sarosiek, K., Wormer, B., Tokin, C., Grotting, J.C. and Higdon, K.K. (2017) Incidence and Risk Factors for Major Hematomas in Aesthetic Surgery: Analysis of 129,007 Patients. *Aesthetic Surgery Journal*, **37**, 1175-1185. https://doi.org/10.1093/asj/sjx062

[12] Dutot, M.-C., Serror, K., Al Ameri, O., Chaouat, M., Mimoun, M. and Boccara, D. (2018) Improving Safety after Abdominoplasty: A Retrospective Review of 1128 Cases. *Plastic and Reconstructive Surgery*, **142**, 355-362. https://doi.org/10.1097/PRS.0000000000004572

[13] Couto, R.A., Lamaris, G.A., Baker, T.A., Hashem, A.M., Tadisina, K., Durand, P., Rueda, S., Orra, S. and Zins, J. E. (2017) Age as a Risk Factor in Abdominoplasty. *Aesthetic Surgery Journal*, **37**, 550-556. https://doi.org/10.1093/asj/sjw227

[14] Yeslev, M., Gupta, V., Winocour, J., Shack, B., Grotting, J.C. and Higdon, K.K. (2017) Safety of Cosmetic Surgery in Adolescent Patients. *Aesthetic Surgery Journal*, **37**, 1051-1059. https://doi.org/10.1093/asj/sjx061

[15] Rogliani, M., Silvi, E., Labardi, L., Maggiulli, F. and Cervelli, V. (2006). Obese and Nonobese Patients: Complications of Abdominoplasty. *Annals of Plastic Surgery*, **57**, 336-338. https://doi.org/10.1097/01.sap.0000221460.43861.6b

[16] Hammond, D.C., Chandler, A.R., Baca, M.E., Li, Y.K. and Lynn, J.V. (2019) Abdominoplasty in the Overweight and Obese Population: Outcomes and Patient Satisfaction. *Plastic and Reconstructive Surgery*, **144**, 847-853. https://doi.org/10.1097/PRS.0000000000006018

[17] Grignaffini, E., Grieco, M., Bertozzi, N., Gandolfi, M., Palli, D., Cinieri, F.G., Gardani, M. and Raposio, E. (2015) Post-Bariatric Abdominoplasty: Our Experience. *Acta Biomed*, **86**, 278-282.https://doi.org/10.1155/2015/209173

[18] Çalapkorur, S. and Küçükkatirci, H. (2020) Vitamin Deficiencies and Prevention Methods after Bariatric Surgery. *Mini-Invasive Surgery*, **4**, 15. https://doi.org/10.20517/2574-1225.2019.51

[19] Baptista. L.S., Da Silva, K.R., Da Pedrosa, C.S.G., Claudio-Da-Silva, C., Carneiro, J.R.I., Aniceto, M., De Mello-Coelho, V., Takiya, C.M., Rossi, M.I.D. and Borojevic, R. (2009) Adipose Tissue of Control and Ex-Obese Patients Exhibit Differences in Blood Vessel Content and Resident Mesenchymal Stem Cell Population. *Obesity Surgery*, **19**, 1304-1312. https://doi.org/10.1007/s11695-009-9899-2

[20] Souto, L.R.M., Chaim, E.A., Barbosa, R.C. and Bizzacchi, J.M.A. (2012) Increased Intraoperative Bleeding in Patients Undergoing Abdominoplasty after Gastroplasty Is Not Due to Coagulopathy. *Aesthetic Plastic Surgery*, **36**, 1283-1291. https://doi.org/10.1007/s00266-012-9976-0

[21] Heller, J.B., Teng, E.B.S., Knoll, B.I. and Persing, J. (2008) Outcome Analysis of Combined Lipoabdominoplasty versus Conventional Abdominoplasty. *Plastic and Reconstructive Surgery*, **121**, 1821-1829. https://doi.org/10.1097/PRS.0b013e31816b1350

[22] Swanson, E. (2012) Prospective Outcome Study of 360 Patients Treated with Liposuction, Lipoabdominoplasty, and Abdominoplasty. *Plastic and Reconstructive Surgery*, **129**, 965-978. https://doi.org/10.1097/PRS.0b013e318244237f

The Utility of the Galea in Scalp Reconstruction

Jack D. Sudduth, John M. Sullivan, Marc E. Walker*

Division of Plastic and Reconstructive Surgery, Department of Surgery, University of Mississippi Medical Center, Jackson, MS, USA
Email: *mwalker6@umc.edu

Abstract

Total scalp avulsion is a time-sensitive, catastrophic injury requiring quick, complex decision-making. Traditionally, these injuries were treated with split-thickness skin grafts. With advancements in microsurgery, treatments evolved to scalp replantation, becoming the standard of care in scalp reconstruction. Although the integrity of the scalp's blood vessels is pivotal for successful replantation, the authors believe that scalp replantation should be considered at all costs. In the presented case, a 54-year-old female presented to the emergency room following an incident with an auger that completely avulsed her scalp. She was taken back to the operating room, where scalp replantation was performed. Following replantation, scalp necrosis led to serial debridings in the operating room, and eventually, all of the scalp was debrided down to healthy tissue. Surprisingly, the galea survived despite this, which provided a healthy base for skin grafts. Before definitive coverage was placed, it was decided to utilize a bilaminar acellular dermal matrix along with negative pressure wound therapy to create a more robust bed of granulation tissue. After three weeks of this treatment plan, the patient returned to the operating room, where a healthy, viable bed of granulating tissue was revealed beneath the dermal matrix. Split-thickness skin grafts were taken from her thighs bilaterally and sewn together in a quilt-like fashion to cover the wound bed. The entirety of the graft healed without complication except for one small area that required full-thickness skin grafting in an outpatient setting. Even though the replantation ultimately failed, it allowed the galea to survive, which saved the patient from undergoing a free tissue transfer and allowed her scalp to be reconstructed with split-thickness skin grafts. Even in the setting of polytrauma, the authors hope that anyone treating a scalp avulsion would consider scalp replantation at all costs.

Keywords

Scalp Reconstruction, Scalp Replantation, Failed Replantation, Galea, Polytrauma, Split-Thickness Skin Grafts, Bilaminar Acellular Dermal Matrix

1. Introduction

Total scalp avulsion is a rare and devastating injury. Specific case examples of this typically involve an individual becoming entwined in a rotating piece of heavy machinery. The scalp is typically separated at the loose areolar layer, removing the skin, connective tissue, and galea aponeurotica while leaving the periosteum intact. Other facial structures such as the eyelids or ears can also be involved.

Historically, the treatment of choice for repairing scalp avulsions was with split-thickness skin grafts (STSG). [1] [2] [3] [4] The outcomes of scalp reconstruction with split-thickness skin grafts were less than satisfactory since the new scalp was fragile and not aesthetically pleasing, always requiring a wig. A transition was made to defatting the scalp and using it as a full-thickness skin graft to preserve the hair follicles and avoid having to wear a wig, but this had varying—and primarily poor—outcomes. [5] [6] In 1976, Miller published the first case of successful microvascular scalp replantation, which, in the correct scenario, became the standard of care. [7] However, successful replantation hinges on the integrity of the avulsed vessels. [8] Because replantation is not always viable, choosing a scalp reconstruction method can become rather complex. Additional options for reconstruction include local flaps, free flaps, tissue expansion, and negative pressure wound therapy (NPWT). Because of the number of options, Cen *et al.* published a clinical decision-making tree for scalp reconstruction. [9]

Various case reports have been published for scalp reconstruction, mostly of microvascular replantation. [10] [11] [12] [13] [14] While this is the current standard of care, it is not always successful or, in some cases, possible, and occasionally, alternative solutions are needed. Recently, publications have utilized older methods of split-thickness skin grafts for reconstruction. [8] [15] In the presented case, this was taken one step further by utilizing a bilaminar acellular dermal matrix, Integra, as an intermediary step prior to skin grafting to increase the integrity of the soft tissue reconstruction. Although the scalp replantation ultimately failed, the choice for coverage combined the use of Integra, negative pressure wound therapy, and split-thickness skin grafts based on the foundation of a surviving galea.

2. Case Report

In January 2021, a 54-year-old female with a history of intravenous drug abuse presented to the emergency room intubated and sedated after an incident with an auger. The auger entrapped her hair and avulsed her scalp circumferentially while also completely transecting the upper half of the right ear. Additionally, to free her hair from the machine, she received multiple hand and wrist fractures bilaterally, including a partial digital amputation on her right hand. She was taken to the operating room for possible scalp replantation, surgical debridement, and fixation of the upper extremity injuries with possible replantation of the partially amputated digit. A three-team approach was taken to address the

issues at hand. The first team analyzed the avulsed scalp on a sterile back table for possible vessels that could be used for replantation [Figure 1(A)]. The second team investigated the head and found both the superficial temporal arteries and one vein that could be used for possible scalp replantation. The third team began investigating and repairing the upper extremity injuries and fractures. Given the nature of the injury and the polytrauma associated with the patient, the finger was not replanted. Scalp replantation was attempted with bilateral superficial temporal artery anastomosis and left-sided temporal vein anastomosis [Figure 1(B)]. Before leaving the operating room, a handheld doppler was used to identify individual cutaneous perforators marked with a Prolene stitch.

Following surgery, the patient was transferred to the intensive care unit for monitoring [Figure 2(A) & Figure 2(B)]. The patient was started on 81 mg aspirin, Lovenox, and broad-spectrum antibiotics postoperatively. In the preceding days following replantation, the scalp began to show signs of venous congestion on the right parietal region that extended to the right ear. Leech therapy was initiated on day two and continued through day four. After it was clear that portions of the right parietal scalp were developing necrosis, the patient was taken to the operating room for surgical investigation and debridement. The necrotic portions were debrided to healthy underlying tissue within the galeal layer. Over the coming days, the cutaneous skin extending to the occiput of the scalp continued to declare itself as non-viable. The patient returned to the operating room, where the posterior ischemic tissue was removed down to viable galeal tissue. Progression of ischemic necrosis continued for two weeks, requiring multiple return trips to the operating room. Unfortunately, the entire skin of the scalp was eventually debrided away, but interestingly, the galeal tissue had successfully been revascularized except for a few 3 - 4 cm areas. These areas of total tissue necrosis resulted in exposed calvarium.

