Predictors of successful outcomes in first web space contracture release

Derek L. Masden · James P. Higgins

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Abstract

Background The success of a first web space contracture release is dependent on the individual parameters of thumb movement. Examining these parameters individually, it is possible to predict which components are important for providing successful outcomes.

Methods We identified all patients who underwent a first web space contracture release over 7 years. Patients were examined for the following: *radial abduction*—abduction of the thumb in the plane of the hand; *palmar abduction*—abduction of the thumb 90° to the plane of the hand; and *opposition*—distance between first and fifth palmar digital crease. Measurements were compared between affected and unaffected hands, and correlations between components and patients' Disability of the Arm, Shoulder, and Hand (DASH) scores were determined.

Results Thirty-nine patients underwent release of a first web space contracture; 11 agreed to participate. Opposition distance was significantly greater in the affected hand than in the unaffected hand. Grip strength was significantly lower in the affected hand. There were no significant differences in the radial or palmar abduction angles between hands. There was a moderate relationship between opposition distance and DASH score. There was no relationship between DASH and the other physical measurements.

Conclusions It is possible to obtain normal radial and palmar abduction angles after first web space release; however, success is not dependent on these absolute angles of abduction. Success of a release is related to the amount

of opposition obtained, and it is difficult to achieve equivalent opposition to the unaffected hand. Grip strength and opposition remain decreased following contracture release.

Keywords Contracture release · Grip strength · DASH · Thumb · Web space contracture

Background

First web space contracture is a debilitating condition that can severely impair patients' hand function. The resulting restricted thumb movement can dramatically affect one's ability to oppose their digits and have devastating impacts on both vocational and avocational pursuits. These contractures have many etiologies including congenital, traumatic, and post-surgical [14]. They can be treated by several modalities including skin grafts, z-plasties, local-regional flaps, free tissue transfer, intrinsic muscle releases, and trapeziectomy [1, 2, 19, 20]. The aim of these procedures is to increase the overall movement of the thumb and thereby improve hand function. Despite the various techniques for first web space contracture release, there is minimal published data that evaluate the overall outcome of these procedures or demonstrate a correlation between the parameters of a web space release to improved outcomes in hand function.

The Disability of the Arm, Shoulder, and Hand (DASH) outcome measure is an instrument that allows physicians to assess physical function and symptoms in patients with upper extremity disorders [11]. It has been repeatedly validated as a tool to measure hand and arm function in patients with disabilities and is the gold standard for upper extremity outcome measures [10, 18].

D. L. Masden · J. P. Higgins (✉)
The Curtis National Hand Center, Union Memorial Hospital,
3333 North Calvert Street, #200 Johnston Professional Building,
Baltimore, MD 21218, USA
e-mail: anne.mattson@medstar.net

We hypothesized that the success of a first web space contracture release could be predicted by evaluating the components of the release (the three axes in which the thumb moves about the hand) and how they correlate to patients' DASH outcome scores following a release.

Methods

We performed a retrospective review of patients who had undergone first web space contracture release by hand surgery faculty at our hand center over a 7-year period (2003–2009). Potential patients were identified by searching the electronic patient data base for any patient associated with CPT (14040) or ICD-9 codes (728.3 and 709.2) associated with web space contracture release.

Patient charts were obtained and reviewed for confirmation of preoperative diagnosis, pertinent preoperative data, and review of operative reports for procedure type and concomitant, previous, and subsequent hand surgical procedures. Once identified, only patients who had an isolated first web space contracture release were selected.

Patients were contacted via telephone call and asked to undergo a current physical evaluation, including fluoroscopic imaging, and complete a DASH outcome questionnaire. The dependent variables measured were the components of a first web space contracture release including radial abduction (thumb abduction in the same plane as the hand), palmar abduction (abduction of the thumb perpendicular to the plane of the hand), and opposition of the thumb (ability to sweep the thumb across the palm). Outcomes included DASH scores and grip strength.

Data points for both the affected (hand that underwent contracture release) and unaffected hand were collected in the following manner:

Radial abduction: the angle between intersecting lines of the first and third metacarpal as measured on an anteroposterior image of the hand under fluoroscopy under maximal abduction (Fig. 1).

Palmar abduction: the angle between intersecting lines of the first and third metacarpal as measured on a true lateral image of the hand under fluoroscopy under maximal abduction (Fig. 2).

Opposition: the distance, in millimeters, between the first and fifth metacarpal head, as measured between the first and fifth palmar digital crease under maximal opposition. For this measurement, higher oppositional distances demonstrate poor opposition. We chose to measure opposition because it was a measurable distance in all of these patients. In order to evaluate how the thumb sweeps across the palm, we attempted

to quantify how it approaches the ulnar side of the hand, and thus the small finger. Many of these patients had injuries to the distal part of the thumb, hardware preventing interphalangeal joint movement, or loss of the index finger, either secondary to trauma or as a method of contracture release. As such, the consistent anatomy between all of these patients that contributed to thumb opposition was the first and fifth metacarpal. In the majority of patients with first web space contractures, this can be measured.

