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Higher Complication Rates in Self-Inflicted Gunshot Wounds After Microvascular Free Tissue Transfer

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Objectives/Hypothesis: Microvascular free tissue transfer is often employed to reconstruct significant facial defects from ballistic injuries. Herein, we present our comparison of complications between self-inflicted and non–self-inflicted gunshot wounds after microvascular free tissue transfer.

Study Design: Retrospective case review.

Methods: Approval was obtained from the John Peter Smith (JPS) institutional review board. We performed a retrospective review of cases of ballistic facial injuries between October 1997 and September 2017 that underwent vascularized free tissue transfer for reconstruction. Comparisons were made between self-inflicted and non–self-inflicted gunshot wounds after microvascular free tissue transfer. The χ^2 test was used for all comparisons. *P* value and 95% confidence interval (CI) were reported.

Results: There were 73 patients requiring free flap reconstruction after gunshot wounds to the face during the study period. There was a statistically significant difference in the rates of nonunion between self-inflicted and non–self-inflicted wounds ($P = .02$, 95% CI: 0.9 to 35.8) There were also no significant differences in flap failure ($P = .10$, 95% CI: −2.8 to 24.2), plate exposure ($P = .28$, 95% CI: −6.7 to 33.0), wound infection ($P = .40$, 95% CI: −8.9 to 31.2), scar contracture ($P = .60$, 95% CI: −8.1 to 25.1), and fistula formation ($P = .13$, 95% CI: −2.8 to 28.8) between patients with self-inflicted and those with non–self-inflicted wounds. Overall, complication rates were significantly higher in the self-inflicted group compared to the non–self-inflicted group ($P < .0001$, 95% CI: 32.6 to 68.6).

Conclusions: Patients with self-inflicted injuries had more complications postoperatively than those with non–self-inflicted injuries. This is likely helpful in surgical planning and patient counseling.

Key Words: Ballistics, free flaps, complications.

Level of Evidence: 4

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INTRODUCTION

Management of ballistic injuries to the face presents a significant challenge to the reconstructive surgeon. Although high-velocity projectiles from rifles commonly enact significant damage to the maxillofacial skeleton, low-velocity weapons such as handguns and shotguns can also inflict significant damage through the creation of secondary projectiles via bone and tooth fragements.[1]

Early management of ballistics injuries involves Acute Trauma Life Support principles, with modifications made for those occurring in combat. Next, debridement of wounds and reduction of fractures helps to prevent infection and reduces pain and bleeding.[1] Historically, many surgeons have deferred primary reconstruction, largely as a result of high rates of wound infection, hematoma, and progressive necrosis associated with free bone grafts.[2] Instead, wounds were allowed to heal secondarily, with a delayed reconstruction using free bone grafting or distraction osteogenesis.[2–4]

The advent of vascularized free tissue transfer has allowed for the transfer of healthy sustainable tissue into the wound bed, and thus, earlier reconstruction of bony defects in the facial skeleton. In the past 20 years, vascularized bony grafts, such as the fibular free flap, scapular free flap, and iliac crest with internal oblique flap have all been employed successfully to reconstruct significant facial defects from ballistic injuries.[5] Free-tissue transfer allows for early and definitive reconstruction of large defects as it is not reliant on surrounding devascularized tissue.[6–8]

Few studies have explored complication rates after reconstruction of gunshot wounds. Among those that have, none have compared self-inflicted and non–self-

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inflicted gunshot wounds. Futran et al. reported a series of 54 free flap reconstructions for ballistic facial injuries in which they extensively explored the definitive management of severe facial traumatic wounds with free flaps, but no comparisons were made between self-inflicted and non–self-inflicted mechanisms of ballistic trauma.[8] Other studies have reviewed vascularized free flap reconstruction of ballistic injuries, and found that immediate autologous tissue reconstruction has allowed for shorter hospitalizations and fewer overall surgeries than other reconstructive methods; again, none have compared self-inflicted and non–self-inflicted injury patterns.[7,8]

Herein, we compare our experience between complication rates of self-inflicted and non–self-inflicted gunshot wounds after microvascular free flap reconstruction. We believe the data presented in this article will be instructive in surgical planning and patient counseling.