The galea remained viable after the final debridements, and it was determined that it would be stable to receive a graft. However, because of the tenuous progression of this case and the exposed calvarium, the decision was made to add an intermediate step before grafting. A bilaminar acellular dermal matrix, Integra, was chosen to help make the wound bed more robust and hopefully improve the long-term reconstruction. Before the application, the galea was debrided for a final time, and any areas of exposed cranium were burred until punctate bleeding was present. A negative pressure dressing was placed over the Integra and replaced weekly for three weeks. The silicone sheeting was removed, revealing a well-vascularized and well-incorporated dermal matrix [Figure 3(A) & Figure 3(B)]. Split thickness skin grafts taken from bilateral thighs were meshed and used to cover the vascularized wound bed. The entirety of the skin grafts, except for one area over previously exposed calvarium, healed without complication. The one area of 3 cm was eventually grafted with a full-thickness skin graft in an outpatient setting. Ultimately, the patient healed with complete scalp coverage [Figure 4(A) & Figure 4(B)].

Figure 1. (A) Avulsed scalp prior to replantation; (B) Scalp replantation demonstrating a venous anastomosis with a venous coupler (yellow arrow).

Figure 2. (A) Anterior view status post scalp replantation; (B) Right lateral view status post scalp replantation.
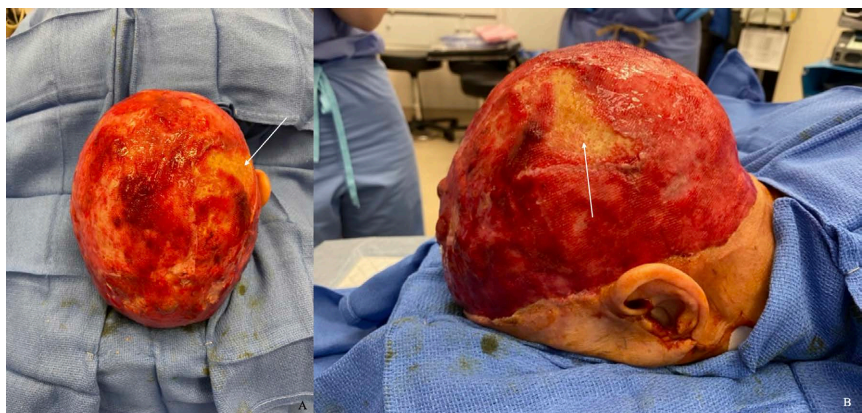
Figure 3. (A) Coronal view of superior scalp 5 weeks status post-accident demonstrating healthy granulation tissue over the galea after ADM removal and a small area of exposed calvarium (white arrow); (B) Left sagittal view of superior scalp 5 weeks status post-accident demonstrating healthy granulation tissue over the galea after ADM removal and a small area of exposed calvarium (white arrow).

Figure 4. (A) 4 weeks status post split-thickness skin graft placement with sutures still in place; (B) 13 weeks status post split-thickness skin grafts demonstrating a healed scalp. Presenting for small full-thickness skin graft placement.

3. Discussion

Scalp reconstruction after total scalp avulsion is a complex, time-sensitive operation typically repaired with scalp replantation. [12] In the polytrauma setting there are often more severe and pressing injuries. In this case, despite the various injuries inflicted by the auger, scalp replantation was attempted. With the repair of only two arteries and one vein, a large portion of the underlying galeal layer remained viable even as the more superficial tissue developed necrosis. Because of the galea's successful revascularization, the patient was able to receive STSGs and forego a free microvascular flap.

While it is essential to weigh the risks and benefits of proceeding with scalp replantation, especially in polytrauma patients, because of the chance of survival of the scalp's deeper, more vascular layers, replantation should be considered at all costs. It is likely, in this case, that the superficial layers of the scalp necrosed from its perforators being crushed or sheared at the time of the accident. Despite this, the replantation provided enough flow for the galea to remain viable. Dadaci *et al.* reported a similar finding in a patient that underwent scalp replantation. The patient developed necrosis of the scalp and required serial debridements of the entire scalp, but the galea survived and was covered with STSGs. [11] They did not report using an ADM, however. An ADM, such as Integra, is prudent to consider as an adjuvant treatment to enhance coverage and provide a stable wound bed for STSGs, especially over exposed calvarium. ADM has been shown to facilitate vascularization over native and exposed structures to help create a vigorous bed of granulation tissue. [16] In this case, applying Integra with NPWT served the additional purpose of building a base of tissue that would disguise any surface irregularities.

The authors believe that salvaging the galea during serial provided the best opportunity for successful grafting. Alternatively, removing the galea and bur-

ring down the entire skull before utilizing Integra and STSGs would have provided no additional chance of successful coverage. The galea additionally increased the scalp's thickness, providing more protection from subsequent trauma. Using Integra for coverage of an entire scalp may seem cost prohibitive but having a more potent bed of tissue to graft on increases the chances of successfully taking STSGs.

In this case, the authors hope to show the importance of always considering scalp replantation even in the setting of polytrauma. If the replantation fails, the galea could still survive, providing vascularized tissue that readily accepts STSGs.

Ethical Statement

All procedures followed were in accordance with the ethical standards of the responsible committee on human experimentation (institutional and national) and with the Helsinki Declaration of 1975, as revised in 2008 (5). Informed consent was obtained from all patients for being included in the study. Additional informed consent was obtained from all patients for which identifying information is included in this article.

Conflicts of Interest

The authors declare no conflicts of interest regarding the publication of this paper.

References

[1] Wynn, S.K. (1951) Free Pattern Skin Graft in Total Scalp Avulsion. *Plastic and Reconstructive Surgery* (1946), **7**, 225-236. https://doi.org/10.1097/00006534-195103000-00004

[2] Whalen, W.P. (1957) Avulsion of the Scalp. *Plastic and Reconstructive Surgery* (1946), **19**, 225-228. https://doi.org/10.1097/00006534-195703000-00006

[3] Robinson, F. (1952) Complete Avulsion of the Scalp. *British Journal of Plastic Surgery*, **5**, 37-50. https://doi.org/10.1016/S0007-1226(52)80005-0

[4] Pandya, N.J., Gupta, J.L., Bhatnagar, S.K. and Srivastava, J.L. (1977) Avulsion Injury of the Scalp. *Plastic and Reconstructive Surgery*, **59**, 448. https://doi.org/10.1097/00006534-197703000-00035

[5] Jeremiah, B.S. (1971) Avulsion of the Scalp and Its Reconstruction. *Plastic and Reconstructive Surgery*, **48**, 604. https://doi.org/10.1097/00006534-197112000-00024

[6] Dickson, L., Kattan, A. and Thoma, A. (2010) Two-Technique Reconstruction Following Traumatic Scalp Avulsion: Replantation and Composite Graft. *Plastic and Reconstructive Surgery*, **125**, 151e-152e. https://doi.org/10.1097/PRS.0b013e3181d45b69

[7] Miller, G.D., Anstee, E.J. and Snell, J.A. (1976) Successful Replantation of an Avulsed Scalp by Microvascular Anastomoses. *Plastic and Reconstructive Surgery*, **58**, 133-136. https://doi.org/10.1097/00006534-197608000-00001

[8] Fijalkowska, M. and Antoszewski, B. (2018) Complications after Scalp Suturing Posttraumatic Avulsion. *Journal of Craniofacial Surgery*, **29**, e670-e672. https://doi.org/10.1097/SCS.0000000000004764

[9]   Cen, H., Jin, R., Yu, M. and Weng, T. (2021) Clinical Decision Model for the Reconstruction of 175 Cases of Scalp Avulsion/Defect. *American Journal of Otolaryngology*, **42**, Article ID: 102752. https://doi.org/10.1016/j.amjoto.2020.102752

[10]   Anbar, R.A., *et al.* (2012) Scalp Reconstruction Prodedures. *Revista Brasileira de Cirurgia Plástica*, **27**, 156-159. https://doi.org/10.1590/S1983-51752012000100026

[11]   Dadaci, M., Yildirim, M.E.C. and Ince, B. (2019) Experience of Replantation and Reconstruction in Total Scalp, Partial Forehead, and Ear Avulsions. *Journal of Craniofacial Surgery*, **30**, 2268-2270. https://doi.org/10.1097/SCS.0000000000005993

[12]   Kalra, G.S., Goil, P. and Chakotiya, P.S. (2013) Microsurgical Reconstruction of Major Scalp Defects Following Scalp Avulsion. *Indian Journal of Plastic Surgery*, **46**, 486-492. https://doi.org/10.4103/0970-0358.121984

[13]   Kashyap, N., Singhal, M., Tiwari, R., Chauhan, S. and Manas, R. (2020) Scalp Avulsion Injuries and Replantation: Is Deep Temporal Artery an Alternate Option? *Annals of Plastic Surgery*, **84**, 178-182. https://doi.org/10.1097/SAP.0000000000002005

[14]   Jennings, M., Willet, J., Cook, S., Harbison, J., Caplash, Y. and Solanki, N.S. (2021) Total Scalp Avulsion: Practical Tips for Successful Replantation. *ANZ Journal of Surgery*, **92**, 880-881. https://doi.org/10.1111/ans.17148

[15]   Liu, C. and Liao, N. (2003) Treatment of Overtime Avulsion of Scalp with Split Thickness Scalp Skin Grafting: 7 Cases of Reports. *Chinese Journal of Reparative and Reconstructive Surgery*, **17**, 388-390.

[16]   Iorio, M.L., Shuck, J. and Attinger, C.E. (2012) Wound Healing in the Upper and Lower Extremities: A Systematic Review on the Use of Acellular Dermal Matrices. *Plastic and Reconstructive Surgery*, **130**, 232S-241S.
         https://doi.org/10.1097/PRS.0b013e3182615703

![Scientific Research Publishing logo]

Multi-Segmental Osteocutaneous Free Fibula Flap for Three-Dimensional Post-Traumatic Thumb and Wrist Reconstruction

Jack D. Sudduth, Shireen Dogar, Narges L. Horriat, Marc E. Walker*

Division of Plastic and Reconstructive Surgery, Department of Surgery, University of Mississippi Medical Center, Jackson, MS, USA
Email: *mwalker6@umc.edu

Abstract

Thumb reconstruction following a traumatic injury challenge depends on the extent of the injury. Ideally, reconstruction should restore thumb length and position and retain thumb stability, mobility, and strength, while preserving sensation and aesthetics. Achieving these outcomes can be especially challenging in severe cases of soft tissue and bony loss. The authors present a case of a 20-year-old right-hand dominant female involved in a motor vehicle accident who sustained severe crush injuries and burns to her right hand. Her injuries included soft tissue and bony defects extending from the thumb to the distal radius, namely avulsion of the thumb and significant loss of the distal radial and carpal column, resulting in severe wrist instability. We employed a three-segment vascularized osteocutaneous fibula flap to reconstruct the thumb and wrist to restore bony construct, carpal support, and soft tissue coverage. Thumb motion could not be achieved, but this technique offered a sensate, functional post for opposition and the appearance of an anatomic hand. Because of this surgery, the patient was enabled to graduate from college and pursue full-time employment. The authors hope that this report will add to the fund of knowledge and surgeon armamentarium for similar devastating injuries demanding thumb and wrist reconstruction.

