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Complex Foot Trauma: Amputation *vs.* Reconstruction - Clinical Evaluation and Long-Term Quality of Life

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Abstract

Background: Complex foot injuries are debilitating injuries that can negatively affect patients' quality of life. Traditionally, amputation was a typical treatment for these injuries. With the development of new surgical techniques, foot salvage has since found its place as a treatment modality of complex foot trauma. With this change arouse the question: Which treatment of the two is the best option for patients? In this retrospective cross sectional cohort study, the two treatment outcomes are compared. This study also evaluates the patients' quality of life, and the bacterial contamination levels of open wounds resulting from complex foot trauma.

Patients and Methods: 26 patients with complex foot trauma were recruited retroactively from 2002 through 2014. Their quality of life was evaluated using five self-report questionnaires. The results of bacterial cultures taken from open wounds of complex foot trauma were collected. The patients were categorized in two groups: Amputation vs. reconstruction. They were compared in terms of features of foot injury, the number of surgical interventions, complications, the length of hospital stay, and accompanying multiple traumas. Zwipp score correlation with mentioned variables was calculated.

Results: 22 patients (76.9%) were in the foot reconstruction group, and four patients (15.3%) in the foot amputation group. No significant difference was found between the two groups within the parameters studied. The only exception was the Zwipp score: Here the amputations group had a significant worse score, p=0.009. Function scores were worse than pain scores. No significant difference was found in scores of quality of life between amputation and reconstruction groups. More than half of the open wound microbiological cultures were negative for bacterial growth.

Conclusion: Complex foot trauma remains an incapacitating injury with either treatment. Neither of the two treatments (salvage and amputation) proved to be a superior option for the patients. Functional restrictions were the main causes of low quality of life. The improvement of functional rehabilitation programs should be focused on to achieve better outcomes.

Keywords: Complex foot trauma; Reconstruction; Amputation; Bacterial burden of open wounds; Quality of life

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Introduction

Etiology and classification of foot trauma

The foot as a result of its location at the end of the lower extremity, makes it very vulnerable to trauma. Actually, its injuries are seen on daily basis in emergency rooms [1]. Any high energy force can cause complex trauma to the foot, like motor vehicle accidents [2,3], war injuries and work related injuries [1].

Foot trauma is categorized according to injury severity as "simple foot trauma," and "complex foot trauma." Zwipp created a scoring system to clarify what defines a complex foot trauma [4]. He divided the foot into five anatomic planes, Pilon, Talus, Calcaneus, Chopart and Lisfranc. Each dislocated or fractured plane adds one point to the score. Points are also added for soft tissue injuries as according to the Tscherne classification of soft tissue injuries [5]. Each foot trauma with a final score of five points or more is considered a complex foot injury.

Foot amputation has since ancient times been the only known treatment of high energy

foot trauma [6]. With the development of wound management techniques, the innovation of antibiotics and later the advent of arterial repair techniques made foot salvage amenable and caused a dramatic decrease in amputation rates [7]. The current treatment options for these injuries fall into two main categories: Amputation and reconstruction.

The purpose of the study

The study aims to determine whether patient after reconstruction or amputation differ in terms of: Patients' age at trauma, type of injury, whether they had multiple trauma, number of performed operations and the length of hospital residency. The correlation between Zwipp score and rate of amputation was also calculated.

The primary bacterial burden of open wounds was reviewed to determine the most dominant organism contaminating open wounds of complex foot trauma.

Patients and Methods

This study is a cross-sectional study with additional retrospective data collection.

Patients were selected from SAP Charité registration computer data base in the orthopedic and trauma department in Charité Virchow University hospital (Center of Musculoskeletal Surgery). The research targeted all patients who had foot trauma in the years between 2003 and 2014, Figure 1.

The inclusion criteria were:

1-Age at trauma ≥ 18 years

2-A foot injury that occurred in the years between 2003 and 2014

3-A foot trauma that scored ≥ 5 points in the Zwipp score system.

Methods: Part of the study data was obtained from the selected patients' archives, including gender, age at trauma, isolated foot trauma *vs.* foot trauma as a part of multiple trauma, foot injuries, the number and type of surgical interventions, complications, the length of hospital stay, and bacterial contamination at admission.

