The short musculoskeletal functional assessment (SMFA) score amongst surgical patients with reconstructive lower limb injuries in war wounded civilians

Carrie Teicher a,*, Nancy L. Foote b, Ali M.K. Al Ani b, Majd S. Alras b, Sufyan I. Alqassab b, Emmanuel Baron c, Khalid Ahmed d, Patrick Herard e, Rasheed M. Fakhri b

* Epicentre, New York, NY, United States
b MSF, Amman, Jordan
c Epicentre, Paris, France
d MSF, Dubai, United Arab Emirates
e MSF, Paris, France

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A B S T R A C T

Background/objectives: The MSF programme in Jordan provides specialized reconstructive surgical care to war-wounded civilians in the region. The short musculoskeletal functional assessment score (SMFA) provides a method for quantitatively assessing functional status following orthopaedic trauma. In June 2010 the Amman team established SMFA as the standard for measuring patients' functional status. The objective of this retrospective study is to evaluate whether the SMFA scores can be useful for patients with chronic war injuries.

Methods: All patients with lower limb injuries requiring reconstruction were enrolled in the study. Each patient's SMFA was assessed at admission, at discharge from Amman and during follow-up in home country. In the analysis we compared patients with infected versus non-infected injuries as well as with both high and low admissions dysfunctional index (ADI).

Results: Among infected patients, higher ADI correlated with more surgeries and longer hospital stay. Infected patients with ADI > 50 required an average of 2.7 surgeries while those with ADI < 50, averaged 1.7 operations (p = 0.0809). Non-infected patients with ADI > 50 required an average of 1.6 operations compared to 1.5 for those with ADI < 50 (p = 0.4168).

Conclusions: The ADI score in our sample appeared to be useful in two areas: (1) hospital course in patients with infection, where a high ADI score correlated with longer hospital stays and more surgeries, and (2) prognosis, which was better for non-infected patients who had high ADI scores. A scoring system that predicts functional outcome following surgical reconstruction of lower limb injuries would be enormously useful.

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Introduction

Violence in the Middle East continues to contribute to civilian morbidity and mortality with lower limb trauma common in war injuries [2,3,4]. These injuries affect a young active population and surgical interventions, ranging from reconstruction to amputation, are often required to preserve this functional part of the society [5,6]. Surgical reconstruction of lower limb injuries in war-wounded civilians produces a range of functional outcomes that have a major impact on the patients’ future. Patient prognosis is potentially predictable using a scoring system which would help guide decision-making concerning reconstruction compared to amputation thereby assisting in mitigating the challenges surrounding such medical decisions [7,8].

The short musculoskeletal functional assessment (SMFA) provides a method for quantitatively assessing functional status following orthopaedic trauma via a self-evaluation tool. This self-reported health-status questionnaire is used for quantitatively assessing the functional status and treatment impact on patients affected by a broad range of musculoskeletal injuries. The SMFA was developed via the condensation of a previously designed and
longer questionnaire, the musculoskeletal functional assessment (MFA). The SMFA has two parts: the dysfunction index, which detects elements of functional status, and the bothersome index, which allows patients to evaluate how bothered they are by specific functional challenges. The questionnaire aims to provide a standardized measure of the patient's physical limitations, which can serve for both individual patient management and community-based outcome, studies [1].

The Médecins Sans Frontières Operational Centre Paris (MSF-OCP) programme in Amman, Jordan is a tertiary care hospital and rehabilitation centre provides specialized reconstructive surgical care to war-wounded civilians in the region [9]. MSF has been performing reconstructive surgical care since August 2006 treating approximately 385 patients per year. The facility is located on the premises of the Jordanian Red Crescent Hospital (JRC). In June 2010 the SMFA was adopted as the standard for measuring patients' functional status. The objective of this retrospective study is to evaluate whether the admission dysfunction index (ADI), as determined by SMFA scores, is a useful prognostic tool for patients with chronic war injuries treated in the Amman facility.