Keywords

Thumb Reconstruction, Wrist Reconstruction, Microvascular Reconstruction, Free Fibula Flap, Thumb Amputation

1. Introduction

Thumb and wrist reconstruction in the setting of traumatic amputation requires

complex surgical planning, beginning with early and aggressive debridement [1]. Of the options available for reconstruction, the vascularized free fibula flap (FFF) has been described as the best overall choice for traumatic injuries [2] [3] [4]. Taylor *et al.* first reported successful free vascularized bone transfer in 1975 [5]. In 1986, Wei *et al.* expanded the idea of vascularized bone transfer to include an osteocutaneous flap to provide additional skin coverage when needed [6]. Since then, there have been various applications of the free vascularized osteo-cutaneous fibula flap, the most notable of which has been the reconstruction of long, segmental bone defects [3].

FFF is used following tumor resection in most case reports of thumb and wrist reconstruction [7] [8]. Reconstruction following oncologic resection for tumor ablation is designed based on bony and soft tissue defects that are surgically planned according to necessary oncologic margins. However, traumatic injuries can be more challenging as anatomic structures are not preserved compared to surgically planned cases. Instead, reconstruction is planned based on what remains intact following traumatic tissue loss in these cases. The size of the bony defect, the number of bony segments needed, the presence of soft tissue loss, and the amount of soft tissue coverage required are variable and often unpredictable, often requiring more complex reconstructive decision-making [9] [10].

The FFF is the best reconstructive option for significant bony defects with concomitant soft tissue loss. The bone can be divided into segments that bridge multiple defects—providing three-dimensional reconstruction—and the skin paddle can be tailored for broad soft tissue coverage [11]. Pederson notes that contaminated wounds are best covered with muscle or other vascularized soft tissue, which increases infection resistance due to hypervascularity [1]. Additionally, FFF provides better healing quality and a higher incorporation rate than non-vascularized grafts due to its innate promotion of osteogenesis [2] [3] [4] [12] [13]. Dailiana *et al.* and Humail *et al.* report that the FFF is useful for defects involving the distal radius and hand, as the architecture of the fibula matches that of the proximal carpal row [13] [14]. Problems with the FFF include infection, nonunion, secondary fracture, joint instability, and arthritis, yet, even so, the benefits of FFF still outweigh those of other bone grafts [15]. Thus, this case report describes a multi-segmental osteocutaneous free fibula flap for post-traumatic three-dimensional thumb and wrist reconstruction.

2. Case Report

A 20-year-old, right-hand-dominant female with no past medical history presented to the emergency department following a motor vehicle accident. At the time of presentation, she sustained significant avulsion of the right dorsal radial skin with surrounding full-thickness thermal injury, complete loss of the radial aspect of the distal radius at the radial styloid and scaphoid fossae, displacement of the scapho-trapezio-trapezoid complex and carpometacarpal joint, bony loss of 75% of the thumb proximal phalanx and metacarpal, and an open index me-

tacarpal base fracture (Figures 1(a)-(c)). The radial dorsal tips of each distal interphalangeal joint demonstrated full-thickness abrasions, but the remaining skin contained good capillary refill and normal sensation throughout. The flexor digitorum superficialis and profundus were intact to all digits, as were all extensors. The flexor pollicis longus remained intact, and the thumb tip demonstrated sensate volar skin. The thumb extensors and abductors were avulsed, abraded, and unable to be salvaged.

The patient was taken emergently to the operating room for debridement of all devitalized tissue, removal of foreign debris, reduction of fractures, and evaluation of remaining soft tissue and its viability. The distal radioulnar joint was found to be preserved on supination and pronation. However, a significant loss of radial height and radial buttress effect led to severe carpal instability and radial subluxation. After complete debridement, the index finger metacarpophalangeal joint was pinned percutaneously with Kirchner wires, the distal radioulnar dislocation was reduced, and the radiocarpal joint was stabilized with an external fixator (Figure 2). Finally, the wound was temporized with a loose approximation of remaining skin, and a negative pressure dressing was placed over the remaining open wounds.

Given the patient's injuries, much consideration was taken in determining a reconstructive course that would allow for a maximal functional and aesthetic outcome. Ultimately, we planned a complex reconstruction of the thumb and distal radius with a multi-segment osteocutaneous free fibula flap. Osteotomies were measured and planned to achieve optimal shape and position of the thumb using contralateral radiographs and digital planning using 3D CT imaging (Figure 3). Before reconstruction, we irrigated and debrided any residual devitalized tissue and ensured a clean and healthy wound bed (Figure 4). A free fibula flap was then marked and harvested from the ipsilateral leg (Figure 5(a) & Figure 5(b)). Three segments of vascularized bone based on the peroneal artery pedicle were created using these osteotomies, starting distally with a 2 cm segment for the proximal phalanx, followed by a 4 cm segment for the thumb metacarpal and a 3.5 cm segment for the reconstruction of the radial carpal column. An additional 3 cm segment of bone graft was harvested from the fibula to restore the radial styloid as a buttress for the carpus (Figure 6).

The neo-thumb was secured with plates into an anatomic position onto the remaining native bony segments, and the new carpal construct (most proximal segment) was secured to the ulnar carpus with two compression screws. The bone graft was secured to the remnant radius to serve as a radial buttress to prevent radial translation of the carpus. Vascular anastomoses were made from the flap pedicle to the radial artery and a superficial vein. The skin paddle was used to cover the bony construct and all vital structures, while a split-thickness skin graft was used to cover the remaining soft tissue defect (Figure 7). The vascularized skin flap and native muscle covered all bone, hardware, and neurovascular structures. An implantable doppler was placed around the artery for flap monitoring.
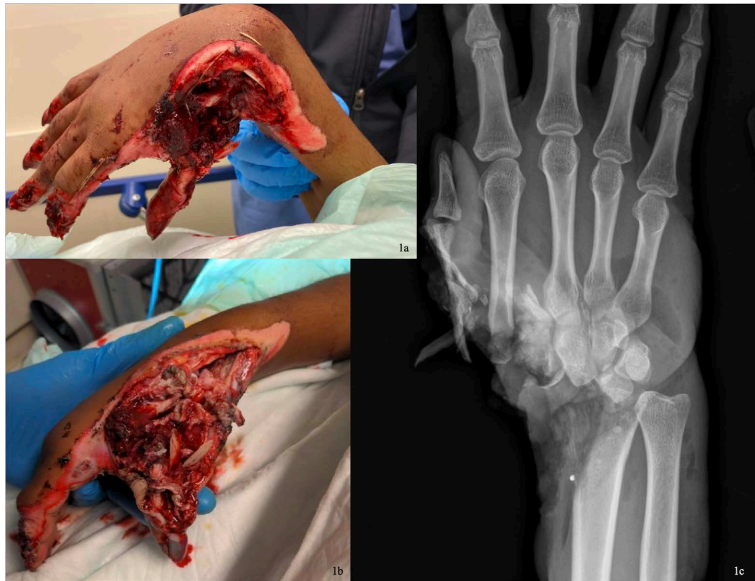
Figure 1. (a) Right radial wrist demonstrating intact volar thumb soft tissue; (b) Right radial wrist on presentation with debris and cross contamination; (c) Radiograph of right hand on presentation demonstrating significant loss of distal radius and destruction of thumb metacarpal and radial carpal bones.
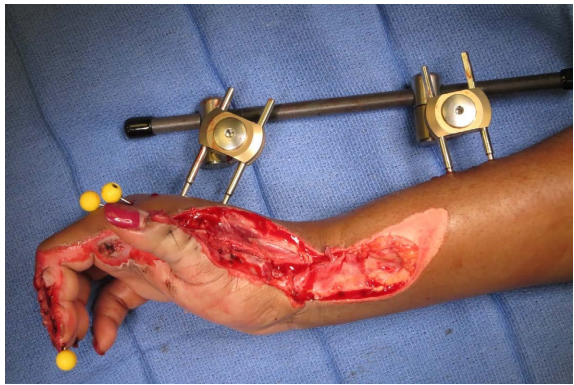
Figure 2. Status post initial debridement, external fixation for stability of hand and wrist, partial soft tissue closure.
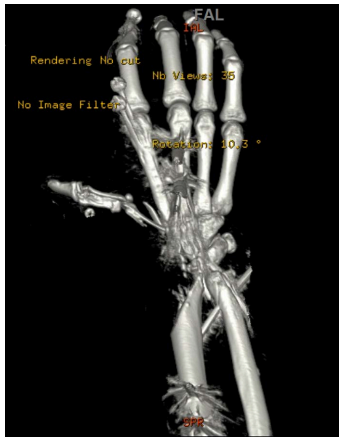
Figure 3. Computed tomography 3D reconstruction of right hand.
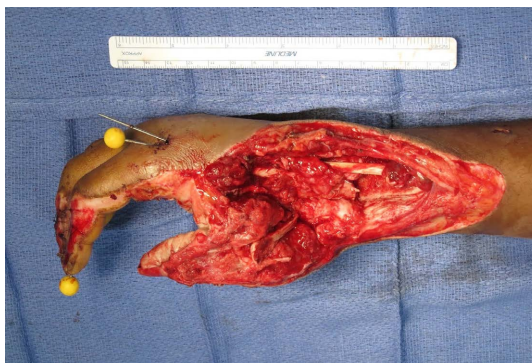
Figure 4. After irrigation and debridement, demonstrating a healthy wound bed.

Figure 5. (a) Free fibula flap marking and skin paddle design from ipsilateral lower leg; (b) Free fibula flap after dissection.

Figure 6. Intraoperative fluoroscopic lateral view after bony reconstruction with free fibula flap.
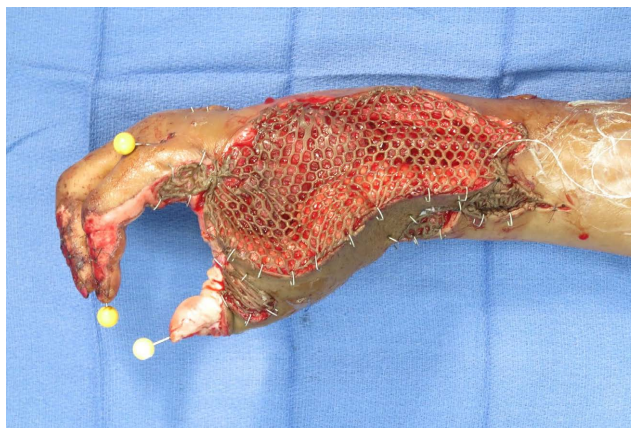
Figure 7. Closure and coverage after microvascular anastomosis to the proximal radial artery and inset and fixation of osteocutaneous construct.

