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The prevalence and development of burn scar contractures: A prospective multicenter cohort study

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ABSTRACT

Objective: The objective of this study was to identify the prevalence and development of after burn joint limitation by scar contracture.
Methods: In 2011–2012, consecutive patients were enrolled in this prospective multi center cohort study. Eligible were all patients admitted to the 2 participating Dutch Burn Centers with acute burns across or adjacent to the neck, shoulder, elbow, wrist, hip, knee and ankle. Passive range of motion was measured in week 3 and subsequently every 3 weeks until discharge, on discharge from the hospital and during follow-up at the outpatient clinic at 3-6-9-12 months after burn.
Results: Limited range of motion of non-operated burned joints (N = 195) was restored back to normal within 6-9 months. From the operated burned joints (N = 353), 58.6% demonstrated a limited range of motion at 3-6 weeks declining to 20.9% at 12 months. The upper part of the body was affected more often by scar contracture than the lower part. At 12 months, the shoulder was limited most often (51.3%) and the hip least often (0%). Reconstructive surgery was performed in 13.3% of the operated burned joints.
Conclusions: Persistent joint limitations at 12 months were exclusively present in joints that needed skin grafting for rapid wound closure. The upper part of the body was more prone to contracture formation than the lower part, from which the shoulder was most often involved. More than half of the limited range of motion seen in the acute phase, resolved in the long term. The need for reconstructive surgery was less than expected.

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1. Introduction

It is generally accepted that the development of a burn scar contracture across or adjacent to a joint may result in loss of range of motion, posing a threat to functional activities and quality of live. As burn scar contractures are common sequelae of burns [1–3] it would be expected that their prevalence and development had been extensively studied. However, the opposite is true. Standard protocols with reliable measurement tools and methods for clinical evaluation and research are lacking and data on the prevalence and development of joint limitations by burn scar contracture are inconsistently reported. [4]. Furthermore, large cohorts are not available, although recently the ACT study was published by Richard et al. [5]. The first results of this interesting study were published in 2017, with data on prevalence of scar contracture and other details still to follow. However, follow-up beyond discharge was not included. Because of that, reported data on the prevalence of burn scar contracture vary considerably between these studies [4,6].

The lack of knowledge about burn scar contracture prevalence and their natural history hampers the evaluation of current care and the development of new treatment strategies to prevent or correct burn scar contracture. And as Holavanahalli et al. [7] noted, even to "know" and to "tell" patients what to expect after injury can go a long way in terms of the coping and adjustment process. Therefore, we conducted a cohort study to document prevalence and natural history of burn scar contracture over time.

Identifying the prevalence and development of burn scar contracture, starts with a generally accepted definition of burn scar contracture. However, there is a lack in consistency in the literature on this point. The terms contracture, musculoskeletal contracture and burn scar contracture are liberally used to describe a limited range of motion (ROM) during recovery of a burn patient. According to the suggested definition of Richard et al. [8] in our study a burn scar contracture is defined as an impairment caused by replacement of skin with pathologic scar tissue of insufficient extensibility and length, resulting in a loss of motion or tissue alignment of an associated joint or anatomical structure.

2. Methods

2.1. Subjects

In 2011–2012, for 12 months consecutive patients were enrolled in this prospective multi-center cohort study. Eligible were all patients admitted to the participating Dutch Burn Centers (Red Cross Hospital, Beverwijk and Martini Hospital, Groningen) with acute burns across or adjacent to one or more of the following joints; neck, shoulder, elbow, wrist, hip, knee and ankle.

Burns 'adjacent to' a joint were defined as a burn at a maximum distance of 1/3 of the length of the adjoining body part/limb. Patients were excluded if they had pre-existing physical disability, had a length of stay shorter than 2 days, or died within 1 month after injury. Burns were considered deep if they were operated on by grafting with mesh graft or Meek graft. Burns were considered superficial if they were not operated because no skin grafting was necessary for rapid wound closure.

The study was evaluated and approved by the Institutional Ethics Committee (Martini hospital no. 2011-19).