The results of bacterial contamination at admission were obtained from the registered culture results of the wound bed at first surgical intervention directly after admission.

The quality-of-life data were collected using clinical scores. Five self-reported questionnaires were sent by post to the selected patients.

The used questionnaires were: German version of Foot Function Index (FFI) [8], Visual Analogue Scale (VAS) (foot and ankle) [9], Foot and Ankle Disability Index (FADI) [10], Body Image Quality of Life Inventory (BIQI) [11], and Foot and ankle patient satisfaction questionnaire SF 36 [12].

Twelve out of 26 patients returned the answered questionnaires. Compliance rate was 46.1%.

Clinical statistics: Statistical analyses were conducted at the $p<0.05$ level of significance.

The results of bacterial contamination at admission have calculated as percentages. All statistical tests were performed with SPSS software for windows.

Results

Patients were between ages 18 and 72 years at time of trauma, and

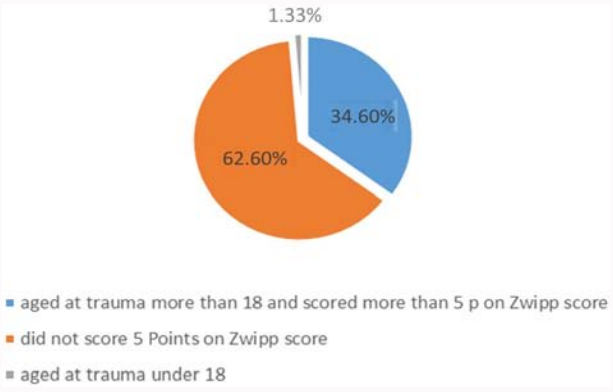

Figure 1: Patients with foot trauma. Of 75 patients with multiple foot trauma, only 34.6% scored 5 points or more on Zwipp score and aged 18 or more at the time of trauma, 1.33% had complex foot trauma and aged under 18 at the time of trauma, and 62.6% did not score 5 points or more on Zwipp score.

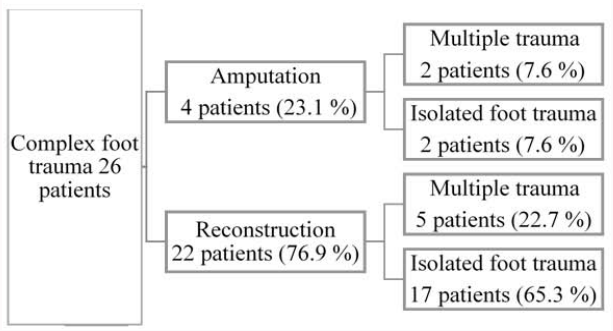

Figure 2: Type of trauma. Two amputated patients had multiple trauma *vs.* five salvaged patients with multiple trauma. No significant difference in multi-trauma rates between the amputated and reconstructed groups was found (p=0.26) at * p>0.05.

Table 1: Group demographics.

	Females n=3 (11.5%)	Males n=23 (88.4%)
Primary amputation	2 (7.6%)	19 (73.1%)
Reconstruction	1 (3.8%)	2 (7.6%)
Secondary amputation	-	2 (7.6%)

average age was 38.2 ± 13.6 years. Three were three female patients (11.5%), and 23 male patients. Mean age at trauma among the females was 48 ± 24.5 years (min. 23; max. 72). Mean age at trauma among the males was 37 ± 11.8 (min. 18; max. 55). Table 1 shows amputation and reconstruction rates in female and male patients.

Patients received their injuries in different circumstances. Their injuries were divided between multiple trauma and isolated foot trauma (monotrauma). Figure 2 illustrates the type of trauma in both group's amputation and reconstruction.

Of the 26 patients who were diagnosed with complex foot trauma, four patients had primary foot amputation (15.3%), and 22 patients had foot salvage (76.9%). Two of the reconstructed patients (7.6%) had a secondary amputation as a complication. The overall amputation rate was 23%.

Primary amputation group

There were four patients mean age was 48.2 ± 19.2 years. Two of the four patients (50%) had multiple trauma. The mean number of operations was 5.5 ± 4.5. Consequently, they had to stay stationary

Table 2: Amputation *vs.* reconstruction: Group characteristics.