Materials and methods

Patient population

Most patients seen at the MSF hospital had penetrating wounds at the initial injury and had undergone previous operations. Previous operations occurred primarily in Iraq (n = 81) and were conducted by a variety of different structures with patients subsequently being referred for transport to the MSF programme in Amman for specialized care. For all patients, there was a significant delay between initial injury and arrival in the Amman project. All patients with lower limb injuries requiring reconstruction were retrospectively selected to be included in this analysis (n = 84). Patients were excluded if non-standard surgical procedures were required or if an infection was evident before the first surgery. If a patient had a known infection, reconstructive surgery occurred only after 6 months of clinical cure from infection.

Procedures and conditions included were based on the Military Extremity Trauma Amputation/Limb Salvage (METALS) Study and included one or more of the following: bone graft or bone transport, corrective osteotomy, arthrodesis, local or free flap coverage, complete deficit of a major nerve and a two staged approach for infected osteomyelitis [21]. The reconstruction was done according to the algorithm shown in Fig. 1.

Administration of the SMFA questionnaire

The SMFA score questionnaire is based on 46 questions [10]. Patients were divided into two main groups for analysis; those who had an admission dysfunctional index (ADI) greater than or equal to 50 and those having less than 50. This distinction separates those patients who report levels four and five (high difficulty to completely disabled) for all SMFA questions (total index will be 50 or greater) from those who answered all the questions with level 3 and less so that we are comparing the patients who came with severe dysfunction with those who presented with less dysfunction. A previously validated Arabic version of the SMFA was not available at that time. Translation of the document was done by an Arabic-English translator and reverse translation was done by a

![Fig. 1. Enrollment of surgical reconstruction patients.](image-url)
second independent translator. A committee of local experts fluent in both languages reviewed the final document. Illiterate patients were interviewed by a health care provider who had no previous interactions with the patient and was not familiar with their clinical status.

SMFA score was documented for each patient at admission, discharge and during the follow up (in their home country). A standard formula was used to measure the dysfunctional and the bothersome indices for each of these periods [10]. We divided each of the admission groups (over 50 ADI and less than 50) into infected and not infected. We made this division because the presence of osteomyelitis may affect the number of surgeries, complication rate, and duration of stay for each patient [16,9]. It can also affect the follow up results in their home country.

Patients were discharged from the outpatient component of the project in Amman once they had: (1) no clinical or serological signs or symptoms of infection, (2) radiological studies demonstrating an early bridging callus; and (3) the ability to perform four basic activities of daily living, defined as being able to independently use the toilet, stand to cook, bath, and dress [9].

After discharge to their home country all patients remained in follow up care by the MSF network of doctors. Patients were followed for union status, recurrence of infection and the follow up SMFA questionnaires. Bone union was reported if the patient had (1) radiologic evidence with bridging of the fracture by bone, callus, or trabecula, including three/four cortices and (2) clinical evidence with the absence of pain or tenderness on palpation [11]. Infection recurrence was defined as any two of (1) signs of inflammation with or without discharging wound, (2) C-reactive protein 10 mg/L or greater and (3) radiological imaging revealing sequestrum formation. Differences between the admission index and the final dysfunctional SMFA index were calculated for each patient.

Data analyses

Each patient’s SMFA was assessed at admission, at discharge from Amman and during follow-up in home country. The last follow-up questionnaire was in April 2012. In the analysis we compared patients with infected (infections found at surgery) versus non-infected injuries as well as with both high and low ADI.

All the patients had a deep bone culture during their surgeries regardless of presentation. Patients with a positive deep bone culture were considered infected. Any surgical complications that developed during a patient’s stay in Amman were recorded as early surgical complications. The patients with an admission dysfunctional index greater than or equal to 50 were recorded as ‘over fifty ADI’ while those with less than 50 were recorded as ‘less than fifty ADI’. Data was analyzed using Stata 12 (StataCorp, College Station, Texas, USA).