2.2. Assessment

The patient's passive ROM was measured with a lateral goniometer according to the standardized protocols of Norkin and White [9] and performed by well-trained, experienced therapists. The study of Edgar et al. [10] demonstrated that assessing joint ROM with a goniometer can provide accurate and objective measurement results in the burns population. Using a goniometer, the minimum detectable change for ankle ROM was $\geq 5°$ and for all other joints tested $\geq 9°$. Based on these findings, in our study a ROM for the ankle of more than 5° short of the normative ROM value was considered limited ROM and for all other joints a ROM of more than 9° short of the normative ROM value was considered limited ROM.

The normative ROM values of the American Association for Orthopedics Surgery (AAOS) [9] were used. Planes of motion measured at each joint and the associated normative ROM values are presented in Table 1.

Time points of measurements during hospitalization were in week 3 and subsequently every 3 weeks until discharge, on discharge from the hospital and during follow-up at the outpatient clinic at 3-6-9-12 month after burn. Measurements at discharge were included to make our data comparable to existing data, as several authors took this point as reference to identify the prevalence of burn scar contracture [11–14]. Furthermore, patient records were checked for reconstructive surgery until 2 years after burn. Data on patient and burn characteristics were obtained from the National Dutch Burn Repository R3.

Table 1 – Measured POM and Normative ROM values.

Joint	POM[a]	Degrees
Neck	Extension	45
	Latereal flexion	45
	Rotation	60
Shoulder	Flexion	180
	Abduction	180
Elbow	Flexion	150
	Extension	0
	Supination	80
Wrist	Flexion	80
	Extension	70
Hip	Flexion	120
	Extension	20
	Abduction	40
Knee	Flexion	135
	Extension	0
Ankle	Dorsiflexion	20
	Plantar flexion	50

[a] POM;planes of motion.

2.3. Treatment

Depending on the depth and TBSA of the burn wound, treatment consisted of topical therapy either or not followed by grafting with autologous split skin mesh graft or Meek graft. Additionally, all patients received physical rehabilitation care, according to the treatment views of the Dutch Working Group on Burn Rehabilitation. Physical rehabilitation interventions started shortly after admission at the burn center, with anti-contracture positioning, active-, active assisted and passive ROM exercises, muscle strengthening and cardio-pulmonary training. Mobilization out of bed started as soon as possible, depending on the patient's general condition, ability and tolerance. The use of splints is still a point of debate in the Netherlands. During hospitalization, splints may be used to protect fresh grafts and as additional means for positioning. In the two participating burn centers splinting to prevent or correct burn scar contractures is not a commonly used intervention anymore, because convincing evidence is lacking our opinion [6]. Finally, pressure garments were used as a standard part of scar treatment.

2.4. Data analysis

Descriptive analysis of data was performed using IBM SPSS 20 (Version 20.0. Armonk, NY: IBM Corp.). Furthermore, multilevel regression modelling was performed (MLwiN 2.35, 2015) to identify predictors for after burn joint limitation.

3. Results

In total 173 patients with burns over or adjacent to 548 joints were enrolled in this study. Patient and burn characteristics are presented in Table 2 and the number of joints measured at the different time points during recovery in Table 3.

Table 2 – Patient- and burn characteristics.

Total number of study patients	173
- Operated	117
Total number of study joints	548
- Operated	353
Male, percent	63.6
Age at injury, mean (years)	37.3
- Min.–Max.	0–90
- Median	37
- SD	24.6
Length of stay, mean (days)	23.2
- Min.–Max.	2–108
- Median	19
- SD	17.3
TBSA burned, mean (%)	11.3
- Min. - Max.	0.5–92
- Median	7
- SD	13.5
TBSA burned deep, mean (%)	8.3
- Min.–Max.	0.5–59
- Median	8.5
- SD	4

3.1. Prevalence of limited ROM

Of the entire group of 548 joints included, both non-operated and operated, 47.0% had a limited ROM at 3 weeks after burn. After 12 months, the limitations were reduced to 9.4% (Fig. 1). When subdividing the overall group in non-operated (N = 195) and operated burned joints (N = 353), it was found that the ROM of non-operated burned joints, was restored back to normal within 6–9 months, despite a prevalence of 36.6% limitations in joint range of motion at 3 weeks after burn. The operated group of 353 burned joints showed 58.6% limitations in joint range of motion at 3 weeks after burn. At 12 months after burn the prevalence of limitations in joint range of motion was reduced to 20.9% (Fig. 2).