	Primary amputation	Reconstruction	p-value significance at p>0.05
Patients number	4	22	-
Age at trauma	48.2 ± 19.2 years	36.45 ± 12 years	0.3192
Multiple trauma	2 (50%)	5 (22.7%)	0.26
Zwipp score	8	6	**0.009**
Operation number	5.5 ± 4.5	7.45 ± 5.11	0.3911
Hospitalization	40.5 ± 0.7 days	54.8 ± 42.1 days	0.3022
complications	1 (25%)	7 (32%)	0.07

Table 3: Bacterial culture results of open wounds of complex foot trauma.

Culture results	No of patients
No growth	14
Pseudomonas	3
Fungus	1
Staphylococcus hemolytic + Staphylococcus epidermis	1
Staphylococcus epidermis + Brevibacterium	1
Pseudomonas + Pantoea agglomerans	1
Acinetobacter calcoaceticus	1

under hospital care for a considerable time; average hospital residency was 55 ± 26 days. Only one patient (25%) had a complication (Stump cellulitis) (Table 2, 3).

Reconstruction group

The complex foot trauma was reconstructed in 22 patients (76.9%). They aged at trauma 18 and 55 years average age was 36.45 ± 12 years. Zwipp score ranged from five to nine (mean score 6 ± 1.5). Five patients (22.7%) had multiple trauma. In total eleven patients (50%) had either a Chopart or Lisfranc injury, ten patients (45.45%) had calcaneal injuries, nine patients (40.9%) had talus injuries, or only five patients (22.7%) had Pilon fractures. Twenty-one patients (96.5%) had open 3rd grade soft tissue injuries, and one patient (4.5%) had a 3rd grade closed soft tissue injury. The two patients who received secondary amputation had higher Zwipp scores (seven and eight respectively), and suffered from more severe arterial and bone injuries in comparison with other reconstructed patients. Mean operation number was 7.45 ± 5.11 (min. 1, max. 21). Subsequently, the average hospital residency was 54.8 ± 42.1 days (min. 10, max. 206). Three patients (13.6%) had foot replantation. Seven patients out of our 22 patients suffered from complications during their treatment course, complication rate 31.8%.

Primary amputation *vs.* reconstruction

As seen in the last two sections, patients in the two groups had dissimilar injuries and required different surgical interventions. They recorded diverse values in age, Zwipp score, and hospital residency, the number of operations, surgical interventions and complications. They were compared among the above variables using Chi square test at * p>0.05 (Table 2). All concerning variables were insignificantly different. The only exemption was Zwipp score. The amputation group had a significantly higher mean Zwipp score than the reconstruction group (8 ± 0 in primary amputation, 6 ± 1.5 in reconstruction group; p=0.009). Interestingly, high Zwipp scores were also recorded in the two patients who had secondary amputations (7 and 8 points).

Bacterial load at the admission

The bacterial culture data from all open wounds in the studied group were collected from the patient documentation. Culture specimens were harvested directly from the wound bed at admission. Twenty-six patients had complex foot trauma. Of these, 25 patients had a 3rd grade open wound foot injury, and one presented with 3rd grade closed soft tissue injury. Thus, 25 culture specimens were expected, but only 22 culture results were found in the computer database. Two thirds of the studied specimens (63.6%) came out with a sterile culture (Table 3).

Table 4: SF36 amputation *vs.* reconstruction.

	Mean scores of salvage patients [%]	Scores of amputeepatient [%]	Statistical difference (p value) at p>0.05
SF36 Physicalfunctioning	35	0	-
SF36 Role limitation due to physical health	25	0	-
SF36 Role limitation due to emotional problems	70.8	0	-
SF36 Energy-fatigue	54.3	40	0.799
SF36 Emotional wellbeing	66.5	36	0.5742
SF36 Socialfunctioning	67.3	37.5	0.5811
SF36 Pain	45.58	22.5	0.6786
SF36 General health	45.6	45	0.9915

Table 5: The correlation between Zwipp score and the results of BIQI, FADI, FFI pain, FFI function and VAS questionnaires.

