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Reconstructive

The Effectiveness of Burn Scar Contracture Release Surgery in Low- and Middle-income Countries

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Background: Worldwide, many scar contracture release surgeries are performed to improve range of motion (ROM) after a burn injury. There is a particular need in low- and middle-income countries (LMICs) for such procedures. However, well-designed longitudinal studies on this topic are lacking globally. The present study therefore aimed to evaluate the long-term effectiveness of contracture release surgery performed in an LMIC.

Methods: This pre-/postintervention study was conducted in a rural regional referral hospital in Tanzania. All patients undergoing contracture release surgery during surgical missions were eligible. ROM data were indexed to normal values to compare various joints. Surgery was considered effective if the ROM of all planes of motion of a single joint increased at least 25% postoperatively or if the ROM reached 100% of normal ROM. Follow-ups were at discharge and at 1, 3, 6, and 12 months postoperatively.

Results: A total of 70 joints of 44 patients were included. Follow-up rate at 12 months was 86%. Contracture release surgery was effective in 79% of the joints ($P < 0.001$) and resulted in a mean ROM improvement from 32% to 90% of the normal value ($P < 0.001$). A predictive factor for a quicker rehabilitation was lower age ($R^2 = 11\%$, $P = 0.001$). Complication rate was 52%, consisting of mostly minor complications.

Conclusions: This is the first study to evaluate the long-term effectiveness of contracture release surgery in an LMIC. The follow-up rate was high and showed that contracture release surgery is safe, effective, and sustainable. We call for the implementation of outcome research in future surgical missions. *(Plast Reconstr Surg Glob Open 2020;8:e2907; doi: 10.1097/GOX.0000000000002907; Published online 15 July 2020.)*

INTRODUCTION

Burn injury is a major global health issue, causing substantial mortality and morbidity worldwide. Each year 200,000–300,000 people die due to fire-related burns, with the highest incidence and mortality reported in low- and middle-income countries (LMICs),[1–3] with LMICs as defined by The World Bank.[4] Survivors of severe burns may face devastating sequelae due to the development of burn scar contractures.[5,6] Contractures are defined as the replacement of skin by excessive scar tissue of insufficient extensibility, which results in a loss of range of motion (ROM).[7] Contractures can also be disfiguring or painful.[8]

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Although adequate burn management can prevent the development of scar contractures, it is often not accessible to patients in LMICs.[2] The need of contracture release surgery in LMICs is unknown. However, as 5 billion people have limited access to safe surgical care in LMICs and 11 million people require medical attention for severe burns each year, the need for reconstructive interventions is evident.[1,2,9] Even in high-income countries, contractures are still frequently observed in severely burned patients, and reconstructive surgery is often indicated.[10] In the Dutch burn centers, for example, 20.9% of joints with burns develop a contracture and 13.3% of joints undergo reconstructions.[11,12]

The principle of contracture release surgery is to release or excise the scar and to cover the defect with tissue that lengthens the scar. Many surgical techniques are described in literature.[13] If adjacent tissue is available, local transposition flaps are recommended.[14–16] There is a wide variety of local flaps. They provide healthy tissue, thereby adding pliability and extensibility, which further improves joint function.[14,17,18] If enough adjacent tissue is not available for a local flap, skin grafts are mostly used, preferably autologous full-thickness grafts (FTGs), as they recontract less than split skin grafts.[18–20]

Although various techniques are available for contracture release surgery, the evidence of its effectiveness is lacking globally.[13,21,22] A systematic review of this topic showed that all included studies had methodologic and statistical shortcomings.[22] The authors called for future studies to use validated outcome measures and clear statistical analyses.[15,22]

In LMICs, in underserved populations, contracture release surgery is often provided by volunteer surgeons during surgical missions.[9,23,24] These missions are frequently debated, for example, due to limitations in quality of care and aftercare, which might impair their long-term results.[25–27] A recent systematic review of the effectiveness of reconstructive surgical missions showed that currently no quality studies are available.[28]

Therefore, the present study aimed to evaluate the effectiveness of contracture release surgery during surgical training missions in an LMIC, with follow-up up to 1 year postoperatively, using ROM as validated outcome measure.

