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Long Term Outcomes of Huber Opposition Transfer for Augmenting Hypoplastic Thumb Function

Lindley B. Wall, MD, **Aalok Patel, BS**, **Summer Roberts, BS**, and **Charles A. Goldfarb, MD**

Investigation performed at Department of Orthopaedic Surgery, Washington University School of Medicine, Shriners Hospital for Children, St. Louis Missouri

Abstract

Purpose—This study was conducted to report the functional outcomes of the Huber opposition transfer (abductor digiti minimi muscle) in type II and IIIA hypoplastic thumbs.

Methods—Patients who had undergone a Huber opposition transfer with at least 5 years of follow-up were included in this study. There were 21 thumbs included; 12 returned for a detailed evaluation and 9 were included with a medical record review. Outcome measures included range of motion and pinch strength; PODCI and PROMIS scores were collected on those who could return. There were 15 type II and 6 IIIA thumbs.

Results—Range of motion was significantly less than normal for both the interphalangeal (IP) and metacarpophalangeal (MCP) joints. For the returning cohort, key and tripod pinch were 44% and 65% of normal. The median Kapandji score was 9 (range 6–10). PODCI scores were high for global, upper extremity function, happiness, and pain. PROMIS scores were similar to normal, except for parent reports of physical function. For all included patients, there was a revision surgery rate of 22%, primarily related to persistent instability.

Conclusions—The Huber opposition transfer for type II and IIIA thumbs was shown to provide good subjective outcomes, despite limited range of motion and strength, at a minimum 5-year follow-up.

Type of study/level of evidence—Therapeutic level IV.

Keywords

Opposition Transfer; Huber; Hypoplastic Thumb; Congenital

INTRODUCTION

The hypoplastic thumb is a congenital anomaly on the spectrum of radial longitudinal deficiency (1). Hypoplastic thumbs can present as isolated anomalies or can be associated

Corresponding Author: Lindley B. Wall, M.D., Assistant Professor Orthopaedic Surgery, Washington University School of Medicine, 660 South Euclid Avenue, Campus Box 8233, St. Louis, MO 63110, 314-362-9369, wallli@wudosis.wustl.edu.

with varying degrees of wrist and forearm deficiencies. Originally classified by Blauth, and subsequently modified by Buck-Gramko and Manske based on the degree of deficiency and stability, hypoplastic thumbs make accomplishing normal activities of daily living challenging (2,3,4). Various methods have been used to treat patients with hypoplastic thumbs in hopes of improving function. For patients with Type II or IIIA hypoplastic thumbs, with a stable carpometacarpal (CMC) joint, reconstruction includes strengthening thumb opposition and providing metacarpophalangeal joint stability. Patients without a stable CMC joint, those with Type IIIB, IV, or V thumb hypoplasia, are typically treated with pollicization (4,5,6).

The primary surgical options for powering thumb opposition are either transfer of the abductor digiti quinti (ADM) muscle or tendon transfer of the flexor digitorum superficialis (FDS) of the ring finger to power opposition. The use of the ADQ was first described by Huber in the 1920s and has been suggested to be superior to the FDS transfer (7). Littler and Cooley (1968) believed that the advantage of utilizing the ADQ was its replacement of an intrinsic hand muscle with another intrinsic muscle of similar strength rather than utilization of an extrinsic muscle such as the FDS (7). Additionally, it has been suggested that the appearance of the thenar eminence is also improved after an ADQ opposition transfer (8). Manske noted that the extensor digiti minimi can abduct the little finger as well, partially negating any loss of function associated with the use of the ADQ (9). However, while a few studies have examined outcomes in patients who have undergone the FDS transfer for thumb opposition (10,11,12), studies focusing on long-term outcomes for patients having undergone the ADQ transfer are sparse. Furthermore, the studies that do examine outcomes incorporate a larger, mixed cohort composed of congenital patients as well as patients having loss of opposition due to traumatic injury (8,13).

The purpose of this study was to assess the subjective and functional outcomes of patients with Type II or IIIA hypoplastic thumbs treated by the ADQ opposition transfer with a minimum 5-year follow-up.