Of the joints with operated burns, at 3 weeks after burn, the neck was limited most frequently (63%), followed by the joints of the lower extremity (59.2%) and the upper extremity (53.6%) respectively (Fig. 3). After 12 months in all three groups less joints were limited, however, the neck and upper extremity were more frequently limited (28%) than the lower extremity (6.5%), with the number of limitations of the lower extremity showing a remarkable fast decline at 3 months after burn to 25.4%.

Of the individual joints of the upper extremity with operated burns, the shoulder was, by far, the most frequently affected joint in terms of limitation of ROM during the entire period of recovery (Fig. 4). Even after 12 months, still 51.3% of shoulder joints were limited. The elbow and wrist were limited at three weeks in 36.2% and 50.0% of cases, respectively, both declining to about 16% at 12 months.

Of the individual joints of the lower extremity with operated burns, at 3 weeks after burn the hip, knee and ankle showed a prevalence of joint limitations of 73.1%, 54.1% and 50.4%, respectively. At 12 months after burn the limitations of the knee and ankle had declined to about 10% whereas the hip had no limitations at all at that time (Fig. 5).

When ranking the operated individual joints on prevalence of limitations at 12 months, the shoulder is by far the most frequently limited joint, followed by the neck, elbow, wrist, ankle, knee and hip. Comparing the ranking at 12 months to the period in the acute phase at about 3 weeks showed that the ranking order in both periods is quite

different. At 3 weeks the joints of the lower extremity were more frequently limited than the upper extremity. However, at 12 months the joints of the upper extremity were more frequently limited, with exception of the shoulder, which was limited most frequently in both periods (Fig. 6).

Because of the presumed interdependency between multiple adjacent joints, the number of limited connecting burned joint combinations were analyzed at discharge and at 12 months and are shown in Table 4. At the upper extremity more often two or more connecting joints were affected compared to the lower extremity. The joint combinations of the lower extremity however were proportionately limited more often. Furthermore, Table 4 shows that not all joints involved in the multi joint burn combinations resulted in a limited ROM. At discharge, between 26.9% and 52.0% of the multi-joint combinations were limited. At 12 months, it was 0–8.3%.

Another point of interest is the impact of the localization of burns, i.e. across or adjacent to a joint, on the prevalence of

Table 3 – Number of joints measured at specific time points during recovery.

	3 wk[a]	6 wk[a]	3 mos[a]	6 mos[a]	9 mos[a]	12 mos[a]	Discharge
Neck	29	30	29	26	22	15	35
Non-operated	12	14	13	12	10	5	18
Operated	17	16	16	14	12	10	17
Shoulder	71	59	65	57	49	41	77
Non-operated	19	18	14	13	12	10	21
Operated	52	41	51	44	37	31	56
Elbow	93	74	94	77	51	35	92
Non-operated	32	23	31	24	15	13	26
Operated	61	51	63	53	36	22	66
Wrist	100	88	103	84	63	46	104
Non-operated	31	29	31	21	14	12	28
Operated	69	59	72	63	49	34	76
Hip	43	37	42	42	34	29	46
Non-operated	15	13	15	16	13	11	17
Operated	28	24	27	26	21	18	29
Knee	64	60	68	56	43	33	73
Non-operated	20	18	24	17	12	9	25
Operated	44	42	44	39	31	24	48
Ankle	46	39	46	40	32	30	50
Non-operated	13	10	12	11	9	9	14
Operated	33	29	34	29	23	21	36

[a] Time after burn.

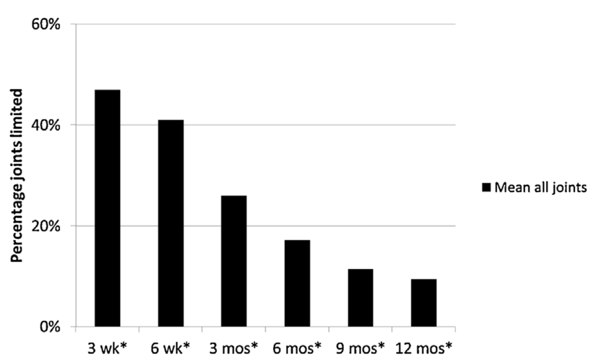

Fig. 1 – Mean limited ROM all joints. Non-operated and operated.
*** = time after burn.**