Over the subsequent days, the skin paddle suffered from venous congestion; however, the bone and muscle remained vascularized. Despite multiple attempts at salvaging the skin paddle, this was eventually taken back to the operating room and debrided. A salvage groin flap was employed to provide skin coverage and protect the bony construct of the wrist, which was ultimately successful. After the flap was separated and allowed time to heal, the patient underwent extensive hand therapy. At her one year follow-up appointment, she maintained a sensate and functional thumb with an index-thumb pinch. She graduated from college, returned to driving, and began working full-time.

3. Discussion

The importance of the thumb is well-documented in the surgical literature. According to the AMA Guides to the Evaluation of Permanent Impairment, thumb amputation results in 40% loss of hand function, while amputation of the index or long finger accounts for only 20% loss of hand function [16]. The thumb's vital role in hand function is attributed to its unique ability to flex across the palm's width [17]. It maintains this extensive range of motion because the thumb only has two phalanges, a short metacarpal, and a saddle-shaped carpometacarpal joint. When trauma and destructive changes are introduced to this joint, it inevitably affects the posture and function of the entire hand. For carpometacarpal joint destruction, stability of the thumb is more critical than functional movement [17]. Addressing the complexities of thumb injuries is paramount to restoring the hand's functionality and improving the patient's quality of life.

Hand trauma occurs frequently and represents a significant portion of nonfatal injuries requiring medical intervention. The global incidence of hand trauma has been unchanged since 1990, with thumb amputation accounting for the most significant burden of disability internationally [18]. With the high incidence and morbidity associated with thumb trauma, it is essential to define reconstructive objectives. Pet *et al.* state that reconstructive goals should seek to

restore thumb length, strength, position, stability, mobility, sensation, and aesthetics [19]. Reconstructive methods are based on two thumb injury classifications: defects and amputations. The primary objective of thumb defect reconstruction is to resurface or replace damaged components, whereas the reconstructive goal for thumb amputation is to restore with replantation, and often these objectives of reconstruction overlap. For example, a thumb amputation with a substantial volar pulp defect may require replantation and flap coverage for skin resurfacing [20].

A functional thumb should be stable enough to perform pulp-to-pulp or tripod pinch for fine object manipulation and hand-digital cylinder grasp for larger objects. These functional demands require a post for opposition that rests outside the plane of the palm. There needs to be sufficient length to oppose the remaining digits, mobility of all joints involved in opposition, adequate sensation for pulp pinch, and acceptable aesthetic appearance when reconstructing the thumb.

A recent case report by Graham *et al.* demonstrated a similar approach to thumb reconstruction. [21] Their patient had disruption of the thumb's metacarpophalangeal joint and were able to successfully restore the joint's form a function with preserved sensation using a vascularized FFF. In the current case, the authors describe a traumatic injury extending proximally from the thumb to the distal radius. This injury created a combination of functional demands, including the restoration of 1) wrist stability, 2) thumb length, 3) thumb position, and 4) aesthetic appearance. A multi-segmental free fibula flap construct was designed to recreate the functional position of the thumb and stability of the wrist. While full functionality of the thumb could not be preserved, this reconstructive approach allowed for an anatomic-appearing hand with a sensate thumb and restoration of index-thumb pinch and opposition. Given the severity of the injury, the overall outcome of the reconstruction was considered successful as we achieved stable bony construct and soft tissue coverage and avoided more proximal surgical amputation of the hand.

4. Conclusion

A free fibula flap is a viable option for post-traumatic total thumb and wrist reconstruction. This technique allows for a sensate post for opposition and a normal hand aesthetic.

Conflicts of Interest

The authors declare that they have no conflict of interest.

Informed consent was obtained from all patients to be included in the study. Additional informed consent was obtained from all patients for which identifying information is included in this article.

All procedures followed were in accordance with the ethical standards of the responsible committee on human experimentation (institutional and national)

and with the Helsinki Declaration of 1975, *as revised in* 2008 (5).

References

[1] Pederson, W.C. (2001) Upper Extremity Microsurgery. *Plastic and Reconstructive Surgery*, **107**, 1524-1537. https://doi.org/10.1097/00006534-200105000-00034

[2] Simsek, T., Engin, M.S., Demir, A., *et al*. (2012) Reconstruction of Hand Injuries with Multiple Metacarpal Defects Using Free Fibular Osteoseptocutaneous Flap. *Microsurgery*, **32**, 520-526. https://doi.org/10.1002/micr.21977

[3] Daniel, R.K. and Weiland, A.J. (1982) Free Tissue Transfers for Upper Extremity Reconstruction. *Journal of Hand Surgery—American Volume*, **7**, 66-76. https://doi.org/10.1016/S0363-5023(82)80017-8

[4] Korompilias, A.V. and Soucacos, P.N. (2009) Vascularized Bone Grafts in Trauma and Reconstructive Microsurgery, Part 1. *Microsurgery*, **29**, 337-341. https://doi.org/10.1002/micr.20673

[5] Taylor, G.I., Miller, G.D. and Ham, F.J. (1975) The Free Vascularized Bone Graft. A Clinical Extension of Microvascular Techniques. *Plastic and Reconstructive Surgery*, **55**, 533-544. https://doi.org/10.1097/00006534-197505000-00002

[6] Wei, F.C., Chen, H.C., Chuang, C.C. and Noordhoff, M.S. (1986) Fibular Osteoseptocutaneous Flap: Anatomic Study and Clinical Application. *Plastic and Reconstructive Surgery*, **78**, 191-200. https://doi.org/10.1097/00006534-198608000-00008

[7] Anderson, I.B., Gilmour, A., Rahman, K.M.A., *et al*. (2013) Thumb Reconstruction Using a Free Osseocutaneous Fibular Flap Following Excision of an Epithelioid Haemangioendothelioma. *European Journal of Plastic Surgery*, **36**, 391-394. https://doi.org/10.1007/s00238-013-0811-x

[8] Hein, C., Watkins, B. and Zuckerman, L.M. (2016) Thumb Reconstruction with Arthrodesis to the Second Metacarpal Following Sarcoma Excision. *Case Reports in Orthopedics*, **2016**, Article ID: 8061036. https://doi.org/10.1155/2016/8061036

[9] Yajima, H., Tamai, S., Ono, H., *et al*. (1999) Free Vascularized Fibula Grafts in Surgery of the Upper Limb. *Journal of Reconstructive Microsurgery*, **15**, 515-521. https://doi.org/10.1055/s-2007-1000131

[10] Akin, S., Ozgenel, Y. and Ozcan, M. (2002) Osteocutaneous Posterior Interosseous Flap for Reconstruction of the Metacarpal Bone and Soft-Tissue Defects in the Hand. *Plastic and Reconstructive Surgery*, **109**, 982-987. https://doi.org/10.1097/00006534-200203000-00028

[11] Lee, H.B., Tark, K.C., Kang, S.Y., *et al*. (2000) Reconstruction of Composite Metacarpal Defects Using a Fibula Free Flap. *Plastic and Reconstructive Surgery*, **105**, 1448-1452. https://doi.org/10.1097/00006534-200004040-00029

[12] Yuceturk, A., Tuncay, C., Isiklar, U. and Tandogan, R. (1998) Vascularised Bone Graft Applications in Upper Extremity Problems. *Microsurgery*, **18**, 160-162. https://doi.org/10.1002/(SICI)1098-2752(1998)18:3<160::AID-MICR5>3.0.CO;2-P

[13] Humail, S.M., Ghulam, M.K. and Zaidi, I.H. (2014) Reconstruction of the Distal Radius with Non-Vascularised Fibular Graft after Resection of Giant Cell Tumour of Bone. *Journal of Orthopaedic Surgery* (*Hong Kong*), **22**, 356-359. https://doi.org/10.1177/230949901402200318

[14] Dailiana, Z.H., Malizos, K.N. and Urbaniak, J.R. (2005) Vascularized Periosteal Flaps of Distal Forearm and Hand. *The Journal of Trauma*, **58**, 76-82. https://doi.org/10.1097/01.TA.0000124269.37054.0A

[15] Legname, M., Barbary, S. and Dautel, G. (2011) Distal Radius Reconstruction Using

a Split Vascularized Fibula. Two Cases Following Giant Cell Tumor Resection. *Orthopaedics & Traumatology: Surgery & Research*, **97**, 762-765. https://doi.org/10.1016/j.otsr.2011.06.010

[16] Rondinelli, R.D., Genovese, E., Katz, R.T., *et al.* (2022) The Upper Extremities. AMA Guides to the Evaluation of Permanent Impairment. Sixth Edition, American Medical Association, Chicago. https://doi.org/10.1001/978-1-64016-212-9

[17] Flatt, A.E. (2002) Our Thumbs. *Proceedings* (*Baylor University. Medical Center*), **15**, 380-387. https://doi.org/10.1080/08998280.2002.11927870

[18] Crowe, C.S., Massenburg, B.B., Morrison, S.D., *et al.* (2020) Global Trends of Hand and Wrist Trauma: A Systematic Analysis of Fracture and Digit Amputation Using the Global Burden of Disease 2017 Study. *Injury Prevention*, **26**, i115-i124. https://doi.org/10.1136/injuryprev-2019-043495

[19] Pet, M.A., Ko, J.H. and Vedder, N.B. (2014) Reconstruction of the Traumatized Thumb. *Plastic and Reconstructive Surgery*, **134**, 1235-1245. https://doi.org/10.1097/PRS.0000000000000716

[20] Tosti, R., Treiser, M.D. and Eberlin, K.R. (2020) Contralateral Heterotopic Thumb-to-Thumb Replantation with Free Ulnar Forearm Fasciocutaneous Flap and Targeted Muscle Reinnervation. *Journal of Hand Surgery—American Volume*, **45**, 71e1-71e5. https://doi.org/10.1016/j.jhsa.2019.03.004

[21] Graham, E.M., Hilton, J. anderson, S. and Mendenhall, S.D. (2022) Free Fibula Flap Thumb Salvage after a Gunshot Wound: Case Report Emphasizing the Orthoplastic Approach. *Orthoplastic Surgery*, **7**, 19-24. https://doi.org/10.1016/j.orthop.2021.12.001

Incidence of Haematoma Formation in Relation to Smoking in Abdominoplasty Cases

Dalal Al Mansoori, Anood Alqaydi, Shamsa Alameri, Medhat Emil*, Ibrahim Al Marzooqi, Aysha Al Naqbi, Muhammad Tariq Ayub, Dalia Medhat Habib, Omar Alameri