DASH score: tabulated from each patient's DASH questionnaire using the method described from The DASH Outcome Measure website: <http://www.dash.iwh.on.ca/>.

Grip strength: measured using a dynamometer (Jamar; Sammons Preston Rolyan, Bolingbrook, IL) at position three with each patient seated with their elbow joint flexed at 90° and their forearm in the neutral position. The patient's wrist was maintained between 0–30° of dorsiflexion and 0–15° ulnar deviation. The average of three measurements was recorded. We chose grip strength as measured by the dynamometer because in order to exert full grip strength, the patient must be able to abduct their thumb as much as possible around the dynamometer to exert maximal force.

Exclusion criteria included patients unable to return for follow-up, patients with bilateral hand injuries, concomitant thumb amputation at or proximal to the nail fold, middle- or small-finger ray amputations or greater than three-digit amputations, and any patient unable to flatten their hand on a planar surface.

Statistical Analysis

Physical measurements were compared between affected and unaffected hands by a paired *t* test. Correlations between physical measurements and the DASH score were also determined, and regression computations and graphs were made using Statgraphics statistical software (version XV, StatPoint Technologies, Inc., Herndon, VA).

Results

We identified 39 patients over a 7-year period that underwent release of a first web space contracture. Of these, 11 agreed to participate, for a participation rate of 28%. Ten contractures were secondary to trauma and one was due to a neurologic insult. Mean time from insult to contracture release was 14.5 months and mean follow-up after release was 32.5 months. Techniques of contracture

Fig. 1 Measurements of radial abduction angles. The *right image* illustrates the utility of using the third metacarpal as the stable unit of the hand as several patients had index finger amputations related to their injury or reconstruction

release included eight z-plasties, five web space deepenings, and three free flaps. Five patients underwent a combination of the above.

The first comparisons examined were between affected and unaffected hands. The angle of radial abduction was decreased in the affected hand (51.5 ± 3.8) compared to the unaffected (54.8 ± 3.1); however, this was not found to be statistically significant ($p=0.35$). Similarly the angle of palmar abduction was decreased in the affected (53.6 ± 5.1) compared to the unaffected hand (54.5 ± 2.6), but this too was not significant ($p=0.88$). Opposition distance was greater in the affected than unaffected hand (25.7 ± 2.9 vs. 20.1 ± 1.6 mm; $p=0.04$), which correlates to decreased ability of thumb opposition. Grip strength was also decreased in the affected hand, and this was statistically significant as well (48.2 ± 7.2 vs. 89.2 ± 8.0 lb; $p=0.002$) (Table 1).

Next, the components of a contracture release were correlated with DASH scores to determine if there was any relationship between the dependent variables and the patient outcomes. There was no relationship between radial abduction and DASH scores (correlation coefficient= -0.29 ; $p=0.39$) or palmar abduction and DASH scores (correlation coefficient= -0.28 ; $p=0.4$). There was a moderate relation-

ship between opposition distance and DASH score (correlation coefficient= 0.59 ; $p=0.056$) (Fig. 3).

Conclusions

First web space contractures are devastating injuries that can impact hand function even after surgical correction. In this series, we found that even after contracture release, affected hands continued to have significantly worse opposition and functional grip strength when compared to a patient's contralateral unaffected hand. This is in contrast to both radial and palmar abduction. For these measurements, following contracture release, the patient's ability to abduct in these planes was no different than the unaffected hand. Thus, while normal radial and palmar abduction angles (when compared to the unaffected hand) are achievable with surgical correction of first web space contractures, it is difficult to achieve or approach normal limits of opposition with surgery.

To determine if there were predictors of successful outcomes in first web space contracture release, we examined the relationships between the components of a release and the patients' DASH scores. In this series, there

Fig. 2 Measurements of palmar abduction angles

Table 1 Relationship between first web space parameters of affected and unaffected hands

	Unaffected hand	Affected hand	<i>p</i> value
Radial abduction (degrees)	54.8±3.1	51.5±3.8	0.35
Palmar abduction (degrees)	54.5±2.6	53.6±5.1	0.88
Opposition distance (mm) ^a	20.1±1.6	25.7±2.9	0.04
Grip strength (kg)	89.2±8.0	48.2±7.2	0.002

^a First to fifth palmar digital crease

was no relationship between the postoperative angle of palmar or radial abduction and a patient's DASH outcome. Although it was possible to achieve “normal” abduction angles in the affected hands, this did not appear to be reflected in DASH scores. Therefore, success of a first web space contracture release (defined as improving DASH scores) is not dependent on an absolute angle of radial or palmar abduction. There was a moderate relationship between opposition and DASH scores. As the oppositional distance increased, signifying worsening opposition, so did the patient's functional outcome as measured by the DASH. The *p* value for this relationship does lie just outside of the 95% confidence interval, which is why we consider it a moderate relationship. Accordingly, success of a release is related to the amount of opposition in the hand following surgical correction of a contracture.