METHODS

This pre-/postintervention study was conducted at the Haydom Lutheran Hospital (HLH), a rural tertiary hospital in Tanzania, sub-Saharan Africa. Patients who underwent contracture release surgery between December 2017 and October 2018 were eligible and included if they provided written informed consent. Ethical approval was obtained from the Medical Research Coordinating Committee of the National Institute for Medical Research of Tanzania (NIMR/HQ/R.8a/Vol.IX/2652).

In Tanzania, plastic surgeons are only scarcely available, and at the HLH, they are not present. At HLH, contracture release surgery is therefore performed during biannual surgical training missions of 2 weeks, supported by the Dutch NGO Doctors of the World. Interventions were performed by accredited plastic surgeons from The Netherlands, always together with local surgeons of the HLH. The team from Doctors of the World consisted of 1 anesthetist, a coordinator, and 2 surgeons, providing supervision on aftercare by telecommunication all year round. The team from the HLH consisted of 3 surgeons and several residents. The HLH provided all the equipment, medication, and staff for the perioperative care, including anesthesia and the aftercare.

Intervention

Treatment planning was according to international guidelines, specified to the resource-limited healthcare setting of the HLH.[21] In this study, local fasciocutaneous flaps were used when feasible (eg, z-plasty, 5-flap plasty, or interposition flap).[14,18,20] When local flaps were not sufficient or not available to fully cover the defect, the flaps were combined with an additional skin graft, preferably FTGs. The flap design was marked preoperatively. Local infiltration with adrenaline diluted in saline was applied to limit blood loss.[29] Tourniquets were not applied. All procedures were performed under general anesthesia.

Local physiotherapists provided rehabilitation services during admission, consisting of instructions for active and active-assisted ROM exercises. All patients received explicit exercise instructions during follow-up.

Data Collection

Patient and Treatment Characteristics

Patient characteristics including age, sex, weight, and comorbidity were documented. We classified contractures of the large joints and fingers using a modified classification of Ogawa et al.[5]: type I, superficial with adipose layer preserved; type II, linear band; type III, linear band with diffuse scarring surrounding the band; and type IV, broadband scar. Location of contracture, time since burn injury, and etiology were documented, as were contracture release surgery technique, adverse events, and graft take or flap failure were documented. Effective take was defined as >80%, partial graft or flap necrosis was defined as tissue survival between 30% and 80%, and complete graft or flap necrosis as tissue survival of <30%.

Outcome Assessment and Analysis

Passive ROM of the large joints was measured using lateral goniometry according to the protocol of Norkin and White.[30] Finger ROM was measured in the first position, according to Richard et al.[31] In burns, joint ROM can be assessed accurately with a goniometer.[32]

ROM data were indexed to percentages of normal values, rather than absolute ROM values to control for different normal ROM values of the various joints. Normal values were retrieved from the American Academy of Orthopedic Surgeons for large joints[33] and from Richard et al.[31] for fingers (**see table, Supplementary Digital Content 1**, which displays normal ROM values according to American Academy of Orthopedic Surgeons, **http://links.lww.com/PRSGO/B400**). Assessments were done before surgery and at 1, 3, 6, and 12 months after surgery. Loss to follow-up was minimized by extensive counseling of patients by telephone and compensation for traveling costs.