Department of Plastic and Reconstructive Surgery, Zayed Military Hospital, Abu Dhabi, United Arab of Emirates
Email: *medhatemil1@hotmail.com

Abstract

Objective: This study aims at assessing the relation between smoking and the incidence of haematoma formation in abdominoplasty surgery cases. *Patients and Methods*: This is a 4 years retrospective study involving the patients who underwent abdominoplasty surgery between the period of May 2015 and April 2019 in Zayed Military Hospital, Abu Dhabi, United Arab of Emirates. The incidence of haematoma formation was assessed in relation to tobacco use in these patients. *Results*: 164 patients met the inclusion criteria of the study. 35 patients were smokers (21.3%) and 129 patients were non-smokers (78.7%). The mean age was 38.4 (21 - 59 years). The mean BMI was 27 kg/m^2 (21.4 - 34.7 kg/m^2) and the mean hospital stay was 6.5 days (4 - 19). 23 patients in the study developed haematoma (14%). 11 of them had surgical evacuation of the haematoma (6.7%) while the rest were aspirated in the out-patient clinic. Out of the 23 patients who developed haematoma, 17 patients were smokers and 6 were non-smokers. The incidence of haematoma among smokers was 48.6% (17 out of 35 cases) while its incidence among nonsmokers was 4.7% (6 out of 129 cases) showing a clear relationship between smoking and hematoma formation ($p < 0.005$). Haematoma significantly occurred more in males ($p < 0.005$) with 17 males developing hematoma (37%) compared to 6 females (5.1%). Combining liposuction of the lower flanks and/or plication of the recti muscles to the abdominoplasty procedure did not result in significant increase in the haematoma formation incidence ($p = 0.248$). *Conclusion*: Our study shows a direct relationship between smoking and haematoma formation in abdominoplasty cases. Cessation of smoking during the perioperative period is required before embarking on such a procedure.

Keywords

Haematoma, Smoking, Abdominoplasty Surgery, Tobacco Use

1. Introduction

Tobacco smoking represents the most preventable cause of several fatal and disabling diseases worldwide. A significant proportion of cardiovascular diseases, various oral and pulmonary neoplasms, nonmalignant respiratory diseases, and peripheral vascular disorders can be attributed to the use of cigarettes. [1] Several ingredients in tobacco have been suspected to cause changes in the arterial wall leading to instability of blood vessels with increased risk of major bleeding. [2] [3] This study is aimed at assessing the relationship between smoking and the incidence of haematoma formation in patients who underwent abdominoplasty surgery.

2. Patients and Methods

This is a 4 years retrospective study conducted on patients who underwent abdominoplasty procedures in the Plastic Surgery Department at Zayed Military Hospital, Abu Dhabi, UAE from beginning of May 2015 till end of April 2019.

The aim of the study was to review hematoma incidence in relation to smoking habits in abdominoplasty patients. The data of the patients were analyzed retrospectively from the patients' files and through the computer system and kept in Excel sheet.

2.1. Patient Selection Criteria

The patients who underwent full abdominoplasty procedure during the selected period were included in the study. Those who underwent dermatolipectomy, in the form of excision of the redundant skin below the umbilicus level without dissection above the umbilicus, or those who had preexisting haematological diseases were excluded from the study.

The medical records of each patient were reviewed to identify characteristics such as age, sex, body mass index (in kilograms per square meter) and the smoking status. The minimum follow up period was determined to be 30 days postoperatively for the assessment of development of postoperative haematoma. The diagnosis of haematoma was made by clinical examination in the form of swelling and tenderness of the abdomen, needle aspiration and ultrasound examination.

2.2. Statistical Analysis

The data collected was stored in a simple manner for comparison. Descriptive and frequency statistics were performed to understand the population. Then, a series of statistic tests were conducted Using SSPS to determine if an association between smoking status and hematoma incidence was evident. Fischer's exact test was used for independent variables. Finally, the alpha was set at $\alpha = 0.05$.

2.3. Operative Technique

The procedure is done under the effect of general anaesthesia in the supine posi-

tion with preload of one dose of intravenous antibiotic cover. The incision is performed following an upward concave line 7 cm from the anterior vulvar commissure in females or root of the penis in males. This is carried out above the anterior rectus fascia centrally, and above the external oblique aponeurosis laterally. The dissection is continued in a cephalic direction to the umbilicus. The umbilical stalk is preserved and dissected circumferentially from the elevated abdominal flap with continuation of the dissection in the cephalic direction mostly in the midline region till the xiphisternum. If there is divarication of the recti muscles, plication is done in 2 layers using permanent sutures. If there is excessive fat accumulation at the lower part of the flank region, liposuction of that area is done. Excision of the lower part of the skin flap is done. Haemostasis is ensured. The umbilicus is extruded through the overlying skin and sutured with half horizontal mattress non absorbable sutures to its new location about 9 - 11 cm from the incision line. The Scarpa's fascia is repaired with 2/0 inverted absorbable sutures. The skin is sutured in two layers using 3/0 absorbable inverted interrupted dermal sutures and continuous subcuticular sutures. The wound drained with two negative pressure drains kept at the supra and infraumbilical regions. Dressing is applied with overlying compressive garment. (**Figure 1**)

2.4. Postoperative Care

The patient is kept in the bed in the modified Fowler's position postoperatively and mobilization is started on the first postoperative day. Low molecular weight heparin 40 mg is started 6 hours postoperatively and continued once daily for 5 days. Antithrombotic pneumatic compression stockings are started in the operation theatre and continued till discharge. The drains are kept on negative pressure and removed when the drainage is less than 20 ml of fluid in 24 hours for each drain. The patients are usually discharged by the fifth postoperative day. The umbilical sutures are removed after 2 weeks. The patient continues to wear the abdominal pressure garment after the abdominoplasty surgery for a period of one month. If plication of the recti muscles is done during the abdominoplasty procedure, the duration is extended to 3 months postoperatively.

Figure 1. Pre and post operative photos of abdominoplasty case.

3. Results

During the period from the beginning of May 2015 till the end of April 2019, 173 patients underwent abdominoplasty surgery. Nine patients were excluded from the study; eight of them had dermatolipectomy and one patient had haematological disorder of Klinefilter syndrome. Accordingly, only 164 patients met the inclusion criteria; 46 of them were males and 118 were females.

The mean age of the patients included in the study was 38.4 (21 - 59 years). The mean BMI was 27 kg/m² (21.4 - 34.7 kg/m²). The mean hospital stay was 6.5 days (4 - 19). The patient who stayed for 19 days had haematoma with complications.

Out of the 164 patients included in the study, 35 patients were smokers 21.3% (31 males and 4 females) and 129 patients were non-smokers 78.7% (15 males and 114 females). (Table 1)

23 patients in the study developed haematoma 14% (17 males and 6 females).

11 of the patients who developed postoperative haematoma had to undergo exploration and evacuation of the haematoma surgically (6.7% of the total number of abdominoplasty patients) (Figure 2), while the other 12 patients were managed by repeated aspirations of small amount of blood in the out-patient department. (7.3% of the total number of abdominoplasty patients)

Table 1. Variables among smokers and non-smokers in the study.

Variable	Smokers 35 (21.3%)			Nonsmokers 129 (78.7%)			Total 164 (100%)
	No. of Pt.	% from Smokers	% from Total	No. of Pt.	% from Non smokers	% from Total	No. & %
Males	31	88.6%	18.9%	15	11.6%	9.1%	46 (28%)
Females	4	11.4%	2.4%	114	88.4%	69.6%	118 (72%)
Haema.	17	48.6%	10.4%	6	4.7%	3.6%	23 (14%)
Haem. in Males	16	45.7%	9.8%	1	0.8%	0.6%	17 (10.4%)
Haem. in Females	1	2.9%	0.6%	5	3.9%	3%	6 (3.6%)
No Haem.	18	51.4%	11.0%	123	95.3%	75%	141 (86%)
Haema. operated	8	22.9%	4.9%	3	2.35%	1.8%	11 (6.7%)
Haema. operated M.	8	22.9%	4.9%	1	0.8%	0.6%	9 (5.5%)
Haema. operated F.	0	0%	0%	2	1.55%	1.2%	2 (1.2%)
Haema. aspirated	9	25.7%	5.5%	3	2.35%	1.8%	12 (7.3%)
Haema. aspirated M	8	22.85%	4.9%	0	0%	0%	8 (4.9%)
Haema. aspirated F	1	2.85%	0.6%	3	2.35%	1.8%	4 (2.4%)
Abd. With C.P. in M.	2	5.7%	1.2%	3	2.35%	1.8%	5 (3%)
Abd. With C.P. in F.	1	2.9%	0.6%	75	58.1%	45.7%	76 (46.3%)
Haem. Abd. C.P. M.	1	2.9%	0.6%	0	0%	0%	1 (0.6%)
Haem. Abd. C.P. F.	1	2.9%	0.6%	0	0%	0%	1 (0.6%)

Pt.: Patient; M.: Male; F.: Female; Haem.: Haematoma; Abd.: Abdominoplasty; C.P.: Combined Procedure (Plication of Rectus abdominus muscles/Liposuction).

Figure 2. Smoker patient who developed haeamatoma postoperatively which required surgical evacuation. Pre and post operative photos.

As mentioned before, out of the 23 patients who developed haematoma, 17 patients were smokers (16 males and 1 female) and 6 were non-smokers (1 male and 5 females).

So out of the 35 patients who were smokers in the study 17 patients developed haematoma formation (Incidence 48.6% among smokers) while out of the 129 patients who were non-smokers only 6 patients developed haematoma formation (Incidence 4.7% among non-smokers). Smokers have statistically significant score in developing hematoma, suggesting smoking as major risk factor for hematoma formation ($p < 0.005$).

The patients who developed haematoma among smokers and required surgical evacuation were 8 patients (22.9% of the number of smokers and 4.9% of the total number of the patients). On the other hand, the number of non-smoker patients who developed haematoma and required surgical evacuation were 3 patients (2.35% of the number of non-smokers and 1.8% of the total number of the patients).

There were 18 smokers who did not develop haematoma postoperatively (51.4% of the smokers). On the other hand, 95.3% of the non-smokers did not develop haematoma postoperatively.

The incidence of haematoma was higher in males (17 patients out of 46 male patients included in the study (37%) compared to females (6 patients out of 118 female patients included in the study (5.1%). 31 cases out of total 46 male patients were smokers (67.4%) while 114 cases out of total 118 female patients were

non-smokers (96.6%). (Table 2) Male smokers had the highest significant risk in developing Hematoma (p < 0.005).