Correlation of Zwipp score with	BIQI	FADI	FFI pain	FFI function	VAS
r value	-0.26	-0.2	-0.013	**0.094**	-0.05
p value	0.422	0.534	0.968	**0.771**	0.867

Only a week non-significant correlation was found between Zwipp score and FFI function at r>0 and p<0.05

Table 6: The correlation between Zwipp score and the results of foot and ankle patient satisfaction questionnaire SF 36 scores.

Correlation of Zwipp score with	r value	p value
SF36 Physicalfunctioning	-0.403	0.282
SF36 Role limitation due physical health	**0.054**	**0.89**
SF36 Role limitation due to emotional problems	**0.057**	**0.883**
SF36 Energy-fatigue	**0.271**	**0.481**
SF36 Emotional wellbeing	**0.086**	**0.826**
SF36 Socialfunctioning	**0.381**	**0.311**
SF36 Pain	-0.02	0.96
SF36 General health	-0.161	0.679

A weak non-significant correlation was found between Zwipp score and SF36 in roles of limitation due physical health, limitation due to emotional problems, energy-fatigue, emotional wellbeing, and social functioning at r>0 and p<0.05.

Clinical scores

Twelve out of 26 patients diagnosed with complex foot trauma returned the questionnaires. The compliance rate was 46.1%. Most of them had foot reconstruction (11 of 12: 91.6%). Ten of them (83%) were treated with foot reconstruction, one patient had primary foot amputation (8.3%), and one patient had secondary amputation. Compliance rate among salvaged patients was much higher than amputee patients (50% salvaged *vs.* 25% amputee).

Only nine patients answered Foot and ankle patient satisfaction questionnaire (SF 36), making the compliance with this questionnaire

lower than the others. The scores of reconstruction patients and the amputee patient are illustrated in Table 4.

The Body Image Quality of Life Inventory (BIQI) scores ranged from -33 to +17 (mean score -6.9 ± 14). Mean BIQI score amputation patients -7 ± 1.4. Mean BIQI score reconstruction patients -6.9 ± 15. p=0.9929.

Candidates mean Visual Analogue Scale (VAS) values extended from 10.8% to 83.5%. Mean VAS total was 38.3% ± 19.5%. There was no significant difference between reconstruction and amputation groups in this scale p=0.8748. The worst scores were found in finding suitable shoes, in walking, and regarding ankle rigidity. Eight patients (66%) claimed that they did not return to work or cannot work anymore. One patient had severe work difficulties. Only three patients (25%) returned to work after follow-up times of three, five, and ten years respectively.

FFI pain scores ranged from 6.7% to 62.5% mean score (34.89% ± 15.3%). Half of the reconstructed patients documented that they cannot walk barefoot because of the pain. FFI function scores were more negative (min 10%, max 78.8%). Mean FFI function was 50.3% ± 20.5%. Nine patients (75%) claimed that they cannot do sports, with three of them having difficulties in climbing stairs, and four unable to walk on even ground. Looking at salvaged *vs.* amputee patients, reconstructed patients had slightly higher mean values in both sections, but they were still statistically non-significant p=0.9401.

Patient's Foot and Ankle Disability Index (FADI) scores stretched from 25% to 78.8%. Mean FADI was 50.9% ± 15.4%. Interestingly, eight patients could not stand on tiptoe. No significant difference between salvage and amputation patients P=0.99.

Zwipp score and quality of life of patients with complex foot trauma

The tables below show a week non-significant correlation between Zwipp score and the results the results of self-reporting questionnaires, Table 5, 6. This non-significant weak correlation could not ascertain the relationship between Zwipp score and quality of life of patients with complex foot trauma.

Discussion

Foot trauma mostly affects the active young population. Naohiro Shibuya, using data from the American National Trauma Data Bank data set between 2007 and 2011, reported 43.87 ± 19.25 years as the mean age of foot trauma injuries [13].

According to Mackenzie et al. [14], the cost of two years of hospitalization as a result of isolated lower limb threatening injury ranged from $81,316 to $91,106, irrespective of whether the limb was amputated or reconstructed. Life time health care costs were $509,275 for an amputated limb, and $163,282 for a reconstructed limb.