MATERIALS AND METHODS

This is a single-institution retrospective chart review. Approval was obtained from the John Peter Smith (JPS) institutional review board. Data were analyzed in aggregate format and no patient identifiers are disclosed. We performed a retrospective review of cases of ballistic facial injuries between October 1997 and September 2017 that underwent vascularized free tissue transfer for reconstruction. Data were collected by the senior author (Y.D.). Comparisons were made between self-inflicted and non–self-inflicted gunshot wounds after microvascular free tissue transfer. The χ^2 test was used for all comparisons. Data analysis was performed using SPSS version 22 (IBM Corp., Armonk, NY). The P value and 95% confidence interval (CI) were reported. Significance was set at $P < .05$.

Inclusion criteria for this study were age 18 years and older, and a gunshot wound to the face treated by single or double free flap surgery. Our reconstructive method involves approaching the face in vertical sections, or fifths of the face. This categorization is used based on area of most significant impact, as some gunshot wounds involve multiple fifths. The central fifth includes the mandibular symphysis, nose, and glabella; the orbital fifth includes the lateral frontal sinus, orbit, body of maxilla, and body of the mandible; and the lateral fifth includes the temple, ear, and mandibular ramus.

RESULTS

Demographics

There were 73 patients requiring free-flap reconstruction after gunshot wounds to the face during the study period. Sixty-seven patients were male, mean age 39.2 years (range, 21–59 years), and five patients were female, mean age 42.4 years (range, 29–57 years). The mean length of stay was 26.2 days (range, 19–41 days) in the self-inflicted group, and 19.2 days (range, 13–31 days) in the non–self-inflicted group.

Location

When comparing the locations of the most significant impact of the gunshot wounds on the face, there were no significant differences in central fifth ($P = .40$, 95% CI: −14.3 to 30.8), orbital fifth ($P = .20$, 95% CI: −9.7 to 23.7), and lateral fifth gunshot wounds ($P = .9$, 95% CI: −16.7 to 24.8). Raw numbers of injuries, separated by location in the face, are displayed in Table I. Individual free flaps performed are detailed in Table II.

TABLE I.
Self-Inflicted and Non–Self-Inflicted Wounds Distributed by Location in the Face

Location	Self-Inflicted	Non–Self-Inflicted	*P*, 95% CI
No.	19	54	
Central fifth	14	34	.4, −14.3 to 30.8
Orbital fifth	1	9	.2, −9.7 to 23.7
Lateral fifth	4	11	.9, −16.7 to 24.8

The central fifth includes the mandibular symphysis, middle maxilla, nose, glabella, and central frontal sinus. The orbital fifth includes the lateral frontal sinus, orbit, lateral maxilla, and mandibular body. The lateral fifth includes the temple, zygoma, and mandibular ramus.
CI = confidence interval.

Complications

There was a statistically significant difference in the rates of nonunion between self-inflicted and non–self-inflicted wounds ($P = .02$, 95% CI: 0.9 to 35.8) There were no significant differences in flap failure ($P = .10$, 95% CI: −2.8 to 24.2), plate exposure ($P = .28$, 95% CI: −6.7 to 33.0), wound infection ($P = .40$, 95% CI: −8.9 to 31.2), scar contracture ($P = .60$, 95% CI: −8.1 to 25.1), and fistula formation ($P = .13$, 95% CI: −2.8 to 28.8). There were also no statistically significant differences in cardiac ($P = .10$, 95% CI: −2.8 to 24.2) or pulmonary complications ($P = .10$, 95% CI: −2.8 to 24.2). In the self-inflicted group, there was one case of late development of a frontal sinus mucocele (3.5 years after initial reconstruction), but there were no cases in the non–self-inflicted group. Overall complication rates were significantly higher in the self-inflicted group compared to the non–self-inflicted group ($P < .0001$, 95% CI: 32.6 to 68.6). Raw numbers are displayed in Table III.

TABLE II.
Vascularized Flaps Used for Reconstruction of Self-Inflicted and Non–Self-Inflicted Injuries

Reconstruction	Self-Inflicted	Non–Self-Inflicted
Total no. of flaps	31	54
Fibular free flap	16	28
OC RFF	6	5
OC SCAP	2	1
RFF	6	15
SCAP	0	0
ALT	1	0
LAT	0	2
Rectus	0	3

ALT = anterolateral thigh free flap; LAT = latissimus dorsi free flap; OC RFF = osteocutaneous radial forearm free flap; OC SCAP = osteocutaneous scapular free flap; Rectus = rectus abdominis free flap; RFF = fasciocutaneous radial forearm free flap; SCAP = fasciocutaneous scapular free flap.