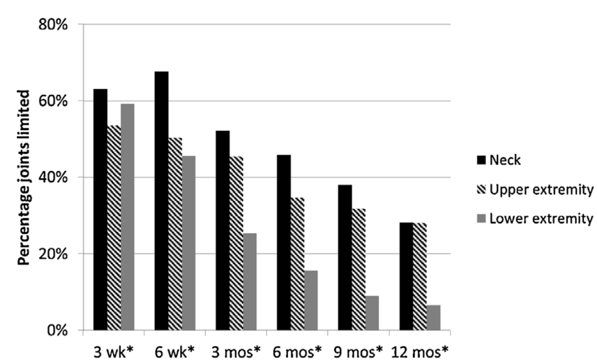

Fig. 3 – Operated burns. Prevalence limited ROM Neck, upper extremity, lower extremity.
*** = time after burn.**

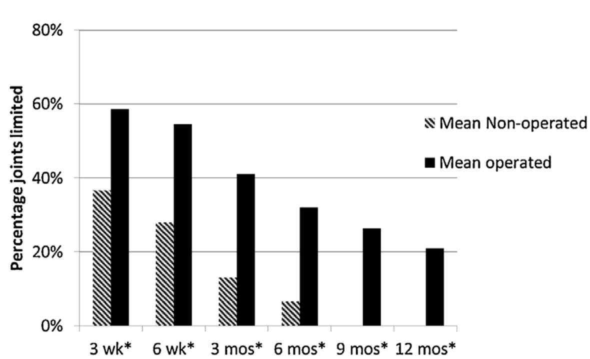

Fig. 2 – Mean limited ROM all joints. Non-operated vs operated joints.
*** = time after burn.**

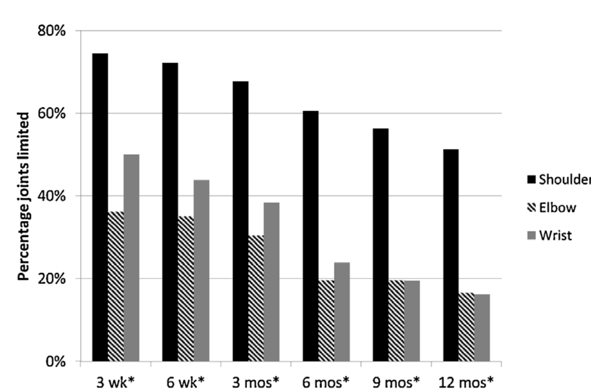

Fig. 4 – Operated burns. Prevalence limited ROM shoulder, elbow and wrist.
*** = time after burn.**

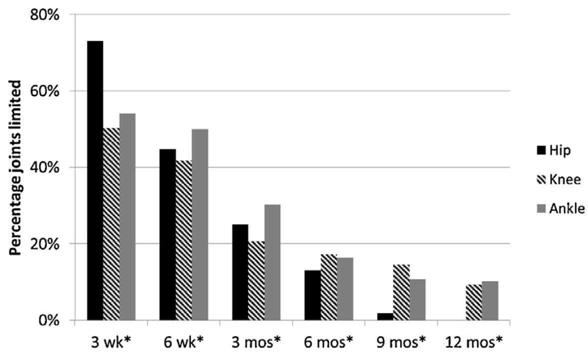

Fig. 5 – Operated burns. Prevalence limited ROM hip, knee and ankle.
***Time after burn.**

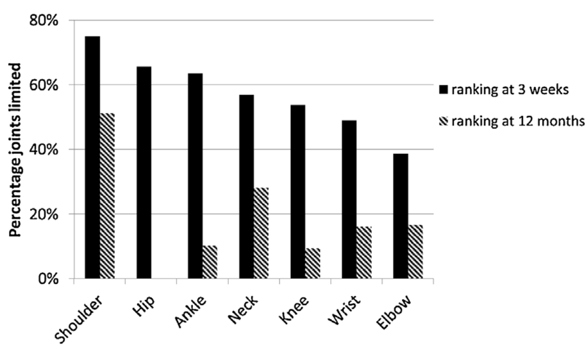

Fig. 6 – Operated burned joints. Ranking prevalence joint limitation at 3 weeks and 12 months after burn.

Table 4 – Number of limited connecting burned joint combinations at discharge and at 12 months.