The aim of the quality-of-life questionnaires was to detect the quality of life of patients with complex foot trauma after treatment. Quality of life is a subjective concept that is not directly measurable [15]. Furthermore, it is a multi-conceptual issue, including emotional, physical, functional, and social aspects [16]. Till now the most exited literature concerned only one or two aspects of quality of life. Therefore, several questionnaires regarding foot and ankle quality of life were used, in order to convey a full and clear impression of patients' quality of life, including social, functional, psychological and body image description of quality of life.

This study targeted patients with civil injuries, where there would have been safety measures in place to protect workers. Therefore, a high rate of complex foot traumas was not expected. Tietz et al. [15] in Regensburg University hospital found that complex foot trauma made up less than half of all types of foot trauma.

Most victims in the group of the study were relatively young. It should be noted that Bennet et al. [17] selected a young group of patients, who had complex hindfoot trauma due to military injuries. Most victims in non-biased age reviews also belonged to the young population.

The studied group was dominated by males. However, Demrilap and Tekin targeted male dominant groups of patients, land-mine workers and Turkish army soldiers respectively. Remarkably, even in larger, non-gender biased reviews males were more likely to have complex foot trauma [15]. Men are more commonly involved in violent and strenuous activities, which could make them more vulnerable to traumas. However, the gradual increased participation of females in such activities may expose them to more physical trauma including foot trauma.

Seven patients (26.9%) in this study had foot insults as a part of multiple trauma. Meanwhile, according to Zwipp in 1997, 52% of multiple trauma patients had complex foot trauma [4]. This large difference might be attributed to the ongoing development of safety measure and means of protection over time. It has in recent decades become more possible to avoid multiple trauma, and to save extremities.

The amputation rate in this study is pretty similar to amputation rates mentioned by other authors. Tietz et al. [15] reported 24%, and Russel et al. [18], 27% after severe lower limb trauma. Busse et al. [19] compared nine observational studies of complex lower extremity trauma, primary amputation rate. They ranged from 18.36% to 45.45% [20,21].

Reconstruction *vs.* amputation

Amputee patients were not older than salvaged patients; but they still had more severe injuries, and a higher Zwipp score.

Jupiter defined age as a risk factor for foot and ankle amputation after trauma [22]. Conversely, to Russell et al. [18], amputation patients are not significantly younger than reconstruction patients (the average age among amputees was 31.92 *vs.* 33.5 years among salvage patients). This was confirmed by Demiralp et al. [22] as well. Similarly, in leg threatening injuries, no noteworthy difference was found in age between salvage and amputee patients [23]. It should be noted that Demiralp et al. [22] and Tekin et al. [23] used small selected groups of male young patients in their studies (land-mine workers for Demiralp et al. [22], and Turkish army soldiers for Tekin et al. [23]), which could explain the absence of age difference between amputation and reconstruction groups. However, even in large case-controlled studies, the results went in accordance with Tekin's and Demiralp's findings. After severe lower extremity trauma, 33% of reconstructed patients were over 40 whereas 27.3% of amputees were over 40, but the mean age of the two groups was similar at about 35 years [23].

Amputation group had statistically significant higher Zwipp score, even the two secondary amputation patients had noticeably high Zwipp score and they would benefit from primary amputation.

However, in Busse et al. [19] comparison review of nine studies

regarding severe lower limb injuries, patients with more severe limb injuries were treated with limb amputation. They recommended proposing the treatment according to the severity of foot trauma. On the other hand, primary and secondary amputations correlated to soft tissue injury, and not to Zwipp scale [24]. Nevertheless, Zwipp set the standard that the decision to amputate should depend on radiological and clinical examination of both soft and bone injuries and the situation of vessels and nerves, but did not define his score as an indicator for amputation [4].

The reconstruction group tended to require more surgeries. Lange et al. compared the number of operations needed for both salvaged and amputee patients after complex lower limb trauma. Salvaged patients required more surgical interventions [25]. Moreover, LEAP study recorded more necessary surgeries for salvaged patients than for primary amputees [26,27]. Georgiadis's report went in favor of their statement as well [21]. In consonance with this, there was no significant difference in lengths of hospital stay between the amputee and salvage groups, but the amputees tended to have shorter hospital stays. The lengths of hospital stay between amputation and salvaged patients after severe lower limb trauma also differed among trauma centers [19]. Nevertheless, Georgiadis, Hertel, and Hutchins reported shorter hospital residencies for amputation patients [19,21,28,29], and reconstructed patients were more likely to be re-hospitalized [26,27].