Subanalyses were performed at 3 levels to evaluate outcome:

1. Planes of motion level (eg, shoulder abduction): We analyzed the difference in percentage ROM preoperatively versus postoperatively. Only planes of motion that were affected were included (<100% of normal ROM preoperatively). It was verified whether excluded motions were still 100% of normal ROM at 12 months' follow-up.
2. Joint level (eg, shoulder): We analyzed the number of joints that were effectively corrected. Effective surgery was defined as follows: when all planes of motion in a single joint showed an increase of at least 25% in ROM postoperatively, or ROM reached the 100% of normal ROM, if increase of ROM in all planes of motions was <25%.
3. Patient level: We analyzed the best joint (joint with most improvement) and worst joint (joint with least improvement) of a single patient. For both categories, we calculated the percentage of joints that were effectively corrected, with "effectively" defined as described above.

Sample Size Calculation and Statistics

We performed an a priori power analysis to estimate the required sample size. We hypothesized that if patients were not treated, the ROM of their joints would not change: the known proportion is 0% improvement. If surgery could improve ROM by 25% in at least 60% of patients, 8 patients would be needed to find a statistically significant difference between treatment and no treatment (α, 5%; power, 90%).

Data were analyzed using IBM SPSS Statistics version 22.0 (IBM Corp., Armonk, N.Y.). Data were described with summary statistics for continuous variables or number and percentage for the calculation of categorical variables. For analyses at the level of planes of motion, the difference in ROM preoperatively versus postoperatively was tested for statistical significance using the paired *t* test. The difference between effective surgery at different measurement occasions was tested with χ^2 tests to examine the long-term effects.

RESULTS

A total of 44 patients, both children and adults, underwent contracture release surgery between December 2017 and October 2018. The mean age of the patients was 9 years (median, 5.5; interquartile range, 3.0–11.5). Patients underwent reconstruction at a mean of 1141 days after the burn injury had occurred (interquartile range, 471–1620 days) (Table 1).

Table 1. Patient Characteristics

Total patients	44 (100%)
Men	20 (45%)
Age	
Mean (SD)	9 (9.1)
Median (IQR)	5.5 (3.0–11.5)
<14 y	35 (80%)
≥14 y	9 (20%)
Time after injury, mean days (IQR_{25-75})	1141 (471–1620)
Traveling time to hospital, mean hours (SD)	5 (8)
ASA classification	
I	42 (96%)
II	2 (4%)
III	0 (0%)
Hb, mean (SD)	11.9 (1.3)
Weight-for-age (<10 y), mean (SD)	−1.2 (1.1)
Weight-for-height (<10 y), mean (SD)	−0.9 (1.3)
BMI, mean (SD)	23.5 (2.1)
Smoker	0 (0%)

ASA, American Society of Anesthesiologists; BMI, body mass index; Hb, hemoglobin.

A total of 70 joints were reconstructed if the fingers of one hand were counted as one joint. If all the fingers were counted separately, a total of 117 joints were corrected. Location and types of contractures are listed in Table 2.[34]

Table 2. Scar Characteristics

	N (%)
Etiology	
Scalds	17 (39%)
Fire	27 (61%)
Estimated TBSA, mean (SD)	7 (8)
Total joints*	70 (100%)
Location	
Head/neck	0 (0%)
Upper extremity*	33 (47%)
Axilla	7 (10%)
Elbow	14 (20%)
Wrist	12 (17%)
Hand digits	22 (32%)
Thumb	11 (16%)
Digit II	12 (17%)
Digit III	17 (24%)
Digit IV	15 (21%)
Digit V	14 (20%)
Lower extremity	15 (21%)
Hip/groin	7 (10%)
Knee	4 (6%)
Ankle	2 (3%)
Greater toe	2 (3%)
Type of contractures†	
Type I: superficial	0 (0%)
Type II: linear	18 (26%)
Type III: diffuse	24 (34%)
Type IV: broadband	28 (40%)

TBSA, total body surface area.

In the group of linear scars, local flaps without graft were used in 12 cases (12/18, 67%), flaps combined with grafts in 4 cases (4/18, 22%), and grafts without local flaps in 2 cases (2/18, 11%). In broadband contractures, local flaps without FTG were applied in 3 cases (3/28, 11%), local flaps combined with graft were applied in 12 cases (12/28, 43%), and grafts only in 13 cases (13/28, 46%) (Table 3 and Fig. 1). Postoperative immobilization of hand joints with k-wires was preferred over a plaster splint (15/22, 68%).