MATERIALS AND METHODS

Institutional review board approval was obtained prior to commencement of this study. All patients who had undergone an ADQ opposition transfer at Shriners Children’s Hospital in Saint Louis and Saint Louis Children’s Hospital from 1990 to 2010 were identified, totaling 68 surgeries. Of the total, 37 surgeries were identified in patients with an ADQ opposition transfer for type II or IIIA hypoplastic thumbs, who were at least 5 years out from surgery and were younger than 18 years of age at the time of surgery. Patients who had opposition surgery for a pollicized digit or thumbs that were not clearly classified as type II or IIIA on chart review were excluded. The treating surgeon exclusively utilized the ADQ transfer rather than the FDS transfer, thus all patients in this cohort were treated with the same surgical strategy.

All eligible patients were contacted and invited to return to clinic for follow-up examination. Data analysis was divided into two groups; one group consisted of patients who were unable to be located or unwilling to return for follow-up and the other consisted of patients who

could be contacted and returned for evaluation. A minimum of 60 months' follow-up was needed for inclusion, both for patients who returned and those who were unable to return.

Medical records were reviewed for demographic data as well as information regarding comorbid diagnoses, concomitant surgeries, and secondary surgeries. Post-operative clinical data regarding thumb interphalangeal (IP) and metacarpophalangeal (MCP) joint motion, as well as assessment of stability of the radial and ulnar collateral ligaments, was collected. All post-operative data was collected from the most recent follow-up in the medical record for patients who were unable to be contacted or were unable to return to clinic. For patients that returned for follow-up, clinical assessment was performed by a fellowship-trained upper extremity physician or a hand certified occupational therapist. Assessments included thumb range of motion, Kapandji score (1–10), stability of the radial and ulnar collateral ligaments of the MCP joint, and key pinch and tripod pinch strength. A Kapandji score of 1 indicated opposition of the thumb to the radial side of the proximal phalanx of the index finger and a 10 indicated opposition to the distal palmar crease (14).

Parents and patients completed the Pediatric Outcomes Data Collection Instrument (PODCI) and Patient Reported Outcomes Measurement Information System (PROMIS) questionnaires, on an age appropriate basis (15, 16). The PROMIS modules were the Physical Function of the Upper Extremity, Pain Interference, Anxiety, Depressive Symptoms and Peer Relationship modules. The PROMIS questionnaires are standardized to a mean of 50 with a standard deviation of 10 where a higher t-score represents more of the concept being measured in each module. Visual Analog Scale (VAS) scores were obtained from both the parent and the patient for pain, appearance, and function on a 10- point scale. A low VAS score (0–1) represented no pain, perfect appearance, and no problem with function; a high VAS score (10) was extreme pain, severe deformity, and very limited function. VAS scores were recorded for each thumb if there had been bilateral operations. PODCI and PROMIS scores were recorded only once per individual, even with bilateral surgeries, as these questionnaires measured more general daily functions. Additionally, we requested patients who were unable to return to the office for follow-up to send photographs of the hand and thumb. We sent those patients three sample photos via email as examples to assess thumb opposition, by Kapandji scores, and appearance. A comparison to normal ROM, strength and questionnaire responses was done using values reported in the literature (15–19).

Twenty-one thumbs in 17 patients were identified as meeting the inclusion criteria for this study. These patients had a comprehensive medical record review. Of these, 9 patients with 11 thumbs returned to clinic for examination, and 1 patient completed subjective questionnaires by phone with photographs for range of motion assessment, forming a 10 patient (12 thumbs) follow-up group (Return Participant cohort). The remaining patients were unable to be contacted despite numerous search efforts to find current contact information (Non-Returning Participant cohort) and their data was compiled from the medical records.

Demographics

The median age at the time of surgery was 2.8 years (range 1.2–10.2 years). Average follow-up was 101 months (range 68–167). Thirteen patients had unilateral hypoplastic thumbs and

4 patients had bilateral hypoplastic thumbs. There were 15 type II, and 6 type IIIA. There were 10 left thumbs and 11 right thumbs. Nine surgeries were done on the dominant hand. Three children had vertebral anomaly, anal atresia, cardiac anomaly, trachea esophageal fistula, limb anomaly association (VACTERL), 1 had Klippel-Feil Syndrome, 1 had ventricular septal defects (VSD), 1 had scoliosis, 1 had cystic kidneys, 1 child had Ig Deficiency, and 1 had cutis marmorat teleangiectatica.