Joint combinations	In total	Limited at discharge	Limited at 12 months
Elbow–wrist (%)	78	21 (26.9)	4 (5.1)
Elbow–shoulder (%)	58	27 (46.6)	4 (6.9)
Shoulder–elbow–wrist (%)	36	12 (33.3)	3 (8.3)
Knee–ankle (%)	25	13 (52.0)	2 (8.0)
Knee–hip (%)	20	9 (45.0)	0 (0.0)
Hip–knee–ankle (%)	5	2 (40.0)	0 (0.0)

joint limitations. The results at discharge and at 12 months were analyzed and shown in Table 5. At both time points, burns across a joint had more impact on joint limitation than burns adjacent to a joint. The shoulder was by far the most frequently limited joint from the across-group (53.8%). At 12 months the number of joints limited in the across and adjacent group were more comparable, with the exception of the shoulder and the hip. While the shoulder is proportionally more limited than the other joints, the hip had no limitations at all in the across — as well as the adjacent group. It is noteworthy that in the adjacent group the hip was most frequently limited at discharge, while at 12 months the hip was the only joint without any limitation.

Considering determinants influencing the ROM, multilevel regression modelling for all joints together, showed that a joint was limited if the patient had a higher TBSA burned ($t = 2.0$; $p = 0.05$) or had surgery ($t = 3.1$; $p = 0.002$). Age of the patient ($t = 1.0$, ns) and sex ($t = 0.48$, ns) were no predictors for joints being limited after burns. In these analyses, the level of analysis is the joint. So, range of motion loss, regardless of the plane of motion, is aggregated to the joint being limited or not.

Table 5 – Percentage of limited joints from burns across or adjacent to a joint at discharge and at 12 months.

	Discharge		12 months	
	Across	Adjacent	Across	Adjacent
Shoulder	53.8	21.4	44.6	6.8
Elbow	29.3	9.6	12.8	3.8
Wrist	36.8	12.3	10.1	6.2
Hip	38.2	27.4	0.0	0.0
Knee	45.1	8.7	5.9	3.6
Ankle	41.5	22.1	5.4	4.9

3.2. *Prevalence of limited ROM at discharge*

At discharge from the hospital 44.1% of the 548 joints included, both non-operated and operated, had limitation of the ROM. From that group, the non-operated burned joints were limited in 30% of cases and the operated burned joints in 57.4% of cases. In the group of operated burned joints, the shoulder was most frequently limited (75.1%), followed by the hip (65.7%), ankle (63.6%), neck (56.9%), knee (53.8%), wrist (49.0%) and elbow (38.7%).

3.3. *Reconstructive surgery*

The need for reconstructive surgery of operated and non-operated burned functional areas was investigated until 2 years after burn. Of the 173 patients included, 22 patients (12.7%) underwent one or more reconstructive surgery procedures. None of the patients from the non-operated group (N = 56) were reconstructed, thus the 22 reconstructed patients were from the group that was operated for initial wound closure (N = 117). In total 18.8% of the patients with operated burned joints needed one or more reconstructive surgery procedures. Of the 548 joints included, 353 needed an operation for initial wound closure. Reconstructive surgery was done in 10.5% (N = 37) of those joints (Table 6).

The 37 reconstructed joints needed 47 reconstructive procedures. Joints from the upper part of the body needed reconstructive surgery more often (89.4%) than those of the lower part (10.6%). The neck was most frequently reconstructed, followed by the shoulder, elbow, wrist, knee and hip. The ankle was not reconstructed (Table 7). In 54.5% of the reconstructed patients, more than one surgical intervention was performed, of which 31.8% were reconstructed more than once on the same anatomical location.

4. Discussion

To the best of our knowledge this is the first longitudinal follow up study on the prevalence of joint limitations after burn injury until 12 months after burn. It showed that from the total of

Table 6 – Prevalence reconstructive surgery.

	All burns	Non-operated	Operated
Patients	173	56	117
Number reconstructed	22	0	22
Percentage reconstructed	12.7%	0.0%	18.8%
Joints	548	195	353
Number reconstructed	37	0	37
Percentage reconstructed	6.8%	0.0%	10.5%

Table 7 – Prevalence reconstructive surgery per anatomical location.