Ethical considerations

All patients presenting to the MSF facility in Amman were treated free of charge. Although individual patient data was included in the medical files of all patients, no ethnic or identifying information was encoded in the database and all analyses were conducted anonymously. As a part of programme monitoring, this analysis was exempt from MSF’s Ethical Review Board review. MSF received authorization to operate in Amman from the Ministry of Health in Jordan via a Memorandum of Understanding. All patients provided written informed consent before all surgical procedures.

Results

There were 84 total patients included in this analysis admitted between February 2010 and August 2012. All patients in this cohort were civilians with previous lower limb injuries; 75 (89%) patients were male and 9 (11%) were female. For all patients in the cohort, the mean age was 32 years (n = 84, SD = 1.34). There was no difference between age and ADI categories (p = 0.08) (Table 1).

Fifty six percent of all cases had positive cultures indicating osteomyelitis at their surgery. The mean admission bothersome index of those patients who had an over 50 ADI was different compared to patients with ADI less than 50 in both infected and non-infected patients (p < 0.0001).

Among infected patients, higher ADI correlated with more surgeries and longer hospital stay. Infected patients with ADI >50 required an average of 2.7 surgeries than those with ADI <50, who averaged 1.7 operations (p = 0.0809). Non-infected patients with ADI >50 required an average of 1.6 operations compared to 1.5 for those with ADI <50 (p = 0.4168).

For non-infected patients, the patients with over 50 ADI required an average of 1.6 operations before transfer to their home country while those with a less than 50 ADI required an average of 1.5 operations/patient (p = 0.4168). There was no difference in infected patients (p = 0.0645) between the patients arriving with over 50 ADI requiring a longer period to achieve discharge conditions and the patients who came with less than 50 ADI (Table 2).

Nonunion rate was higher in over 50 ADI both in infected and non-infected patients while recurrence of infection was seen only in infected patients. There was no difference between the over 50 and less than 50 ADI (p = 0.7672) (Table 3).

In infected patients, the patients who had an over 50 ADI had a bigger difference between the admission and follow up dysfunctional index, with more improvement in function than those with less than 50 ADI (the mean difference was 22.1 and 6.4 respectively)

Table 1
Comparison at admission by ADI.

<table>
<thead>
<tr>
<th></th>
<th>&lt;50 (n = 58)</th>
<th>≥50 (n = 26)</th>
<th>p-Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age (in years, mean)</td>
<td>30.6</td>
<td>35.6</td>
<td>0.0843</td>
</tr>
<tr>
<td>Duration of stay (in days, mean)</td>
<td>109.6</td>
<td>152.9</td>
<td>0.0554</td>
</tr>
<tr>
<td>Number of surgeries (mean)</td>
<td>1.6</td>
<td>2.2</td>
<td>0.0581</td>
</tr>
<tr>
<td>Early surgical complications (18%)</td>
<td>16</td>
<td>12 (46.2%)</td>
<td>0.135</td>
</tr>
<tr>
<td>Admission bothersome index (mean)</td>
<td>32.2</td>
<td>60.2</td>
<td>&lt;0.0001</td>
</tr>
</tbody>
</table>

Table 2
Comparison at admission (by infection status and ADI).

