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Limb salvage results of Gustilo IIIC fractures of the lower extremity

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This study aims to present our results for limb salvage in Gustilo IIIC open fractures of the femur and tibia. 92 patients with Gustilo IIIC fractures operated in our clinic between January 2000 and March 2016 were retrospectively evaluated. Demographic data, ischemia time, method of arterial repair, means of primary and secondary fixation, time to amputation, complications, and final VAS scores were recorded. The difference between the primary amputation rates of tibia and femur fractures was not statistically significant (18% vs 21%, p>0.05). The difference between the secondary amputation rates of tibia and femur fractures was not significant (16% vs 27%, p>0.05). All secondary amputations were done within the first month during the initial hospital stay. Overall limb salvage rate was 69% for Gustilo IIIC fractures of the femur and 58% for Gustilo IIIC fractures of the tibia. The overall limb salvage rate was not significantly different between the two groups (p>0.05). At the final follow-up, patients in the limb salvage group had average VAS scores of 4.3 (femur) and 4.7 (tibia). The decision between amputation versus limb salvage remains a difficult decision that should be jointly made by the treating physicians and the patient.

Keywords: limb salvage; gustilo-anderson; grade IIIC; lower extremity; amputation.

INTRODUCTION

Grade IIIC open fractures of the extremities, which are defined as open fractures presenting with arterial injuries that require repair according to Gustilo and Anderson *(1)*, are devastating injuries that directly threaten the viability of the limb. Due to the high energy nature of the injury, these fractures may be associated with bone loss, injury to soft tissue, injury to nerves, increased compartmental pressures resulting in compartment syndrome and are at high risk for non-union and infection. Furthermore, they require a team approach for optimal results *(2,3)*.

The decision of limb salvage versus amputation epends on many factors, including cultural and socioeconomic issues. Limb salvage may not always be the best treatment for the patient, leading to many repeat surgeries, a great deal of financial and social burden, and low functionality while sometimes only ending in delayed amputation *(4,5)*.

Several attempts were made at establishing objective criteria for predicting the need for amputation. The Mangled Extremity Severity Score

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(MESS) was one of them which suggests a total score of 7 or greater is predictive of amputation. However, its usefulness has been questioned *(6,7)*. Other findings such as the absence of plantar sensation, once thought to be predictive for amputation, were shown not to be a contraindication for limb salvage *(8)*. Some authors have suggested amputation as a viable option *(4)* whereas others have suggested that when patients are appropriately selected, limb salvage can lead to good functional results in most cases with below-knee grade IIIC fractures *(9)* and limb salvage must be undertaken whenever possible *(10)*. Lower Extremity Assessment Project (LEAP) study group has published several articles on this matter. The LEAP study group included Grade IIIB and IIIC fractures in addition to selected Grade IIIA fractures. One of the results was that reconstruction typically results in 2-year outcomes equivalent to those of amputation. There was no significant difference in the Sickness Impact Profile at 2 years. Patients who underwent reconstruction were significantly more likely to be rehospitalized. One subset of the LEAP study evaluated several scoring systems, including MESS and LSI, once again questioning the usefulness and predictive value of the current scoring system *(5)*. A recent review by Schiro et al., also concluded with similar results *(12)*. Perhaps the most significant outcome of the LEAP study is that the outcomes are often affected by factors out of the surgeon's control *(5)*. It is also our opinion that experience and the clinical setting are still the most important factors in deciding on amputation.

The study aims to evaluate our results for limb salvage in Gustilo IIIC open fractures of the femur and tibia. The data is pooled from the data of two previous studies *(13,14)* with additional cases from our clinic since then.