81 patients underwent plication of the recti/liposuction of the lower part of the flanks along with the abdominoplasty operation (5 males and 76 females). Out of them, only one male and one female developed haematoma and both were smokers. No statistical significance was found when comparing haematoma development in patients that underwent combined procedure with abdominoplasty to patients who underwent abdominoplasty only (p = 0.248).

4. Discussion

The relationship between smoking and postoperative complications cannot be overemphasized.

On their systematic review and meta-analysis of 107 studies, Grønkjær, M. *et al.*, confirmed that preoperative smoking was associated with an increased risk of postoperative complications. [4] This fact was also stated before by Sørensen, L.T. on his review and meta-analysis of 140 cohort studies including 479,150 patients. [5] While both of these studies discussed the postoperative complications in general, Winocour J. *et al.* on their retrospective cohort study on 25,478 patients who underwent abdominoplasty surgery, found that haematoma was the commonest complication [6]. Our study aimed to discuss the relationship between smoking and the incidence of haematoma formation in patients who underwent abdominoplasty procedure.

The incidence of haematoma in our study was found to be 14%. Smokers presented 21.3% of the total number of the patients. The incidence of haematoma among them was 48.6% while the incidence of haematoma among non-smokers was 4.7% which shows the great impact of smoking as a risk factor on the incidence of haematoma formation in abdominoplasty cases.

Neaman K.C. *et al.*; on their retrospective review analysis of 1008 patients reported an incidence of haematoma which required surgical evacuation of 2.6%. This was somewhat comparable to our study in which haematomas were evacuated surgically in 6.7% of the cases taking into consideration that the smokers in their study represented 10.7% of the total number of the patients which is almost half of those in our study. [7] Nearly half of our cases who developed haematoma required surgical evacuation 11 out of 23 patients.

Dutot *et al.*; reported that haematoma was the most frequent complication in

Table 2. Haematoma and smoking prevalence among male and female patients.

Variable	Males (46 Patients)		Females (118 Patients)	
	Number	Percentage	Number	Percentage
Haematoma	17	37%	6	5.1%
Smokers	31	67.4%	4	3.4%
Non-Smokers	15	32.6%	114	96.6

their retrospective review of 1128 cases who underwent abdominoplasty surgery (5.7%). Their study included only female patients. [8] In our study we had nearly same value as 6 patients out of the 118 female patients developed haematoma (5.1%). This shows the low incidence of haematoma in female patients as compared to male patients in whom we reported an incidence of 37% (17 out of 46 patients). This can be contributed to the fact that most of the male patients included in the study were smokers; 31 cases out of total 46 male patients (67.4%) while on the other hand most of the female patients included in the study were nonsmokers 114 cases out of total 118 female patients (96.6%). This is matching with other studies which showed that smoking was one of the risk factors of having higher incidence of postabdominoplasty complications in males compared to females. [9]

81 patients out of the 164 patients included in our study had liposuction of the lower part of the flanks, plication of the recti muscles or both during the abdominoplasty procedure (49.3%) of the cases. Only two patients of them developed haematoma and both were smokers. This did not significantly show in our study that combining these procedures with abdominoplasty surgery significantly increases the incidence of haematoma formation contrary to what is mentioned in other studies which showed increased incidence of complications. [6]

To reduce the incidence of haematoma and other complications postoperatively many centers advised to stop smoking in the perioperative period. [10] In a meta-analysis study done by Mills *et al.*, they demonstrated that cessation of smoking caused a relative risk reduction of 41% for prevention of postoperative complications and each week of cessation increases the magnitude of effect by 19% [11]. While some centers advise judicious patient selection and preoperative smoking counseling [12] with the help of nicotine replacement therapy and smoking cessation medications [13], others feel that it seems impossible to turn smokers into nonsmokers and they continue performing abdominoplasty in smokers. [14]

In our center, we recently started a protocol of advising patients to stop smoking for at least 3 months preoperatively and we refer them to the smoking clinic for medication management. Despite advising stopping tobacco use preoperatively, still there will be some patients who will deny smoking to get the procedure performed [15].

Quilting sutures are used intraoperatively in some centers to reduce mostly seroma and to some extent haematoma formation by application of about 10 - 18 sutures. [16] This can be time consuming. In addition, puckering of the skin can occur in some areas of the abdominal flap so it needs a learning curve for proper placement of the sutures. Another tool used intraoperatively to reduce mainly seroma and possible haematoma is the fibrin glue as a tissue adhesive agent [17] [18]. In a systematic review and Meta-Analysis study done by Nasr M.W. *et al.*, they found that patients who received tissue adhesives had a similar incidence of seroma compared with patients who did not receive adhesives [19].

We feel that intraoperative application of quilting sutures or tissue adhesives should be taken into consideration for further work study.

5. Conclusions

Our study shows that there is a direct relationship between smoking and the incidence of haematoma formation. The incidence of haematoma in males was much higher than in females. Combining liposuction of the lower flanks or plication of the recti muscles to the abdominoplasty procedure did not result significantly in increased risk of haematoma formation.

We recommend stopping smoking of about 3 months preoperatively before getting abdominoplasty surgery done in addition to other measures aiming to reduce the incidence of haematoma formation.

Compliance with Ethical Standards

This study was approved by Abu Dhabi Region Ethics and research Committee, Zayed Military Hospital Abu Dhabi.

Surgical consent was obtained from all the patients before surgery. Consents for photography and publication were also signed.

Conflicts of Interest

The authors declare no conflicts of interest regarding the publication of this paper.

References

[1] Krueger, J.K. and Rohrich, R.J. (2001) Clearing the Smoke: The Scientific Rationale for Tobacco Abstention with Plastic Surgery. *Plastic and Reconstructive Surgery*, **108**, 1063-1073. https://doi.org/10.1097/00006534-200109150-00043

[2] Hanna, S.T. (2006) Nicotine Effect on Cardiovascular System and Ion Channels. *Journal of Cardiovascular Pharmacology*, **47**, 348-358. https://doi.org/10.1097/01.fjc.0000205984.13395.9e

[3] Langsted, A. and Nordestgaard, B.G. (2019) Smoking Is Associated with Increased Risk of Major Bleeding: A Prospective Cohort Study. *Thrombosis and Haemostasis*, **119**, 39-47. https://doi.org/10.1055/s-0038-1675798

[4] Grønkjær, M., Eliasen, M., Skov-Ettrup, L.S., Tolstrup, J.S., Christiansen, A.H., Mikkelsen, S.S., Becker, U. and Flensborg-Madsen, T. (2014) Preoperative Smoking Status and Postoperative Complications: A Systematic Review and Meta-Analysis. *Annals of Surgery*, **259**, 52-71. https://doi.org/10.1097/SLA.0b013e3182911913

[5] Sørensen, L.T. (2012). Wound Healing and Infection in Surgery: The Clinical Impact of Smoking and Smoking Cessation: A Systematic Review and Meta-Analysis. *Archives of Surgery*, **147**, 373-383. https://doi.org/10.1001/archsurg.2012.5

[6] Winocour, J., Gupta, V., Ramirez, J.R., Shack, R.B., Grotting, J.C. and Higdon, K.K. (2015) Abdominoplasty: Risk Factors, Complication Rates, and Safety of Combined Procedures. *Plastic and Reconstructive Surgery*, **136**, 597-606. https://doi.org/10.1097/PRS.0000000000001700

[7] Neaman, K.C., Armstrong, S.D., Baca, M.E., Albert, M., Vander Woude, D.L. and

Renucci, J.D. (2013) Outcomes of Traditional Cosmetic Abdominoplasty in a Community Setting: A Retrospective Analysis of 1008 Patients. *Plastic and Reconstructive Surgery*, **131**, 403-410. https://doi.org/10.1097/PRS.0b013e31827c6fc3

[8] Dutot, M.-C., Serror, K., Al Ameri, O., Chaouat, M., Mimoun, M. and Boccara, D. (2018) Improving Safety after Abdominoplasty: A Retrospective Review of 1128 Cases. *Plastic and Reconstructive Surgery*, **142**, 355-362. https://doi.org/10.1097/PRS.0000000000004572

[9] van Uchelen, J.H., Werker, P.M.N. and Kon, M. (2001) Complications of Abdominoplasty in 86 Patients. *Plastic and Reconstructive Surgery*, **107**, 1869-1873. https://doi.org/10.1097/00006534-200106000-00037

[10] Van Slyke, A.C., Carr, M., Knox, A.D., Genoway, K. and Carr, N.J. (2017) Perioperative and Long-Term Smoking Behaviors in Cosmetic Surgery Patients. *Plastic and Reconstructive Surgery*, **140**, 503-509. https://doi.org/10.1097/PRS.0000000000003604

[11] Mills, E., Eyawo, O., Lockhart, I., Kelly, S., Wu, P. and Ebbert, J.O. (2011) Smoking Cessation Reduces Postoperative Complications: A Systematic Review and Meta-Analysis. *American Journal of Medicine*, **124**, 144-154. https://doi.org/10.1016/j.amjmed.2010.09.013

[12] Toyoda, Y., Fu, R., Li, L., Otterburn, D. and Rohde, C. (2018) Smoking as an Independent Risk Factor for Postoperative Complications in Plastic Surgical Procedures: A Propensity Score—Matched Analysis of 36,454 Patients from the NSQIP Database from 2005 to 2014. *Plastic and Reconstructive Surgery*, **141**, 226-236. https://doi.org/10.1097/PRS.0000000000003963

[13] Rinker, B. (2013) The Evils of Nicotine: An Evidence-Based Guide to Smoking and Plastic Surgery. *Annals of Plastic Surgery*, **70**, 599-605. https://doi.org/10.1097/SAP.0b013e3182764fcd

[14] Manassa, E., Hertl, C. and Olbrisch, R.-R. (2003) Wound Healing Problems in Smokers and Nonsmokers after 132 Abdominoplasties. *Plastic and Reconstructive Surgery*, **111**, 2082-2087. https://doi.org/10.1097/01.PRS.0000057144.62727.C8

[15] Coon, D., Tuffaha, S., Christensen, J. and Bonawitz, S.C. (2013) Plastic Surgery and Smoking. A Prospective Analysis of Incidence, Compliance, and Complications. *Plastic and Reconstructive Surgery*, **131**, 385-391. https://doi.org/10.1097/PRS.0b013e318277886a

[16] Pollock, T.A. and Pollock, H. (2012) Progressive Tension Sutures in Abdominoplasty: A Review of 597 Consecutive Cases. *Aesthetic Surgery Journal*, **32**, 729-742. https://doi.org/10.1177/1090820X12452294

[17] Lee, J.C., Teitelbaum, J., Shajan, J.K., Naram, A. and Chao, J. (2012) The Effect of Fibrin Sealant on the Prevention of Seroma Formation after Postbariatric Abdominoplasty. *Canadian Journal of Plastic Surgery*, **20**, 178-180. https://doi.org/10.1177/229255031202000317