The follow-up rate at 1 year was 86% (38/44 patients, mean length of follow-up, 329 days; SD, 52). Mean graft take was 76% (SD, 28%), with an effective graft take in 18 of 32 joints (56%). Complications are listed in Table 4. Overall, 41 complications occurred in 52% of patients (23/44). Flap tip necrosis occurred in 3 out of 30 large joints, and partial flap necrosis occurred in 3 out of 30 large joints (10%).

Table 3. The Type of Contractures and the Type of Surgical Technique Applied

Type	N (%)	Local Flap Only	Local Flap + Graft	Grafts Only
Linear	18 (26%)	12 (67%)	4 (22%)	2 (11%)
Diffuse	24 (34%)	9 (38%)	9 (38%)	6 (25%)
Broadband	28 (40%)	3 (11%)	12 (43%)	13 (46%)
Total	70 (100%)	24 (34%)	25 (36%)	21 (30%)

Local flap only, without additional grafts; local flap + graft is a flap combined with grafts, preferably an FTG; grafts only, grafts were used without a flap.

Fig. 1. Example of a 29-year-old female patient with contracture of both hands. A, Classified as broadband contracture. B, Results at 12 months after releasing the right hand. C, Markings for the contracture release surgery of the left hand. D, Infiltration with adrenaline solution to prevent blood loss. E, Incision of the scar contracture, proximal to the metacarpophalangeal joints, and releasing the contracture. F, Raising the FTG from the abdomen area to cover the defect. G, Direct postoperative result of the left hand, with K-wires inserted in the metacarpophalangeal joints in flexion. H, Result of the left hand at 9 months.

Regarding major complications, 1 death occurred due to respiratory insufficiency caused by bilateral pneumonia.

Surgical Outcomes

Planes of Motion Level

The mean preoperative ROM of all motions pooled was 32.3% of the normal value (n = 228; SD, 31.3). One month after surgery, the mean ROM was 46.2% (n = 220; SD, 39.9), at 3 months, 73.3% (n = 201; SD, 36.4), at 6 months, 84.7% (n = 212; SD, 31.8), and at 12 months, 90.0% (n = 207; SD, 32.0). On all follow-up occasions, the mean ROM increased statistically significantly ($P < 0.001$) (Table 5 and Fig. 2A). Similar improvements of ROM were observed in different types of contractures (Table 6).

Table 4. Surgical Characteristics

Total procedures	44
Total joints	70
Average operation time, min	129
Hospital stay, mean (SD)	11 (7.7)
Graft take	
Mean take (SD)	(76%) 28
Effective take (>80%)	18 (56%)
Partial necrosis (30%–80%)	11 (34%)
Complete necrosis (<30%)	3 (9%)
Total complications	
Patient with complications, n (%)	23 (53%)
Total number of complications	44 (100%)
Major complications, n (%)	
Death	1 (2%)
Bilateral pneumonia	1 (2%)
Flap failure (major joints)	
No failure	22 (68%)
Tip necrosis (>80%)	7 (22%)
Partial failure (30%–80%)	3 (10%)
Complete failure (<30%)	0 (0%)
Other minor complications, n (%)	
Surgical site infection	6 (14%)
Wound dehiscence	5 (11%)
Pin tract infection	5 (11%)

Preoperatively, 0% of the planes of motion reached 100% of normal ROM. At 1 month, this was 12.7% (n = 28/220), at 3 months, 33.3% (n = 67/201), at 6 months, 49.5% (n = 105/214), and at 12 months, 59.0% (n = 124/207).