<table>
<thead>
<tr>
<th></th>
<th>Infected patients (n = 47)</th>
<th>Non-infected patients (n = 37)</th>
<th>p-Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age (in years, mean)</td>
<td>&lt;50 (n = 32)</td>
<td>≥50 (n = 15)</td>
<td>0.3893</td>
</tr>
<tr>
<td></td>
<td>32.4</td>
<td>35.6</td>
<td></td>
</tr>
<tr>
<td>Duration of stay (in days, mean)</td>
<td>106.4</td>
<td>162.8</td>
<td>0.0645</td>
</tr>
<tr>
<td></td>
<td>113.4</td>
<td>139.4</td>
<td></td>
</tr>
<tr>
<td>Number of surgeries (mean)</td>
<td>1.7</td>
<td>2.7</td>
<td>0.0809</td>
</tr>
<tr>
<td></td>
<td>1.5</td>
<td>1.6</td>
<td></td>
</tr>
<tr>
<td>Early surgical complications* (28%)</td>
<td>12 (37.5%)</td>
<td>8 (53.3%)</td>
<td>0.3691</td>
</tr>
<tr>
<td></td>
<td>4 (16.0%)</td>
<td>4 (36.4%)</td>
<td></td>
</tr>
<tr>
<td>Admission bothersome index (mean)</td>
<td>39.9</td>
<td>61.9</td>
<td>0.0015</td>
</tr>
<tr>
<td></td>
<td>22.8</td>
<td>57.8</td>
<td></td>
</tr>
</tbody>
</table>

* Showing the number of patients WITHOUT early surgical complications, one missing value.
but without statistical significance ($p = 0.1162$) (Table 4). In these patients, the improvement in the bothersome index was similar in both groups, being 28 for those with less than 50 ADI and 22.7 for those with more than 50 ADI (Table 5).

In non-infected patients, the findings were similar, with the patients who had an over 50 ADI showing a bigger difference between the admission and follow up dysfunctional index, compared with those with less than 50 ADI (the mean difference was 33 and 0.2 respectively) with statistical significance ($p = 0.0044$). The improvement in bothersome index showed the same pattern with a statistically significant improvement for those who were admitted with an over 50 ADI ($p = 0.0046$).

### Discussion

The short musculoskeletal functional assessment score (SMFA) provides a method for quantitatively assessing functional status following orthopaedic trauma. Its validity, reliability and responsiveness as well as its limitations have been previously reported [10,12]. Limitations of this data relate to the small sample size, translation of the SMFA questionnaire into Arabic and to the data tool’s reliance on patient self-reporting. In the project, the tool was translated into Arabic and then back translated into English because an already existing Arabic translation could not be found.

We report on surgical outcomes using SMFA among civilian victims of violence in the Middle East for more than two years [9]. Among infected patients, we found those with a higher admission dysfunctional index also had an increase in the number of required surgeries, complication rates and the duration of stay.

However, the ADI did not predict relapse and union rate. Infection recurrence and union rate did not show a statistically significant correlation with ADI during the follow up in the home country for either infected or non-infected patients. Respecting the strict rules of management of infections as well as following the basics of reconstruction in all patients may lead to this outcome regardless of condition at arrival. This is consistent with a previous study that also showed a comparable union rate in reconstruction patients regardless of the infection status at arrival [9].

From this data we examined the relationship between the admission dysfunctional index (ADI) and surgical outcomes for reconstruction patients. This score can act as a general health related quality of life instrument reflecting many factors that affect function and patient satisfaction [12]. On the other hand, many

### Table 3

Comparison at follow-up by infection status and ADI.

<table>
<thead>
<tr>
<th>Infection</th>
<th>Infected patients (n = 44)</th>
<th>Non-infected patients (n = 33)</th>
</tr>
</thead>
<tbody>
<tr>
<td>ADI group</td>
<td>&lt;50 (n=29)</td>
<td>≥50 (n=15)</td>
</tr>
<tr>
<td>Union</td>
<td>Chi-square (Fisher’s exact test)</td>
<td>0.814</td>
</tr>
<tr>
<td>Mal union</td>
<td>2 (6.9%)</td>
<td>1 (6.7%)</td>
</tr>
<tr>
<td>Non union</td>
<td>2 (6.9%)</td>
<td>1 (6.7%)</td>
</tr>
<tr>
<td>Infection recurrence</td>
<td>Two sample binomial proportion test</td>
<td>0.7672</td>
</tr>
</tbody>
</table>

### Table 4

Improvement in dysfunctional index by infection status and ADI.