Anatomical location	Reconstructed[a]	Frequency[b]
Neck	9 (2.5%)	17 (4.8%)
Shoulder	11 (3.1%)	12 (3.4%)
Elbow	7 (2.0%)	7 (2.0%)
Wrist	5 (1.4%)	6 (1.7%)
Hip	2 (0.6%)	2 (0.6%)
Knee	3 (0.9%)	3 (0.8%)
Ankle	0 (0.0%)	0 (0.0%)
Total (N = 353)	37 (10.5%)	47 (13.3%)

[a] Frequency of reconstructed joints.
[b] Frequency of reconstructive procedures.

548 joints included, both operated and non-operated, 47.0% had a limited ROM at 3 weeks after burn, which declined to 9.4% at 12 months. Non-operated joints recovered without persistent joint limitations, indicating that the joint limitations found at 12 months were exclusively present in joints that had needed one or more skin graft procedures. Furthermore, the joints of the upper extremity were limited more frequently in the long term than those of the lower extremity.

From the non-operated burned joints, ROM limitations restored completely within 9 months, the vast majority even within 3 months. That does not mean that the joint limitations found in that period, are not to be taken seriously. It is obvious that these limitations may cause functional problems in the acute phase and need the necessary standard rehabilitation interventions. However, in the long term functional problems will diminish and finally disappear, by which time the rehabilitation interventions to restore the joint limitations will become unnecessary. Furthermore, it is noteworthy that the restoration of the ROM of non-operated burned joints, not always kept pace with the time span of wound healing. Non-operated burns will normally heal within a few weeks [15,16], while the restoration of full ROM of several joints took a few months.

Another interesting finding of our study was that from the limited operated burned joints at discharge (57.4%) more than half (36.5%) had resolved at 12 months. The prevalence of 57.4% joints with limited ROM at discharge is higher than those found in de studies of Schneider, Kowalske and Goverman; 39%, 42% and 33.2%, respectively [11,12,14]. This may be due to several factors. Firstly, there was a difference in patient selection. Schneider and Goverman, included patients who met the criteria of the ABA guidelines of major burns, whereas we included all admitted patients regardless of %TBSA burned and burn depth. Secondly, we included only patients with burns across or adjacent to joints, in the other studies this is not mentioned. Furthermore, the definition of contracture and assessment methods differed.

The findings of our study also draw attention to studies that measured the ROM at discharge from the hospital to identify the prevalence of burn scar contractures [11–14]. The question that arises is if all joint limitations found at discharge in those studies were just from developing burn scar contractures, or that factors other than the skin, as mentioned before, were responsible for joint limitation as well. And, does identifying the prevalence of burn scar contracture at discharge provide a realistic representation for this complication?

This point has also been argued by Goverman et al. [11], who noted that the rate of after burn contracture found at discharge did not necessarily represent the burn scar contracture rate found over time, because of the presence of various confounding factors at discharge. In line with that, Dobbs and Curreri [17] already in 1972 reported that limitations in ROM may spontaneously decrease after 6–9 months, because of resolution of hypertrophic scars. Therefore, it may be concluded that ROM limiting factors change over time. Identifying the prevalence of burn scar contracture at discharge would thus have little predictive value for the prevalence of burn scar contracture in the long term, because not all limitations found at discharge will finally result in persistent burn scar contracture in the long term.

Analyzing the influence of burns across- or adjacent a joint on limitation of ROM, showed that burns across a joint resulted in substantially more limited joint ROM than burns adjacent to a joint. This was an expected outcome but had not been documented before as far as we know. Richard et al. introduced the concept of Cutaneous functional units (CFU) in burns and how the amount of CFU affected by burn injury can predict the development of burn scar contracture [18]. In accordance, our study showed that burns adjacent to a joint have impact on the ROM of the associated joints, however to a lesser extent than burns across a joint. Additionally, numerous affected joints concerned two or more connecting joints. This could impact their overall rehabilitation ability and therefore ability to treat the measured joints, although clear evidence about the magnitude of its impact on function is still lacking [22] and needs further investigation.