Subanalysis of the upper extremity (n = 66), lower extremity (n = 24), and hands (n = 137) showed that on all follow-up occasions, the mean ROM values had improved statistically significantly when compared with the mean preoperative ROM ($P < 0.001$). One year after surgery, the mean improvement for the upper extremity was 53.5% of normal ROM ($P < 0.001$), for the lower extremity was 85.5% ($P < 0.001$), and for hands was 56.2% ($P < 0.001$).

Joint Level

At 1 month, 25 out of 115 joints (22%) were effectively corrected, that is, the ROM improved >25% or reached 100% of normal ROM, ($P < 0.001$), at 3 months, 56 out of 105 joints (53%; ($P < 0.001$), at 6 months, 81 out of 109 (74%; $P < 0.001$), and at 12 months, 83 out of 105 joints (79%; $P < 0.001$). The subanalyses of joint groups (ie, upper extremity, lower extremity, and hands) showed

Table 5. Analysis of Planes of Motion, Joints, and Patient Level over Time

	Preoperative	1 mo	3 mo	6 mo	12 mo	Difference Preoperative vs 12 mo	*P**
Planes of motion level†							
Total, n	228	220	201	212	207		
Upper extremity (n = 66), mean ROM (SD)	34.8 (31.9)	54.1 (33.1)	65.7 (30.3)	91.4 (32.1)	88.3 (31.0)	53.5	0.001
Lower extremity (n = 24), mean ROM (SD)	26.3 (28.5)	85.7 (42.7)	96.3 (46.0)	86.4 (39.5)	111.8 (51.3)	85.5	0.001
Hand digits (n = 137), mean ROM (SD)	32.1 (31.5)	36.4 (38.3)	73.1 (35.9)	81.0 (30.0)	88.3 (28.9)	56.2	0.001
Overall (n = 228), mean ROM (SD)	32.3 (31.3)	46.2 (39.9)	73.3 (36.4)	84.7 (31.8)	90.0 (32.2)	57.7	0.001
Joint level‡							
Total, n	117	115	105	109	105		
Upper extremity (n = 33), % (95% CI)	0 (0)	24 (11–48)	48 (26–82)	76 (49–111)	79 (51–115)	79%	0.001
Lower extremity (n = 15), % (95% CI)	0 (0)	71 (34–131)	64 (29–122)	100 (52–174)	100 (48–184)	100%	0.001
Hand (fingers) (n = 69), % (95% CI)	0 (0)	10 (5–22)	53 (37–74)	69 (50–93)	76 (56–101)	76%	0.001
Overall (n = 117), % (95% CI)	0 (0)	22 (14–29)	53 (44–63)	74 (66–83)	79 (71–87)	79%	0.001
Patient level: best joint§							
Total, n	44	42	38	40	38		
Best joint effectively improved, n (%)	—	15 (36)	25 (66)	33 (83)	36 (95)	95%	0.001
Patient level: worst joint¶							
Total, n	44	42	38	40	38		
Worst joint effectively improved, n (%)	—	12 (29)	17 (45)	24 (60)	26 (68)	68%	0.001

ROM data are expressed as a % of normal values (according to AAOS), rather than absolute ROM values due to different normal ROM values for the various joints. Mean differences displayed at 12 months. All other time intervals were statistically significant.

*For analyses at the level of planes of motion, the difference in ROM preoperatively versus postoperatively was tested for statistical significance using the paired *t* test. For analyses at joint level and patient level, the difference between effective surgery at different measurement occasions was tested with χ^2 tests to examine the long-term effects.

†Analysis of the mean ROM of planes of motion (ie, shoulder abduction, elbow extension, etc.) over time. ROM data values are expressed as a % of normal values (according to AAOS), rather than absolute ROM values due to different normal ROM values for the various joints.

‡Analysis of joints. Percentage of joint that had effective surgery. Effective is defined as all directions in a single joint showed an improvement of at least 25% or reached 100% of normal values.

§The number of patients who underwent effective surgery regarding their best joint (joints with most improvement). Effective is defined as an improvement of >25% or reached 100% of normal value. The best joint was defined as the joint with most improvement.