<table>
<thead>
<tr>
<th>Infection status</th>
<th>ADI group</th>
<th>Number of patients</th>
<th>Admission dysfunctional index (mean, only for patients with follow-up information)</th>
<th>Follow-up dysfunctional index (mean)</th>
<th>Mean difference</th>
<th>Mean difference (95% confidence interval)</th>
<th>Test</th>
<th>p-Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Infected patients (n = 19)</td>
<td>ADI &lt; 50</td>
<td>13</td>
<td>31.2</td>
<td>24.8</td>
<td>6.4</td>
<td>−0.07</td>
<td>Two sample t test for the mean of independent samples (equal variance), assuming normal distribution</td>
<td>0.1162</td>
</tr>
<tr>
<td>Both</td>
<td>6</td>
<td>56.6</td>
<td>34.6</td>
<td>22.1</td>
<td>1.0</td>
<td>43.1</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>19</td>
<td>39.2</td>
<td>27.9</td>
<td>11.3</td>
<td>1.6</td>
<td>21.0</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Non-infected patients (n = 15)</td>
<td>ADI &lt; 50</td>
<td>9</td>
<td>31.2</td>
<td>31.1</td>
<td>0.2</td>
<td>−14.1</td>
<td>Two sample t test for the mean of independent samples (equal variance), assuming normal distribution</td>
<td>0.0043</td>
</tr>
<tr>
<td>Both</td>
<td>6</td>
<td>59.3</td>
<td>26.3</td>
<td>33.0</td>
<td>14.9</td>
<td>51.2</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>15</td>
<td>42.5</td>
<td>29.2</td>
<td>13.3</td>
<td>0.0</td>
<td>26.7</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

* Negative number indicates worse result at final.

### Table 5

Improvement in bothersome index by infection status and ADI.

<table>
<thead>
<tr>
<th>Infection</th>
<th>ADI group</th>
<th>Number of patients</th>
<th>Admission bothersome index (mean, only for patients with follow-up information)</th>
<th>Follow-up bothersome index (mean)</th>
<th>Mean difference</th>
<th>Mean difference (95% confidence interval)</th>
<th>Test</th>
<th>p-Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Infected patients (n = 16)</td>
<td>ADI &lt; 50</td>
<td>10</td>
<td>43.8</td>
<td>15.8</td>
<td>28.0</td>
<td>5.5</td>
<td>50.4</td>
<td>Two sample t test for the mean of independent samples (equal variance), assuming normal distribution</td>
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<tr>
<td>Both</td>
<td>6</td>
<td>59.4</td>
<td>36.6</td>
<td>22.7</td>
<td>−15.2</td>
<td>60.7</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>16</td>
<td>49.6</td>
<td>23.6</td>
<td>26.0</td>
<td>8.8</td>
<td>43.1</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Non-infected patients (n = 15)</td>
<td>ADI &lt; 50</td>
<td>9</td>
<td>26.2</td>
<td>34.6</td>
<td>−8.4</td>
<td>−27.5</td>
<td>Two sample t test for the mean of independent samples (equal variance), assuming normal distribution</td>
<td>0.0046</td>
</tr>
<tr>
<td>Both</td>
<td>6</td>
<td>61.8</td>
<td>28.3</td>
<td>33.5</td>
<td>11.8</td>
<td>55.2</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>15</td>
<td>40.4</td>
<td>32.0</td>
<td>8.4</td>
<td>−8.8</td>
<td>25.5</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

* Negative number indicates worse result at final.

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studies showed that it was difficult to show the exact cause of high SMFA scores before and after reconstruction. It is subject to variable factors reflected by the patients and their environment [13,14]. This study revealed that the admission dysfunctional index for both infected and non-infected patients was related to the high admission dysfunctional index reflecting more suffering and lack of acceptance for the circumstances of daily life.