MATERIALS AND METHODS

Institutional Review Board (IRB) approval was obtained for the study. Patients' records were retrieved from the hospital archives. In the cases with amputation, the amputation was considered primary if performed at the first surgical intervention, secondary if performed during the initial hospital stay, and late if it was done on later admissions to the hospital. 45 patients were treated at our institution for Gustilo IIIC femoral fractures between January 2002 and March 2016 and 47 patients for Gustilo IIIC tibial fractures between January 2000 and March 2016. In 8 patients with femur fractures and 10 patients with tibia fractures, limb salvage was not attempted, and primary amputation was performed. The data for the remaining 74 patients regarding demographic properties, date of trauma, type of vascular trauma, accompanying nerve lesions, type of vascular repair, type of primary fixation, type of definitive fixation, treatment (amputation vs limb salvage), and the total number of operations were obtained and analyzed retrospectively. These patients were also interviewed and evaluated with Visual Analogue Score (VAS) at a follow-up of minimum of 2 years. Statistical Analysis was done using SPSS 23 (Chicago, IL) and $p<0.05$ was accepted as significant.

Treatment of these complex injuries requires a multi-specialty approach including cardiovascular, plastic, and sometimes general surgery. Our surgical approach algorithm was similar for both femoral and tibial fractures. All cases started with vascular exploration and subsequent arterial shunting if necessary, followed by fixation and stabilization of the fracture. Only then did arterial and, if necessary, venous reconstruction follow. Nerve exploration was done at this point if necessary. Lower leg double-incision fasciotomy was performed on all patients.

RESULTS

The combined primary amputation rate was 20% (8 femur, 10 tibia). The difference between the primary amputation rates of tibia and femur were not statistically significant ($p>0.05$). All patients with primary amputation had MESS scores of more than 8.

As summarized in Table 1, of the 74 patients with attempted limb salvage, MVAs were the mechanism of injury in 38 (51%), firearms in 20 (27%), fall from height in 6 (8%) and industrial accidents in 10 (14%). Average age of the patients was 33 (14-73). In total, average number of surgeries was 3.3 (1-12).

Table I. — Etiologies of grade 3c fractures of the lower extremity according to fracture site*

	Femur	Tibia	Total no. (%)
MVA**	17	21	38 (51%)
Firearm	15	5	20 (27%)
Fall from height	4	2	6 (8%)
Crush (industrial) injury	1	9	10 (14%)
Total	37	37	74 (100%)

* Only patients selected for limb salvage, excluding patients treated with primary amputation. ** MVA: Motor vehicle accident.

Comparing the etiologies of tibia and femur fractures, MVA comprised nearly half of the cases in both groups, while the frequency of the other injury mechanisms differed significantly ($p<0.005$). All vascular repairs were followed with fasciotomies. 12 patients went on to have a nonunion (9 femur, 3 tibia).

Of 37 patients with femur fractures, 34 were male and 3 were female. The mean age at presentation was 36 (16-73). The mean ischemia time was 9.3 hours (5-13). 32 patients had an ischemia time of more than 6 hours. Of 20 patients requiring repair of the femoral artery, 3 had end-to-end repair while 17 had saphenous vein interposition. All 17 patients requiring repair of the popliteal artery had saphenous vein interposition. The primary fixation method was external fixator in 34(92%) patients and IM nailing in 3 patients (8%). 6 patients had an injury to the sciatic nerve, while 5 patients had peroneal palsy. 2 patients both injured with firearms with sciatic nerve palsy had nerve exploration; however, neither required any nerve repair or reconstruction. Of 34 patients with external fixation, one died due to pulmonary complications in the postoperative period. 12 were converted to a circular fixator, 10 to an IM nail for definitive fixation. 6 cases ended in secondary amputation (16%), 5 being transfemoral and 1 transtibial, at a mean of 13 days (1-30). For the remaining five patients, the initial external fixation was left in place as the definitive fixation method. The mean follow-up was 3.4 years (2-8). The mean number of surgeries patients had was 2.6 (range 1-7). The average VAS score at the last follow-up was 4.3 (1-8).

Of 37 patients with tibia fractures, 31 were male and 6 were female. The mean age at presentation was 31 (14-62). The mean ischemia time was 8.1 hours (4-13). 29 patients had an ischemia time of 6 or more hours. 9 patients had popliteal (24%) and 28 patients had infrapopliteal arterial injury (76%). Saphenous vein interposition was performed in 17 (54%) patients and end-to-end vascular repair was performed in 20 patients (46%). 14 patients had nerve injuries (38%), 12 peroneal and 2 being tibial nerve injuries. 10 patients went on to have secondary amputation (27%). The mean day of the secondary amputation was 11 (4-21). All patients converted to circular fixator at a mean of 26 (16-45 days). Mean follow-up was 4 years (2-7). At the final follow-up, patients have on average undergone 4.1 surgeries (1-12), including temporary fixation, permanent fixation, flap or graft coverage, and implant removal. The average VAS score at the last follow up was 4.7 (2-8).