Another finding of our study was the difference between the upper- and lower extremity concerning the prevalence and development of joint limitations during recovery. Comparing the upper extremity to the lower extremity showed that during hospitalization and at discharge the lower extremity was more limited than the upper extremity, but soon after discharge the number of joint limitations in the lower extremity resolved to a large extent (6.5%), whereas more joints of the upper extremity remained limited, even at 12 months (28%). This difference of joint limitation of both extremities may be the result of rehabilitation interventions, the level of activity and ADL. Anti-contracture interventions consist of exercises and positioning of the extremities focused on ante-flexion and abduction of the shoulder, extension and supination of the elbow, extension of the knee and dorsiflexion of the ankle. During the acute phase of hospitalization, the level of activity and ADL participation is low. And during those periods of less- or inactivity the patient is placed in anti-contracture positions to counteract wound or scar contraction. However, when the patient becomes more active while participating in the ADL, the periods of passive anti-contracture positioning decline. Considering the ADL activities and the plane of motion of burn scar contracture, the effect of ADL activities on contracture formation of the upper extremity and the lower extremity are opposite to each other. Most ADL of the upper extremity such as feeding, bathing etc. are in the position of contracture and during periods of inactivity, like sitting in a chair, the shoulder and elbow are in position of contracture i.e. adduction and internal rotation of the shoulder, flexion and pronation of the elbow. The ADL of the lower extremity however, like standing and walking, are the opposite to contracture formation, namely extension of the knee and dorsiflexion of the ankle. During the period of recovery and rehabilitation, the patient will increasingly participate in ADL, whereby the lower extremity will have more benefit from the ADL than the upper extremity. Furthermore, positioning in anti-contracture positions of the lower extremity like extension of the knee does not interfere with ADL, while anti-contracture positions of the arms like abduction/ante flexion of the shoulder and extension of the elbow, prevents the patient participating in ADL. Although these suggested effects on contracture formation have poor scientific foundation, it is worthwhile to consider as a possible explanation of the differences in the prevalence and development of burn scar contracture formation of the upper- and lower extremity.

When all rehabilitation efforts to prevent or correct a persistent burn scar contracture fail, reconstructive surgery is the most appropriate intervention to restore the limited ROM. Of the 173 patients admitted to the participating burn centers, 12.7% had one or more reconstructive surgeries. This finding is consistent with a 10-year follow-up study of the reconstructive surgical needs after burn injury by Hop et al. in 2014 [19]. They found an incidence of 13.0% patients that underwent one or more reconstructive surgery interventions. However, it is in contrast with the findings of Prassad et al. [20] and Kraemer et al. [21] who found an incidence of 19.9% and 3.7% reconstructed patients, respectively. The dissimilarity between the results may be attributed to the differences in study design, patient and burns characteristics and timing of reconstructive surgery.

Analyzing all 548 joints included in our study showed that 6.8% of all joints underwent one or more reconstructive surgical interventions. The reconstructed joints were all from the group of operated burned joints. From that group 10.5% of the joints were reconstructed, despite a prevalence of 20.9% persistent joint limitations found in our study at 12 months. Even at 24 months after burn, not all burn scar contractures resulting in joint limitations were reconstructed. A possible explanation could be, that not all patients suffering from a scar contracture felt the need for reconstructive surgery at that time and that some joint limitations did not interfere in activities of daily living. The manner in which joint limitation is defined, in this and many other studies, as a fixed number of degrees from the norm, is not necessarily an indication for functional loss. This was recently also pointed out by Korp et al., who systematically reviewed literature on the functional ROM related to burn recovery [22]. Furthermore, in several cases reconstructive surgery was postponed until scar maturation was complete.

5. Limitations

Some measurement data are missing, because patients were not always able to endure the measurement procedure during hospitalization or did not attend the outpatient clinic on a regular base. The measurement assessments had a time span until 12 months after burn. We realize that it would be preferable if the study period lasted till scar maturation was complete. However, there is no real fixed time point for complete scar maturation, which may vary considerably between patients.

6. Conclusion

The results of our study showed that non-operated burned joints were of no threat for persistent joint limitations in the long term, despite a rather high prevalence in the acute phase.

Persistent joint limitations at 12 months were exclusively present in joints that needed skin grafting for rapid wound closure.

The upper part of the body was more frequently limited than the lower part. The shoulder was by far the most frequently limited joint, followed by the neck, elbow, wrist, ankle, knee and hip. More than half of the limited operated burned joints seen in the acute phase resolved in the long term. This indicates that joint limitations found in the acute phase have little predictive value for burn scar contracture development in the long term.

The number of reconstructed joints was less than the actual number of joints limited by a burn scar contracture. Comparing the overall results of our study to previous studies showed little consistency, which stresses the need for uniform study designs, measurement protocols, study population, timing of measurement and the definition of a burn scar contracture.

Conflict of interest

The authors declare no conflict of interest.

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