The median age at surgery of the 12 thumbs (10 patients) who did return for follow-up was 3.3 years (range 1.2–7.2 years) (Return Participant cohort). Eight patients had unilateral and 2 had bilateral type II or IIIA hypoplastic thumbs. There were 11 type II thumbs and 1 type IIIA. There were 11 type N or 0 radii and 1 type 2. Seven procedures were done on the right thumb and 5 on the left. All had a concomitant ulnar collateral ligament reefing of the MP joint. Five surgeries were performed on the dominant hand. One patient, who had bilateral surgeries, had scoliosis and 5 patients had concomitant forearm involvement as a medical comorbidity. One child had a VSD and one an Ig Deficiency.

The median age at surgery of the 9 thumbs (7 patients) who were not able to follow up was 2.8 years (range 1.2–10.2 years) (Non-Returning Participant cohort). 5 patients had unilateral and 2 had bilateral type II or IIIA thumbs. There were 5 type IIIA and 4 type 2 thumbs. There were 5 type N or 0 radii and 4 type 1. Five surgeries were done on the left and 4 on the right. Four of the operations were on the dominant hand. All the surgeries involved concomitant ulnar collateral reefing of the MCP joint and 2 involved carpal tunnel releases at the time of surgery. Three of these children had VACTERL, 1 had Klippel-Feil, 1 had a cystic kidney, and 1 had cutis marmorata teleangiectatica.

Statistical Methods

A two sample paired t-test was used for comparisons of patient vs parent determined VAS scores and range of motion. A P-value of less than 0.05 was considered statistically significant.

RESULTS

Returning Participants (N=10, 12 thumbs)

Range of motion at the IP and the MCP joints and radial and palmar abduction of the surgical thumb are shown in Tables 1 and 2. The arc of motion at the IP joint averaged 24 degrees and at the MCP joint 53 degrees. Palmar and radial abduction averaged 46 degrees and 36 degrees, respectively. Kapandji scores, used to determine thumb opposition ability, had a median of 9 (range 6–10). The average key pinch and tripod pinch strengths were 8 lbs and 7 lbs, respectively. Stability of the radial and ulnar collateral ligaments (RCL and UCL, respectively) was recorded for 7 of the thumbs. Four thumbs (57.1%) had stable RCLs and 3 (42.9%) of these also had stable UCLs. There was an increase in bulk of the thenar eminence in all patients and there was no loss of small finger abduction detected at follow-up.

VAS scores are summarized in Table 3. The parents scored the thumbs appearance worse than the patients. Patient and parent responses did not differ on pain or function VAS scores.

PODCI scores are summarized in Table 4. For those patients that had both a self-reported and a parent-reported score, there were no significant differences between patient- and parent-reported scores. PROMIS scores, summarized in Table 5, showed that patients and parents differed on the peer relations and physical functions modules. Parents reported poorer peer relations and physical function than the patients. Since the PROMIS questionnaire is not age dependent, all participants had this completed; while the PODCI for patients less than 11 years of age was only completed by the parent.

There were no reported complications with the primary surgeries. Two patients had secondary surgeries. One patient had an FDS transfer to augment the Huber opposition transfer and web space deepening with a carpal tunnel release. One patient had an arthrodesis at the IP joint for symptomatic instability, which had not been addressed at the primary surgery.

Non-returning Participants (n=7, 9 thumbs)

Range of motion at the IP and the metacarpophalangeal MCP joints is shown in Table 1. The average time between surgery and final follow-up was 94.9 months with a minimum of 60 months. The average arc of motion was 43 degrees and 55 degrees at the IP and MCP joints, respectively. Chart review showed that 3 surgical thumbs were recorded for stability of the RCL and UCL. Of the 3 for which data was available, 2 had stable RCLs and UCLs and 1 did not.

Three patients had secondary surgeries. One patient had an MCP joint arthrodesis, 1 had a web space deepening, and 1 required had revision reefing of the MCP joint ulnar collateral ligament. The two patients who had a secondary surgery on the MCP joint did have a MCP joint reefing at the index procedure.

Comparison to Normals

We compared range of motion in the Returning Participant group to normal individuals. There was significantly decreased flexion, extension and overall arc of motion at the IP joint after surgery. There was also decreased flexion at the MCP joint (Table 1). Radial abduction and the Kapandji score were also significantly decreased (Table 2). Finally, there was decreased pinch strength, with key pinch at 44% (range 26–65%) and tripod pinch at 65% (range 38–91%) of normal (17–19).