Latest medical records of these patients show that none of the remaining 57 patients were operated for late amputations at the last follow-up (mean 3.7 years). None of the patients interviewed at the last follow-up stated they would prefer a primary amputation over limb salvage in retrospect. The difference between secondary amputations of tibia and femur were not found to be significant ($p>0.05$). Overall limb salvage rate was 69% for Gustilo IIIC fractures of the femur and 58% for Gustilo IIIC fractures of the tibia. The overall limb salvage rate was not significantly different between the two groups ($p>0.05$).

DISCUSSION

The decision between amputation versus limb salvage remains very difficult for all parties involved. Scoring systems are not very useful for predicting, especially for deciding the borderline cases in which they are most needed. The decision to amputate should be jointly made by the treating team and the patient. Limb salvage may mean a long, drawn-out treatment that puts a social and

economic burden on the patient and still result in amputation.

One of the strongest points of the study is that both patient groups were treated by the same surgical team, in the same hospital with same diagnostic and surgical algorithms. This is a major factor that makes our results comparable.

While not found to be statistically significant, secondary amputation rates after grade IIIC tibia fractures (27%) are higher than that after femur fractures (16%). Total amputation rate was 36% (42% for tibia, 30% for femur). This is probably due to the fact that soft-tissue coverage of tibia is less tolerating than that of femur and results in higher rates of unsalvageable injuries. This is in accordance with the fact that 8 of 37 patients with tibia fractures (22%) required later flap coverage while none of the patients with femur fractures required flap coverage.

A very similar study reporting results in Gustilo IIIC fractures in the lower limb was done by Soni et al. in 2012[15]. Their patient cohort has very similar demographics to our cohort. They reported that collectively 11 (60%) were due to MVA, 5(28%) due to falls, 1 due to firearms (1%) and 1(1%) due to crush injury. The difference between particularly those due to guns and industrial accidents is evident. The primary amputation rate was 11%, which was 20% in our series. Later amputation was undertaken in 1 case (1%) vs 16 (22%) in our case. We attribute this difference to the higher numbers of firearm and industrial injuries in our cases which may tend to do more extensive soft tissue damage. It is also possible that in total, 61 out of 74 patients had an ischemia time of more than 6 hours in our case (77%), compared to 6 out of 16 (38%). The mean number of surgical procedures was 2.9 compared to 3.3 in our series. The difference may be in part due to routine fasciotomy in all patients which required a further skin grafting surgery in all cases.

One subset of LEAP study group investigated late amputation rates following limb-threatening lower extremity trauma. Their reported rate for late amputation was 3.9%. None of the patients had a for late amputation in our series; even those who probably would function better with a prosthesis. Moreover, when retrospectively questioned, all patients with limb salvage stated that they would not prefer amputation at the initial presentation. We believe this to be at least partly due to the cultural stigma associated with missing limbs. This also shows that patients' priorities may be different than that of the surgeon and what seems the better treatment option may not always lead to patient satisfaction.

CONCLUSION

The decision between amputation versus limb salvage remains a difficult decision that should be jointly made by the treating physicians and the patient. In our patient cohort, the difference between the primary amputation rates of tibia and femur were not statistically significant (18% vs 21%). The difference between secondary amputations of tibia and femur were not found to be significant (16% vs 27%). All secondary amputations were done within the first month during the initial hospital stay. Overall limb salvage rate was 69% for Gustilo IIIC fractures of the femur and 58% for Gustilo IIIC fractures of the tibia. The overall limb salvage rate was not significantly different between the two groups. At the final follow-up, patients in the limb salvage group had average VAS scores of 4.3 (femur) and 4.7 (tibia).

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