¶The number of patients who underwent effective surgery regarding worst joints (joints with least improvement). Effective is defined as an improvement of >25% or reached 100% of normal value. The worst joint was defined as the joint with least improvement.

AAOS, American Academy of Orthopedic Surgeon.

statistically significant improvement between all follow-up occasions (Table 5 and Fig. 2B).

Regarding age, at 1 and 3 months, it was predictive for effectiveness (Nagelkerke $R^2 = 11\%$ and 11%, respectively); a higher age was associated with a lower chance of effect on these measurement occasions ($P < 0.001$). After 6 months, the predictive power was less ($R^2 = 6\%$), and at 12 months, age was no longer a predictor of effect ($R^2 = 3.6\%$; $P = 0.11$). Thus, the improvement of ROM was equal in older patients but took longer. The number of days postinjury was only a significant additional predictor for effectiveness at 3 months ($R^2 = 0.22$; $P = 0.01$).

Patient Level

Examining each individual's most effectively treated joint, at 1-month follow-up, 15 of 42 patients had effectively improved in their best joint (35.7%; $P < 0.001$). At 12 months, 36 out of 38 patients had effectively improved (94.7%; $P < 0.001$) (Table 5 and Fig. 2C).

Examining each individual's least effectively treated joint, at 1-month follow-up, 12 out of 42 patients had effectively improved in their worst joints (28.6%; $P < 0.001$). At 12 months, 26 out of 38 patients had effectively improved (68.4%; $P < 0.001$) (Table 5 and Fig. 2C).

DISCUSSION

This is the first longitudinal study that assessed the effectiveness of contracture release surgery using ROM as a primary outcome measure and a clear statistical analysis. Our results demonstrate that in a rural setting in an LMIC, contracture release surgery could be performed safely and was effective in the vast majority of cases, resulting in significant improvement in ROM. Furthermore, it was effective on the long term. At 1 year, the follow-up rate was 86%, which was above expectations. A possible explanation is the effective collaboration among local and visiting doctors, hospital management, and patients.

The few other studies that evaluated the effectiveness of contracture release surgery used various different outcome measures, which makes the comparison of outcomes difficult.[19,35–42] A systematic review of this topic concluded that most of these previous studies did not describe the type of contracture, or failed to conduct a proper statistical analysis, which further limited the interpretation of res ults.[22,35,37–39,42] ROM was the most frequently used outcome measure.[28–33]

In accordance with earlier studies, our study showed that ROM using lateral goniometry is a feasible outcome measure to evaluate burn scar contractures.[31,32,44,45] However, we developed a new strategy to assess the effectiveness of contracture release surgery. The change in ROM was analyzed on 3 levels: planes of motion, joints, and patient level. This was done because a single plane of motion is not representative of the complete joint or patient.

In the present study, local flaps were most frequently applied in linear contractures, as opposed to broad contractures, in which FTGs were more frequently applied.