Discussion

Web space contractures can be destructive to hand function; this is especially true when they affect the first web space. If possible, prevention of first web space contractures should be the goal [6]. Although numerous dynamic splinting techniques have been described for prevention [4, 13], in reality, there is a need for good surgical correction of the contractures that do develop. When treating patients with first web space contractures, the hand

surgeon has many tools in their surgical armamentarium [5, 8, 16, 17]. These options enable the surgeon to mobilize the thumb and hopefully increase hand function. Thumb movement is complex and the goal of a contracture release should be to liberate the thumb sufficiently so that it can achieve near normal motion when compared to unaffected hands.

Multiple studies have evaluated and compared release techniques in terms of anatomical outcomes [3, 9]. However, to date, there have been no studies that have evaluated what components of thumb movement are most important for a successful contracture release in terms of clinical outcomes. Fan et al. reported on 11 patients who underwent recreation of the thumb with transplantation. The evaluation concentrated on how wide the thumb–index space became and patient performance on the Michigan Hand Outcome Questionnaire [7]. Although there is some data regarding functional outcomes, there is no correlation to how functional status corresponds to how the thumb moves around the axis of the hand. In 1988, Lewis et al. described outcomes as “good, satisfactory, or poor.” Although this study has a larger number of subjects, the evaluation was not objective, and all the web space releases were done in syndactyly patients and did not involve the thumb [15]. A smaller study that evaluated the technique of using external fixation for contracture release did look at “thumb abduction” both before and after intervention but did not define “thumb abduction” or how it was measured [1]. Although some studies tried to evaluate functional outcomes of contracture release, they did so to evaluate one technique of contracture release. Our study is not limited to any one type of contracture release, but focuses instead on the components of a release and evaluates what components of a release are most important for a patient's functional outcome.

We have analyzed the individual parameters of a first web space contracture release and evaluated their contribution toward clinical outcomes. In this study, we have shown that although it is possible to achieve normal radial and palmar abduction angles, this does not have a significant contribution to DASH outcomes score. Conversely, it is difficult to approach normal limits of opposition with surgical release of these contractures. This is clinically significant because after contracture release, the extent of opposition is most closely related to better DASH scores as shown in this series.

Fig. 3 Thumb opposition versus DASH score

These facts can provide the hand surgeon with valuable information and a surgical strategy. The three components of thumb motion identified in this study (radial abduction, palmar abduction, and opposition) can all be measured passively in the operating room during a release. With that in mind, the surgeon can tailor the operation to maximize these parameters, specifically opposition, to achieve improved function. The etiology of a patient's web space contracture, as well as the involvement of bone/joint and/or soft tissue components, will guide the hand surgeon in what type of release to perform. However, increased knowledge of which objective goals correlate with improved function can aid the surgeon to develop an operative plan to achieve them. The surgeon should feel comfortable in the knowledge that normal radial and palmar abduction angles are achievable. If the patient's main concern is the ability to increase the opening angle of the web space, as in to grip a larger dowel, there are data to support that this is achievable. For strict functional outcomes, however, attention should be paid to increasing the thumb's movement across the palm to aid in opposition.

There are limitations to this study. This study is both retrospective in nature and lacks any preoperative data with regard to anatomical measurements or DASH scores. At best, this allows us to draw conclusions about postoperative endpoints rather than any change in function that the patients may have obtained, which may be more significant for patient outcomes. For instance, although in this study, the success of a contracture release is not related to achieving normal abduction angles, it may be related to achieving a change in the abduction angles from the patients' preoperative values.

Additionally, the sample size was small. Our Center is a large tertiary care hand hospital with a referral area of many surrounding states. Many of the patients who had undergone web space release lived far from our hospital making follow-up difficult for them. Although there were 39 potential patients identified, a response rate of 28% severely limited the study population. We did not make comparisons between the different types of contracture releases. With the small sample size, there would not have been enough power for that statistical analysis.

Although our focus was to determine what range of motion endpoints resulted in the greatest subjective or objective improvement in function and not to determine what injuries or conditions resulted in maximal improvement of range of motion after release, we did not use carpometacarpophalangeal joint involvement as part of our exclusion criteria. Carpometacarpophalangeal joint involvement would be worth reviewing with future studies of thumb opposition.

We did not take handedness into account when evaluating the different components and outcomes of contracture release. Jensen et al. have previously studied first web

space angles and found no significant differences with respect to handedness [12]. To contend with these issues, a prospective study is underway, utilizing this model of contracture release evaluation. By studying this in a prospective manner, we can better evaluate the change in thumb function and how that contributes to improvement in patient function. Additional work should be done to address the method of contracture release and how that may impact patient outcomes.

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