To allow for comparison of our results for reconstructive surgery with those of the METALS study group we included patients whose surgeries corresponded to those on the METALS list [21]. We acknowledge that there is a theoretical difference between this study and other studies dealing with similar injuries due to the fact that all our patients were civilians living in the Middle East, which may result in some differences in their functional and social demands.

The main interest for this paper was to find whether the dysfunctional and the bothersome indexes were improved relative to the functional index at admission for those patients who underwent lower limb reconstruction. The presence of the need for reconstruction in the lower limb after major trauma is by itself a poor prognostic factor for expecting the improvement in the functional index [15]. Amputation is suggested as the best alternative in many studies [7,8] but is called into question by many others [16–18]. This study showed that the improvement in the dysfunctional and bothersome indexes differs between those patients who came with over 50 ADI and those with less than 50 ADI in both infected and non-infected patients, with better improvement for those patients who came with a higher index. This result was contrary to our expectations which were that those patients with higher dysfunctional index at admission will have worse outcome.

In infected patients with less than 50 ADI, the bothersome index improvement was not parallel to the improvement in functional index. We believe our findings were consistent with the findings of Pontsford et al. [13], O’Donnell et al. [14] and Belin et al. [19] who correlated the final outcome to the psychological acceptance of the patient rather than the real functional improvement.

Leahy’s study of amputation versus reconstruction showed that for both options the final outcome was a range of dysfunctional index of 20–30 [8]. In our previous study we demonstrated the same findings [9]. Sanders showed that after immediate treatment of closed fractures of lower limb by intramedullary nail [simple closed fracture] there was a comparable mean dysfunctional index one year after surgery, demonstrating residual deficits in functional outcome [20]. Our current study showed that the final index for all the patients regardless of their index at admission also lies within the range of 20–30 (higher for infected patients with over 50 ADI).

In both infected and non-infected patients with lower admission dysfunctional index, we could not improve the dysfunctional index more than the baseline. However, there is an argument to be made for proceeding with reconstruction to prevent future problems. For example, a patient having an unacceptable malunion may come with a low functional index and minimal disability. Correction of this misalignment would not be expected to create an immediate difference in his dysfunctional index, but may prevent further disability in the future.

Patients with over 50 ADI, both infected and non-infected, showed an average improvement index of 22 and 33 points in dysfunctional index and 22 and 34 in bothersome index, respectively, with a statically significant improvement in the follow up dysfunctional and bothersome indexes for non-infected patients. The non-infected patients with higher ADI had the best improvement for both indexes in the follow up evaluation.

A scoring system that effectively predicts functional outcome following surgical reconstruction of lower limb injuries would be useful. The ADI score in our sample appeared to be instructive in two areas. The first being that in the hospital course of patients with infection, a high ADI score demonstrated a longer hospital stays and more surgeries. The second relates to prognosis (as defined by improvement in functional and bothersome indices) which was better for non-infected patients who had high ADI scores. This data suggests some considerations for the counselling of patients in addition to open the door to further questions regarding this cohort.

The presence of infection and a high admission dysfunctional index is a combination that may lead to more surgeries, more complications and longer stay, with little likelihood of significant improvement in physical or social function. This information should be discussed thoroughly with the patients and may lead to better understanding in regard to why amputation is being clinically suggested. Both the infected and non-infected patients with less than 50 admission dysfunctional index can be counselled that they likely will not have a significant functional improvement.

The non-infected patients with high admission dysfunctional index showed the greatest improvement in functional and bothersome indexes and we believe reconstruction is especially beneficial for this group of war trauma victims. Retrospectively the SMFA has been a useful tool to evaluate this cohort and should be considered as part of an evaluation package when looking at outcomes in war wounded reconstructive surgical patients. We believe that further research is needed to be able to correlate SMFA data with definitive clinical treatment or prognostic indicators.

Conflict of interest

None declared.

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