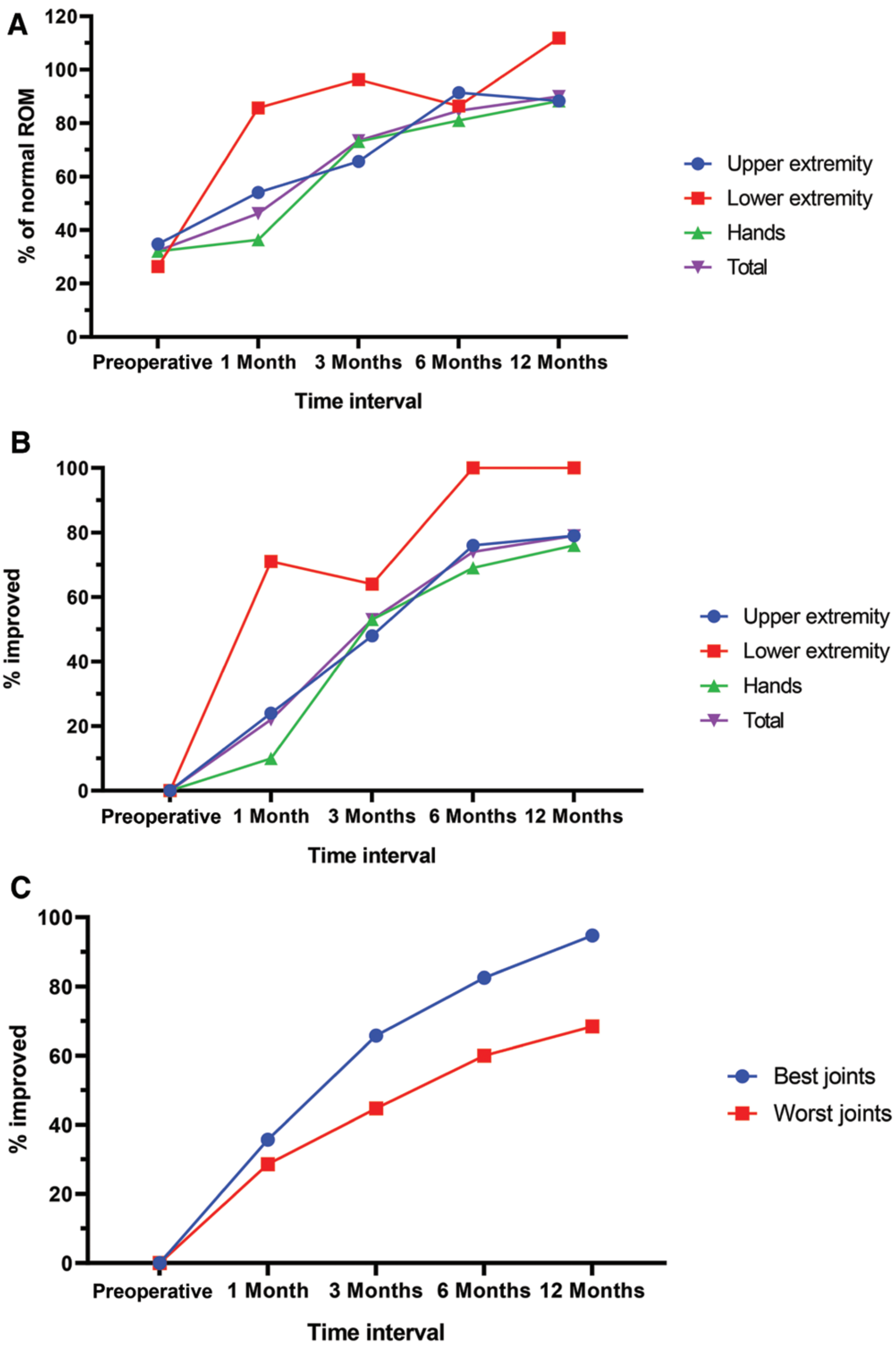

Fig. 2. The effectiveness of contracture release surgery at the level of planes of motion, joints and patients. A, The mean ROM over time of planes of motion (ie, shoulder abduction). The ROM data are indexed to % of normal ROM values rather than absolute ROM values to control for different normal ROM values of the various joints. Normal ROM values are retrieved from AAOS for the large joints[25] and from Richard et al[31] for the finger joints. B, The percentage of joints that effectively improved over time. Effective was defined as all planes of motion in a single joint showed an improvement of at least 25% or >100% of normal ROM values. C, The percentage of patients with an effectively improved joint over time. The best joint was defined as the joint with the most improvement. The worst joint was defined as the joint with the least improvement. Effective was defined as all planes of motion in a single joint showed an improvement of at least 25% or >100% of normal ROM values. AAOS indicates American Academy of Orthopedic Surgeons.