[18] Vidal, P., Berner, J.E. and Will, P.A. (2017) Managing Complications in Abdominoplasty: A Literature Review. *Archives of Plastic Surgery*, **44**, 457-468. https://doi.org/10.5999/aps.2017.44.5.457

[19] Nasr, M.W., Jabbour, S.F., Mhawej, R.I., Elkhoury, J.S. and Sleilati, F.H. (2016) Effect of Tissue Adhesives on Seroma Incidence after Abdominoplasty: A Systematic Review and Meta-Analysis. *Aesthetic Surgery Journal*, **36**, 450-458. https://doi.org/10.1093/asj/sjv276

Hypertrophic Scar Formation and Wound Healing Modulation Fatty Acids as Modulators of Severe Scars

Bárbara Díaz, Valerie Nuñez

Department of General Surgery, Burn Unit Care Dr. Ricardo Gutiérrez Children's Hospital, Buenos Aires, Argentina
Email: drabarbaradiaz@gmail.com

Abstract

Scar tissue usually generates severe discomfort in the short and long term. Common symptoms include anesthetics sequelae, pruritus, joint malfunction, new wounds on the scar surface, and pain. There are several treatments for scars, like compression, topical or intralesional steroid infiltration, 5-fluorouracil, dermabrasion, and surgeries with new scar tissue. For adult patients, it is easier to choose the treatment. However, compression is commonly applied in children to prevent treatments that have adverse effects. This study reports the outcomes of 15 patients submitted to abdominoplasty, traumatic wounds and post-burn scar treatments, which showed significant changes after the continuous use of an ointment composed of petrolatum, cod liver oil, BHT, *Chamomilla recutita* (chamomile) oil, *Helianthus annuus* (sunflower) oil, and *Prunus amygdalus dulcis* (sweet almond) oil. As components of the stratum corneum, unsaturated fatty acids influence the cutaneous structural and immune status and permeability. They also interfere with the maturation and differentiation of the stratum corneum and inhibit the production of proinflammatory eicosanoids, reactive species (ROS and RNS), and cytokines, thereby influencing the inflammatory response and possibly wound healing. This article aims to share our experience with the regular use of an ointment in adult and pediatric patients for three months. The increase in proinflammatory cytokine production at wound sites, resulting in a non-invasive, therapeutical, and effective cutaneous wound healing and scarring modulation, may provide a physiopathological explanation for the fast improvement of scars.

Acids, Eicosanoids, Non-Adverse Effects, Aesthetics, Hypertrophic

1. Introduction

Burn surgeons observe daily that, immediately after the acute treatment, burn patients experience an undetermined evolution stage. That stage is challenging to manage, as it requires long rehabilitation times, particularly in flexion-extension areas, and surgical revisions.

In developing countries, scar treatment is usually challenging due to long distances to specialized centers, treatment costs, difficult access to medical technology, and insufficient recognition of these pathologies by the public health systems.

In Latin America and our practice, phototypes IV to VI of the Fitzpatrick scale are prevalent as brown skin tends to scar pigmentation and has a greater risk of forming hypertrophic or keloid scars [1] [2].

In cosmetic surgery, hypertrophic scars and keloids pose an aesthetic and functional problem. One study found that 60% of the patients were unsatisfied with the cosmetic results of their scars after dermatologic and cosmetic surgery procedures, and up to 90% wanted to improve their appearance [3].

Curefini was initially, and it is currently used as a topical treatment for epidermolysis bullosa and chronic wound healing. No adverse effects and good wound-healing outcomes have been reported. Our team has a long experience in surgical treatments, and we started using the product to treat small, ulcerated lesions that remain in the final stage of burn healing. We observed that healed areas improved faster, showing more elasticity, better texture, less itching, and reduced post-inflammatory vascularity and pigmentation.

Therefore, planning scars is just as important as planning flaps. An efficient topical medication, combined with usual therapies, may aid the modulation of healing stages.

2. Objectives

This article aims to demonstrate that the use of Curefini®, associated with traditional scar modulation therapies, is more efficient in producing better scar cosmetic and functional outcomes than only moisturizing creams associated with those treatments.

The evaluated treatment complied with the specifications for the clinical use of the drugs. In this regard, all clinical research should safeguard the dignity of participating subjects, ensuring their rights, particularly their autonomy and physical, mental, and oral integrity. [4]

3. Material and Methods

This study included 15 patients under acute stage resolution, treated or not with

grafts, presenting hypertrophic scars with erythema or pigmented scars up to six months from the start of healing.

Patients with scars older than two years and stable were excluded because they presented no measurable differences suitable for this study, keloid scars that could not be partially resected or submitted to z-plasty, or keloids requiring immuno-modulatory treatment.

Both adult patients and pediatric patient surrogates granted their consent to participate in this study, per the ethical-legal regulations.

The topical medication used was Curefini®, an ointment composed of sunflower oil, cod liver oil, beeswax, sweet almond oil, petroleum jelly (Vaseline®), and butylated hydroxytoluene (BHT). [5]

The protocol was applied for three months. Curefini® was applied to hypertrophic scars resulting from burns or cosmetic surgeries. Photographic records were made at 30, 60, and 90 days of treatment to evaluate scar evolution in terms of scar pigmentation, itching reduction, and elasticity improvement. The Vancouver Scar Scale [6] [7] [8] (Table 1) and photographic records of the parameters specified in the protocol were used as a reference for scar evolution.

Table 1. Vancouver scar scale.

Scar characteristic	
Vascularity	*Score*
Normal	0
Pink	1
Red	2
Purple	3
Pigmentation	
Normal	0
Hypopigmentation	1
Hyperpigmentation	2
Pliability	
Normal	0
Supple	1
Yielding	2
Firm	3
Ropes	4
Contracture	5
Height (*mm*)	
Flat	0
<2	1
2 - 5	2
>5	3
Total score	13

Despite being a subjective clinical assessment tool designed to describe scars in general—not hypertrophic scars—we chose the Vancouver Scar Scale in this study because it is simple, easy to apply in low-technology settings, and possibly the most recognized burn scar assessment method. The VSS remains widely applicable to evaluate therapy and as a measure of outcome in burn studies. [9]

3.1. Pathophysiology of Healing and Role of Polyunsaturated Fatty Acids

Pathological scars are caused by an excessive response to the activity of TGF-β1. Connective tissue growth factors are overexpressed 100- to 150-fold in hypertrophic and keloid scars, respectively, in response to this cytokine compared with normal fibroblasts. [10] [11]

Our treatment was based on studies that showed that the concentration of polyunsaturated fatty acids (PUFA, EPA, DHA) influences the synthesis and activity of proinflammatory cytokines and inhibits the expression of the gene induced by TGF-β1, inhibiting pro-fibrogenesis. [12] [13]

Those fatty acids may partially inhibit some inflammation processes, such as leukocyte chemotaxis, adhesion expression molecules and leukocyte interactions with the endothelium, the production of eicosanoids, such as prostaglandins and leukotrienes, from arachidonic n-6 PUFA, and T-cell inflammatory cytokine production and reactivity. Eicosapentaenoic acid (EPA) stimulates the biological activity of arachidonic acid (AA) derivatives and the synthesis of active mediators of inflammation resolution, such as resolvins and protectins. [14]

Those mediators compete with cyclooxygenases and lipoxygenases and reduce the expression of COX-2 and 5-lipoxygenase, with a beneficial anti-inflammatory effect of n-3 PUFAs. [15] [16]

3.2. The Role of Vitamin D in Inflammation

Supplied by sunflower, sweet almond oil, and cod liver oil, vitamin D significantly reduces IL-6 and TNF-α levels. Using cholecalciferol receptors, it directly binds to leukocyte DNA, activating the MKP-1 gene and thereby interfering in the inflammatory cascade. [17] [18]

3.3. Virgin Beeswax

It contains long-chain polysaccharides, long-chain free fatty acids, palmitic acid, and exogenous compounds. It is associated with other components as a skin protector, as it is highly hydrophobic. Studies carried out in 2016 report that it has antibacterial activity against *S. aureus* and antifungal activity against *C. albicans*. [5]

3.4. Study Description

Our experience with Curefini® in the combined treatment for burn sequelae began in 2019.

Our "patient 0" was an adolescent female admitted on 08/20/2019 due to an extensive burn by direct fire. She remained hospitalized for a long time due to *Pseudomonas* A infection acquired in the hospital. She was submitted to grafting and discharged on 10/25/2019 (Figure 1). On 03/12/2020, she started elastic bandage compression and Curefini® treatment (Figure 2).

The patient discontinued compressive treatment three months after the start and revisited the hospital on 04/19/2021, showing an elastic, hypopigmented scar with some hypertrophic nuclei under regression (Figure 3).

The patient was maintained under the ointment treatment only.

We then decided to apply an evaluation protocol of the topical treatment without interrupting the usual therapies.

4. Results

Healing is an active process that lasts 12 - 18 months.

Figure 1. Thorax and neck burn.

Figure 2. Neck graft.

Figure 3. Thorax and neck burn 18 months later.

Although between the first 15 to 30 days the patients without compressive treatment showed an increase in purplish-red scar pigmentation, after 90 days the scars showed less erythema due to a decrease in the vascular scar component.

A notable decrease was observed in the Vancouver Scar Scale score in the treated patients during that period. (Table 2)

Although some scars initially showed severe pliability scores, the firmness, pigmentation, itching, and superficial lesions commonly observed in hypertrophic scars were reduced.

Patients who started topical treatment with Curefini® and required surgical treatment (surgical skin flaps, z-plasty, new grafts) showed better post-surgical healing of the new scars.

One of the adult patients presented wound dehiscence due to infection with *Staphylococcus* A (MRSA) and was submitted to surgical debridement and secondary intention wound healing, showing a rapid regression of the initial surgical wound.

It was not possible to evaluate one of the abdominoplasties at 60 days, but at 90 days post-surgery, the wound already had the characteristics of a mature scar.

Only one patient showed no changes between 60 to 90 days, but at 120 days, the wound remained stable.

No patient presented any irritation, pruritus, or allergy signs to the ointment used.

Photographic Record

Wound evolution between 30 and 90 days is shown below. Due to the vast number of records, only the most significant are shown. (Figures 4-18)

Table 2. Vancouver scar scale results.