TABLE III.
Complications of Self-Inflicted and Non–Self-Inflicted Wounds

Complication	Self-Inflicted	Non–Self-Inflicted	*P*, 95% CI
Total no. of patients	19	54	
Flap failure	1	0	.10, −2.8 to 24.2
Nonunion	3	1	.02, 0.9 to 35.8
Plate exposure	4	6	.28, −6.7 to 33.0
Wound infection	4	7	.40, −8.9 to 31.2
Fistula formation	2	1	.13, −2.8 to 28.8
Scar contracture	2	3	.6, −8.1 to 25.1
Cardiac	1	1	.10, −2.8 to 24.2
Pulmonary	1	2	.10, −2.8 to 24.2
Overall no. of complications	18	21	<.0001, 32.6 to 68.6

CI = confidence interval.

DISCUSSION

Facial ballistic injuries are morbid and devastating, requiring extensive operative and postoperative care. In this study, we sought to explore the differences in complication rates between self-inflicted and non–self-inflicted gunshot wounds. In our series, patients with self-inflicted injuries had more complications postoperatively than those with non–self-inflicted injuries. We also found that the location of gunshot wounds on the face were not significantly different between self-inflicted and non–self-inflicted mechanisms.

Although other studies have explored free tissue transfer for facial trauma management,[7,8] this is the first to compare self-inflicted and non–self-inflicted mechanisms of ballistic trauma. We believe the high rates of complications seen in self-inflicted wounds could be due to the greater degrees of comminution of the bony fractures as well as soft tissue damage seen in these wounds. This is also likely due to the closer range of impact compared to non–self-inflicted ballistic wounds.

In general, when first approaching reconstruction, it is important to debride comminuted bone fragments, as well as obviously nonviable soft tissue. Although soft tissue can often be closed primarily or with the adjunct of local advancement, the reconstructive surgeon should consider the possibility of soft tissue contracture leading to limitation of function. In wounds closed under great tension, dehiscence and breakdown are expected complications. Furthermore, soft tissue closure without concomitant reconstruction of bony elements can lead to severe contracture making delayed bony reconstruction more difficult.

In our study, a considerable number of patients with self-inflicted gunshot wounds suffered nonunion after reconstruction. This lack of calcification and healing between the bony fragments is likely due to the greater degree of comminution of the fractures seen in this group. Other causes of nonunion described in the literature include diabetes and smoking status, although we did not specifically explore the extent to which these factors contribute to nonunion. In our cohort, the diagnosis of nonunion was made clinically when there was lack of calcification and healing between the bony fragments. To distinguish this from immature callus formation, these patients were initially evaluated radiologically with panoramic x-rays, then confirmed with computed tomography scans at 1 year postoperatively. Nonunion mostly occurred in the mandible due to its mobility, and weight bearing nature. Plate exposure and wound dehiscence has also been attributed to medical comorbidities.[9]

The choice of free flap to use depends on the extent and composition of the defect. The need to use multiple free flaps is also common in ballistic trauma. The fibula free flap is commonly used for mandibular and maxillary reconstruction. However, osteocutaneous radial forearm and scapula flaps can also be considered if the blood supply is not favorable in the lower extremities. The choice of flap used for soft tissue reconstruction is based on size of the defect. Radial forearm free flaps can be used for smaller defects, whereas scapula, latissimus dorsi, and anterolateral thigh flaps can be used for larger soft tissue defects. Latissimus dorsi free flaps usually require additional skin graft coverage.

A number of patients who suffered self-inflicted gunshot wounds required multiple free flaps. These free flaps were typically performed in a single setting. Single free flaps are usually sufficient to reconstruct head and neck defects. However, when the size and complexity of the defect surpasses what could be sufficiently reconstructed with a single free flap, additional reconstructive modalities should be employed. It is the practice of the senior author (Y.D.) to utilize the most complete reconstructive modality instead of the most convenient. Donor site morbidity and avoidance of complications should also be weighed in the same vein. Knowledge of the increased propensity of patients with self-inflicted gunshot wounds to develop complications, have a longer hospital stay, and require multiple surgeries can be helpful in initial surgical planning and patient counseling.

There are weaknesses to this study; the data herein represent a single surgeon's experience, with possible lack of external validity. There is also the potential introduction of bias favoring a specific operative technique. The retrospective nature of this study also potentially limits its significance. Prospective studies are needed to better delineate the findings reported in this study.

CONCLUSION

Vascularized free-tissue transfer reconstruction of facial ballistic injuries is effective and can be employed immediately after an injury occurs. Patients with self-inflicted gunshot wounds are more likely to develop postoperative complications.

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