Table 6. The Type of Contracture and the Mean ROM over Time*

Type	N†	Preoperative	1 mo	3 mo	6 mo	12 mo	Difference pre/post
Linear	30	48%	60%	79%	97%	102%	55%
Diffuse	95	41%	50%	86%	90%	96%	55%
Broadband	103	20%	37%	57%	74%	81%	61%
Overall	228	33%	37%	46%	83%	90%	57%

*ROM is indexed to normal ROM values according to AAOS.
†Number of planes of motion measured.
AAOS, American Academy of Orthopedic Surgeon.

Interestingly, independent of the type of contracture, similar improvements in ROM were observed up to 1 year postoperatively. In our experience, local flaps are still preferred over FTGs when possible because they have less risk of tissue loss and provide a better quality of skin.[14–16] However, future studies with large cohorts are needed to determine which technique is more effective. Currently, our study suggests that surgical teams that are limited to 1 single surgical technique can effectively use this single technique when no other options are available.

The complication rate was high (52%). The majority of cases, however, were minor and were treated conservatively. This rate was substantially higher when compared with that in other studies, which reported complications of 0%,[38–40] 14.8%,[43] and 17%.[18] As our study was performed in a rural area of an LMIC, the higher rates may be partially explained by limitations in sterility or the nonavailability of wound dressing materials. Compared with studies conducted in similar settings, our complication rate also seems high, as such studies report complication rates between 15% and 56%.[28,46,47] The reason for that may be the strict registration of complications and longer follow-up period of our study. However, even with the complications, surgery was effective.

Our results were obtained in a setting of reconstructive surgery missions. Such missions, which provide patients with reconstructive surgical care in LMICs, are often criticized for their lack of quality of care or sustainability, although data to substantiate this are frequently not available.[26–28,48] A recent systematic review found 5 studies reporting on contracture release surgery performed during missions. The quality of these studies was indeed generally low, with short-term follow-up and none using ROM as an outcome measure.[28]

Strengthening surgical burn care for the 11 million burn victims annually, who live predominantly in LMICs, is desperately needed.[2] Our study demonstrates that there are opportunities for a collaborative model of surgical missions, which implement outcome research during follow-up. The combination of the high complication rate and the follow-up rate shows that providing follow-up after missions is important and feasible; therefore, a dedicated local team should be trained and supported. Adequate duration of follow-up would be 6 months, given that almost all complications and major improvements occurred in this period. Implementing outcome measurements in future surgical missions yields several advantages. It empowers local researchers and helps building an academic culture. The data can be used for quality improvements or can be reported to healthcare authorities and donors to improve accountability.

LIMITATIONS

This study has limitations. To determine whether surgery was effective or not, we chose an improvement of 25% of ROM or reaching 100% of the normal ROM value in all planes of motion in a single joint. This threshold is debatable; however, there are no previous studies to indicate when an operation was considered effective. The threshold of 25% was chosen because this seemed feasible and provided a substantial clinical improvement.

Our study used standard lateral goniometry to measure the ROM of the large joints. However, Parry et al. recently questioned this method in burn survivors.[31,44] Standard goniometry does not take into account the influence of adjacent joint positions and pliability of the skin when measuring motions. Future studies should consider using the method proposed by Parry et al.[44]

We are aware that this is a descriptive single-center study presenting patient outcomes of various techniques in various contractures. This has several disadvantages: it cannot show superiority of one technique over another, and generalizability is limited. However, our study was conducted in a clinical setting in rural Tanzania, focusing on improving patient outcomes, using a common dataset, and promoting quality improvements. As such, this pragmatic study provides urgently needed knowledge and evidence that is applicable to clinical practice in LMICs.[49] In addition, we suggest that our results can be used as a benchmark for future studies performed in similar settings.

CONCLUSIONS

Our study shows that contracture release surgery performed during surgical training missions in LMICs can be performed safely and is effective in the long term. Findings show that minor complications are common; however, the follow-up rate was high, joint flexibility improved significantly, and surgery was effective in the vast majority of patients.

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