In this study reconstructed patients tended to have more complications. (25% amputees *vs.* 32% reconstructed). Complications were more prevalent among salvage patients than amputation patients even after complex lower extremity traumas [26]. Furthermore, complex lower extremity trauma patients who underwent below-knee amputation were generally hospitalized for a routine follow up, as opposed to salvaged patients, who were admitted for complications [23]. Meanwhile, in a LEAP study and other studies, after a complex lower extremity trauma, salvage patients were more often afflicted by osteomyelitis [26,27]. Georgiadis and Busse found an obviously higher complication rate among reconstruction patients [19, 21]. Salvage patients also had more leg swelling [19,30].

Bacterial load at the admission

Bacterial cultures of open leg complex trauma were dominantly sterile. The rates of bacterial growth after a traumatic open wound differed between relevant clinical reviews. Murray et al. [31] revealed that more than half of open traumatic wounds showed no bacterial growth. Only 28.3% positive bacterial culture after open wound fractures Hasan et al. [32]. And (51.42%) positive culture by Agarwal et al. [33]. Open wounds of complex foot trauma are to some extent, sterile wounds. Empiric antibiotic therapy might therefore be avoidable in visibly clean wounds. However, the data from the literature still supports prophylaxis antibiotic therapy for all open fracture wounds [34-38].

The quality of life of patients with complex foot trauma: In this study the main causes of low quality of life were the functional restrictions, which the patients experienced during active foot movements in particular [39], and were then followed by pain. Unfortunately, this deprived patients from participating in work life or doing sports and other recreation activities. Generally, surgery restores the patient's anatomy. Meanwhile, rehabilitation programs and physiotherapy are designed to restore limb or stump function. They prepare patients to reintegrate into social and work life. Müller et al. [27] ascertained that psychological impairment is a clear consequence of complex foot trauma. It should be followed up upon and addressed by rehabilitation. In other words, the psychological impairment in the results discussed reflects serious deficiencies in follow up systems and physiotherapy, as well as in psychological and work rehabilitation programs. Contrary to Bennet et al. [17] findings, they connected the poor outcomes after complex hindfoot trauma to the features of the injuries.

Compared to the general population, patients with foot injuries had more negative SF 36 scores [40].

Patients with complex foot trauma registered lower scores in the majority of pain, function, and satisfaction measures compared to patients with angina pectoralis or heart failure [24]. In cases of multiple trauma, patients with complex foot trauma achieved lower emotional, social, and psychological scores compared with those without foot trauma [41]. Unfortunately, foot injury may be overlooked, especially in multiple trauma patients, and missed injuries could occur in 10% of patients with multiple injuries [42].

There was a wide range found among BIQI score results. This could be due to a difference in socioeconomic classes of the patients in this study, perhaps along with different accident circumstances. This range has also been detected in Demiralp's work [22]. Even if foot injuries are covered by clothing or prosthetics, they still negatively affect patients' satisfaction with their bodies. Subsequently, patients' scores were overwhelmingly negative [22].

Though, Tietz et al. [15] VAS scores were more optimistic (their mean VAS was 42.85%); but then again, they were in accordance with this study's results. Unfortunately, only three patients (25%) returned to work. A better return to work rate was reported by other authors. For instance, in the LEAP study, the return to work rate ranged between 49% and 53% in 2 years following severe lower limb trauma [27]. In a Kinner et al. [24] review, this percentage was 53% for both amputee and salvage patients. 30% of salvage patients and 63% of amputees returned to work in a Dagum et al. [20] publication. At last, Bosse et al. [26] observed that 53% of amputees and 49.4% of reconstructed patients returned to work after complex lower extremity trauma.

Likewise in this study, Demiralp et al. [22] also found modest FADI outcomes among foot reconstruction patients, with a mean FADI value of 64.3 ± 18.1. Kinner et al. [24] FFI scores reported that only 41% of patients with complex foot trauma could do sports compared to the 77% who could do sports before trauma, and 71% of patients were not able to do their recreation activities after trauma.