Patient	Age (yrs.)	Start treat.	30 D	60 D	90 D	Scar	Compression	Graft
AL	46	6	2	0	0	Abdominoplasty	No	No
SS	43	9	10	4	2	Abdominoplasty	No	No
FA	49	8	8	4	0	Abdominoplasty	No	No
ID	2	8	6	4	3	Ant. Thorax burn	Yes	No
MM	10	8	8	7	7	Abdomen burn	Yes	No
CM	2	12	8	6	6	Neck burn	No	Yes
AL	18	12	8	6	4	Neck burn	No	Yes
FJ	6	13	11	8	4	Hand burn	Yes	Yes
CS	12	7	4	4	4	Hand burn	No	No
SV	5	9	7	5	3	Forearm burn	Yes	Yes
FA	4	12	8	6	6	Ankle burn	No	Yes
LB	16	9	8	8	?	Foot burn	No	Yes
MO	20	5	1	0	0	Ciliary burn	No	No
SM	45	5	3	2	0	Lower eyelid tumor	No	Yes
PS	82	5	5	2	0	Lower limb wound	No	No

Figure 4. Abdominoplasty dehiscence by MRSA infection. Scar surface improvement.

Figure 5. Abdominolplasty. Diabetic and hypothyroid patient.

Figure 6. Abdominoplasty hypothyroid patient.

Figure 7. Thorax burn. Compressive treatment missed.

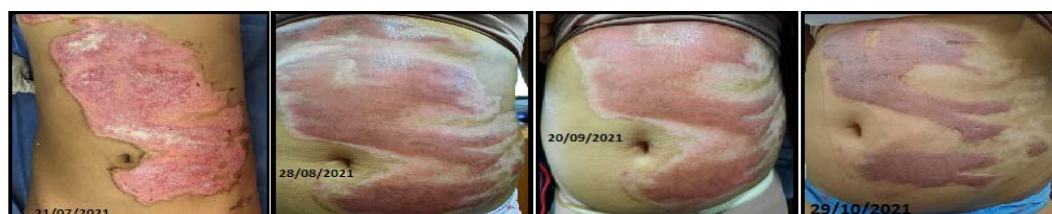**Figure 8.** Neck and shoulder burn ropes. Z plasty and grafting.

Figure 9. Abdominal 2nd degree burn without grafting. Scar surface improvement.

Figure 10. Fire 3er degree neck and thorax burn. Scar surface improvement. Jugular vein prominence.

Figure 11. Fire burn hand sequelae. Grafting without compressive treatment.

Figure 12. Fire acute 2nd degree burn wrist.

Figure 13. Arm sequelae. Grafting and compressive treatment.

Figure 14. Acute 2nd degree foot burn. Grafting.

Figure 15. Acute 3rd degree foot burn.

Figure 16. Traumatic wound and friction burn. Scar surface improvement.

Figure 17. Lower lid Basal Cell Carcinoma. Epidermolysis on the full thickness graft.

Figure 18. Traumatic wound in Chronic Venous Insufficiency.

5. Conclusions

Using a topical treatment with minimal risk of adverse effects as a complementary therapy to inhibit chronic inflammation significantly reduces the number and complexity of scar revision surgeries, provides better comfort for patients requiring compressive dressings, and produces more elastic and less visible scars in a shorter time.

Based on our experience, surgery planning may be now different, as the use of Curefini® before surgery allowed for obtaining more elastic scars and planning flaps with the same grafted skin as the new scars are easier to conceal.

In cosmetic surgery, the use of Curefini® immediately post-op shortens healing time and provides satisfying scar results.

Conflicts of Interest

The authors declare no conflicts of interest regarding the publication of this paper.

References

[1] Berardesca, E. and Maibach, H. (1996) Racial Differences in Skin Pathology. *Journal of the American Academy of Dermatology*, **34**, 667-672.
https://doi.org/10.1016/S0190-9622(96)80070-3

[2] Ribera, N.M. (2016) Características y dermatosis propias de la piel oscura. *Medicina Cutánea Ibero-Latino-Americana*, **44**, 11-23.

[3] Travis, T., Ghassemi, P., *et al.* (2015) A Multimodal Assessment of Melanin and Melanocyte Activity in Abnormally Pigmented Hypertrophic Scar. *Journal of Burn Care & Research*, **36**, 77-86. https://doi.org/10.1097/BCR.0000000000000154

[4] Fratini, F., Cilia, G., Turchi, B. and Felicioli, A. (2016) Beeswax: A Minireview of Its Activity and Its Application in Medicine. *Asian Pacific Journal of Tropical Medicine*, **9**, 839-843. https://doi.org/10.1016/j.apjtm.2016.07.003

[5] Krakowski, A.C., Shumaker, P.R., Feldstein, S.I. and Nguyen, T.A. (2016) A Review of Scar Assessment Scales. *Seminars in Cutaneous Medicine and Surgery*, **34**, 28-36. https://doi.org/10.12788/j.sder.2015.0125

[6] Chae, J.K., Kim, J.H., Kim, E.J. and Park, K. (2016) Values of a Patient and Observer Scar Assessment Scale to Evaluate the Facial Skin Graft Scar. *Annals of Dermatology*, **28**, 615-623. https://doi.org/10.5021/ad.2016.28.5.615

[7] Baryza, M.J. and Baryza, G.A. (1995) The Vancouver Scar Scale: An Administration Tool and Its Interrater Reliability. *Journal of Burn Care and Rehabilitation*, **16**, 535-538. https://doi.org/10.1097/00004630-199509000-00013

[8] Colwell, A.S., Phan, T.T., Kong, W., Longaker, M.T. and Lorenz, P.H. (2005) Hypertrophic Scar Fibroblasts Have Increased Connective Tissue Growth Factor Expression after Transforming Growth Factor-β Stimulation. *Plastic and Reconstructive Surgery*, **116**, 1387-1390. https://doi.org/10.1097/01.prs.0000182343.99694.28

[9] McDaniel, J.C., Belury, M., Ahijevych, K. and Blakely, W. (2008) Omega-3 Fatty Acids Effect on Wound Healing. *Wound Repair & Regeneration*, **16**, 337-345. https://doi.org/10.1111/j.1524-475X.2008.00388.x

[10] Pesce, M.S.C. and D'Agostini, S.M.D. (2014) Ácidos Grasos Omega 3: Respuesta Inmune y su Efecto Sobre Algunas Enfermedades. *Enfermería*, **3**, 33-37.

[11] Calder, P.C. (2013) Omega-3 Polyunsaturated Fatty Acids and Inflammatory Processes: Nutrition or Pharmacology? *British Journal of Clinical Pharmacology*, **75**, 645-662. https://doi.org/10.1111/j.1365-2125.2012.04374.x

[12] Hu, S., Bae, M., Park, Y. and Lee, J. (2020) n-3 PUFAs Inhibit TGFβ1-Induced Profibrogenic Gene Expression by Ameliorating the Repression of PPARγ in Hepatic Stellate Cells. *The Journal of Nutritional Biochemistry*, **85**, Article ID: 108452. https://doi.org/10.1016/j.jnutbio.2020.108452

[13] Ràdmark, O., Werz, O., Steinhilber, D. and Samuelsson, B. (2015) 5-Lipoxygenase, a Key Enzyme for Leukotriene Biosynthesis in Health and Disease. *Biochimica et Biophysica Acta* (*BBA*)-*Molecular and Cell Biology of Lipids*, **1851**, 331-339. https://doi.org/10.1016/j.bbalip.2014.08.012

[14] Calton, E.K., Keane, K.N., Newsholme, P. and Soares, M.J. (2015) The Impact of Vitamin D Levels on Inflammatory Status: A Systematic Review of Immune Cell Studies. *PLOS ONE*, **10**, e0141770. https://doi.org/10.1371/journal.pone.0141770

[15] Secretariat, M.A. (2010) Clinical Utility of Vitamin D Testing: An Evidence-Based Analysis. *Ontario Health Technology Assessment Series*, **10**, 1-93.

[16] Fitch, N., Becker, A.B. and HayGlass, K.T. (2016) Vitamin D [1,25(OH)$_2$D$_3$] Differentially Regulates Human Innate Cytokine Responses to Bacterial versus Viral Pattern Recognition Receptor Stimuli. *The Journal of Immunology*, **196**, 2965-2972. https://doi.org/10.4049/jimmunol.1500460

[17] Olson, K.C., Larkin, P.M.K., *et al.* (2018) Vitamin D Pathway Activation Selectively Deactivates Signal Transducer and Activator of Transcription (STAT) Proteins and

Inflammatory Cytokine Production in Natural Killer Leukemic Large Granular Lymphocytes. *Cytokine*, **111**, 551-562. https://doi.org/10.1016/j.cyto.2018.09.016

[18] Cornara, L., Biagi, M., Xiao, J. and Burlando, B. (2017) Therapeutic Properties of Bioactive Compounds from Different Honeybee Products. *Frontiers in Pharmacology*, **8**, Article 412. https://doi.org/10.3389/fphar.2017.00412

Modern Plastic Surgery

Call for Papers

Modern Plastic Surgery

Modern Plastic Surgery is an international journal dedicated to the latest advancement of plastic surgery. The goal of this journal is to provide a platform for researchers and academics all over the world to promote, share, and discuss various new issues and developments in plastic surgery related problems. All manuscripts must be prepared in English, and are subject to a rigorous and fair peer-review process. Accepted papers will immediately appear online followed by printed hard copy.

Editorial Board

Subject Coverage

The journal publishes original papers including but not limited to the following fields:

- Burn Surgery
- Cosmetic Surgery
- Craniofacial Surgery
- Hand Surgery
- Microsurgery
- Pediatric Plastic Surgery
- Reconstructive Surgery

We are also interested in: 1) Short Reports—2-5 page papers where an author can either present an idea with theoretical background but has not yet completed the research needed for a complete paper or preliminary data; 2) Book Reviews—Comments and critiques.

Notes for Intending Authors

Submitted papers should not have been previously published nor be currently under consideration for publication elsewhere. Paper submission will be handled electronically through the website. All papers are refereed through a peer review process. For more details about the submissions, please access the website.

Website and E-Mail

https://www.scirp.org/journal/mps   E-mail: mps@scirp.org

What is SCIRP?

Scientific Research Publishing (SCIRP) is one of the largest Open Access journal publishers. It is currently publishing more than 200 open access, online, peer-reviewed journals covering a wide range of academic disciplines. SCIRP serves the worldwide academic communities and contributes to the progress and application of science with its publication.

What is Open Access?

All original research papers published by SCIRP are made freely and permanently accessible online immediately upon publication. To be able to provide open access journals, SCIRP defrays operation costs from authors and subscription charges only for its printed version. Open access publishing allows an immediate, worldwide, barrier-free, open access to the full text of research papers, which is in the best interests of the scientific community.

- High visibility for maximum global exposure with open access publishing model
- Rigorous peer review of research papers
- Prompt faster publication with less cost
- Guaranteed targeted, multidisciplinary audience