Quality of life of patients with complex foot trauma, amputation *vs.* reconstruction

Though traditionally, salvage patients have been expected to have a lower quality of life, all utilized scales showed no significant difference in quality of life between reconstructed and amputee patients. Even treatment related factors that could affect the quality of life for patients with complex foot trauma, such as number of surgical interventions, length of hospital stay, and rate of complications were not significantly different between the two groups [26,30,43]. Demiralp et al. [20] and Dagum et al. [22] compared the SF 36 values between salvage and amputee patients, and the results did not favor one treatment's outcomes over the other. Dagum, Dahl, and Georgiadis showed no significant difference in pain scores between amputation and reconstruction patients after foot or lower extremity complex foot trauma [19-21,30]. Meanwhile Hertel et al. [29] results

were in favor of salvage patients.

Tekin et al. [23] found a better quality of life in general health, vitality, and pain scores among amputation patients. Meanwhile, Lange's results presented better functional outcomes with primary amputation [19,25].

In fact, patients suffered from low quality of life irrespective of the proposed treatment. In the amputation group, the potential benefits of the absence of joint rigidity, chronic limb pain, and orthotics related complications were out weighed in the amputation group by the psychological influence of limb loss, prostheses related complications, and chronic phantom pain.

At last, salvage patients were more satisfied with their bodies [22]. Salvage patients were also more content with the aesthetic outcome after treatment [44].

Zwipp score and quality of life of patients with complex foot trauma

Though Zwipp score defined the severity of foot trauma [4]; it did not correlate with the functional outcome or general wellbeing of patients with these injuries. Here, other factors could affect the quality of life of patients with complex foot trauma, like socioeconomic and educational class, rehabilitation programs, and psychological support programs [45]. Kinner et al. [24] also found no relationship between Zwipp score and outcome of scores regarding quality of life, but rather, connected the long-term functional outcome with the severity of bone and joint injuries.

Even in cases of complex trauma of the whole extremity, no clear connection was recorded between the severity of trauma and the quality of life of the affected patients [26]. Neither the severity of fracture and soft tissue injury, nor the presence of associated injuries of the ipsilateral and contralateral limb significantly affected the functional outcome of lower extremity complex trauma [38]. Bosse et al. [26] also confirmed the effects of psychological and social factors on the quality of life of patients with complex lower extremity trauma. Furthermore, in O'Toole et al. [46] study, patient satisfaction after treatment was determined by functional, pain, and depression outcome more than the severity of injury or treatment.

Limitation

In this study the data were presented and pointed out as tendencies. As a result of the small number of patients in each group, the significance was barely achieved. Therefore, the p-values were mentioned, but results are discussed even if the P value did not reach $p<0.05$.

Only adults with complex foot trauma were included, so the results may not be representative of a younger age group. This added another limitation to this study.

The Zwipp score [4], did not include neural or vascular injuries as part of its scoring system, but considered soft tissue injuries indirectly depending on Tscherne classification [5]. Such serious injuries deeply influence decision making in deciding treatment (amputation *vs.* reconstruction) of complex foot trauma. It was not possible in this review to determine a protocol for treatment of complex foot trauma (amputation or reconstruction) according to Zwipp score [4]. However, this score was significantly higher in the amputation group.

A notable limitation was the low compliance rate among the group studied. As has already been discussed, the relatively low compliance rate could be explained by the long follow up time, and the retrospective nature of this study. Another difficulty was that in order to convey a wide spectrum of results regarding the quality of life of studied patients, five questionnaires were used, and some patients (3 patients) were unwilling to answer the long questionnaires. On top of this, questionnaires had some overlapping questions, which could not be avoided.

Conclusion

This study illustrates the direct relationship between functional and psychological rehabilitation and the outcome after a complex foot trauma. It sheds light on the importance of functional rehabilitation and Psychological supporting programs. Thus, reevaluation and improvement of rehabilitation and physiotherapy programs are needed to enhance quality of life for this group of patients.

This review encountered a limited cohort of adult patients. As a consequence, larger reviews are needed to detect the clinical outcome of complex foot trauma. In addition to this, the next step should be to establish a new practical scoring system to evaluate the outcome.

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