DISCUSSION

The hypoplastic thumb lacks opposition, thus limiting thumb function and impairing functions of daily activities. Patients who cannot position the thumb into opposition lack large object grasp and manipulation skills. Both the FDS and Huber opposition transfers have been used to augment this function in type 2 and 3A hypoplastic thumbs. While both techniques have been described in the literature (1–14), critical assessment of the clinical and functional outcomes of the Huber opposition transfer has been limited.

This current study reports the outcomes of a cohort of patients at a minimum follow-up of 5 years after the Huber opposition transfer. Critical assessment demonstrated decreased pinch

strength compared to normal values for this age group. These patients were also found to have decreased IP joint and MCP joint motion, though near normal palmar abduction and high Kapandji scores. Patient-rated outcome scores were encouraging with high PODCI scores for upper extremity function and happiness and PROMIS scores that were similar to normal population. Thus, one can conclude from these findings that the reconstructed thumb has decreased motion and strength, but yields good function and a patient-perceived satisfactory clinical outcome. In our cohort, there was a secondary surgery rate of 22% primarily to address instability.

The previous reports of the Huber opposition transfer also have yielded good results. Manske and McCarroll reported 20 out of 21 children had satisfactory results at a mean follow-up of 37 months, though there was no qualitative objective or subjective assessment (9). Ogino et al presented a cohort of 10 thumbs treated with a Huber opposition transfer (12) with good functional outcomes and improved cosmesis secondary to a modification of the original description of the technique by transferring the origin of the ADM to the palmaris tendon. Once again, however, there was no qualitative assessment of the outcomes. A more recent report by Upton et al, utilized a myocutaneous flap for the ADM transfer (13), and reported survival in all transfers, a key pinch of 40% of normal and limited motion, though no measurements were included. The authors reported that the thumbs were effective posts for prehension, although this was not quantified.

In comparison to the recent report of outcomes of FDS opposition transfer by Vuillermin et al (10), we found a similar decrease in range of motion compared to normal, but a slightly lower PODCI score for happiness and global function, though the scores were within the standard deviation of our results. Similar to these results, we found pinch strength to be lower than normals and our Kapandji score to be similar. Lastly, in contrast to the report by Vuillermin et al, we also included PROMIS scores and found that our cohort had near normal reports for pain, anxiety, depression, and peer relations.

We believe that the Huber opposition transfer yields satisfactory results, comparable to the FDS transfer. However, there are a few arguments against the use of the Huber opposition transfer. First, some surgeons are opposed to harvesting a muscle from the “normal”, non-hypoplastic, ulnar side of the hand, as it may weaken grasp. This concern is difficult to quantify based on the known hand weakness and the young age at primary surgery, however, the strength in Huber patients is similar to those after FDS transfer. Second, there is risk of vascular compromise to the ADM muscle, documented by Littler et al in 1963 (7), although not seen in this cohort. We have treated several other patients, not included in this study, with a palmarly abducted/contracted thumb with a finding of muscle necrosis requiring division of the muscle transfer. Lastly, and perhaps most importantly, the Huber does not have a lengthy tendon to allow for reconstruction of the unstable MP joint stability. Capsular reefing may be performed at the initial surgery, but 22% of our cohort required revision procedures, most often joint stabilizing procedures. While the primary treating surgeon for this cohort preferred the ADQ transfer, we now often utilize the FDS opposition transfer to address MCP joint instability that is commonly found in the hypoplastic thumb, to minimize need for revision surgery.

Our study is limited by the small number of patients returning for follow-up. While this limitation is a potential source of sample bias, the inclusion of patients by chart review provides additional data for consideration and supports the findings of the Returning Participant cohort. An additional limitation is the assessment of the strength of the opposition transfer. This is a difficult population to study secondary to a lack of cooperation and lack of size-appropriate assessment tools in this young age. Assessment of the growing child is also challenging and a true understanding of improved function from opposition transfers is difficult. We utilized a comparison against normal data to best define outcome. Overall, we believe that the Huber opposition transfer provides a functional opposition and reasonable strength for the hypoplastic thumb. However, patients and surgeons should be aware of a 22% revision rate primarily for joint instability.

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Table 1

Post-Operative Range of Motion.

	Flexion	SD	P Value to Normals	Extension	SD	P Value to Normals	Arc of Motion	SD	P Value to Normals
Returning Participants									
IP Joint	22	16	**<0.05**	−2	4	**<0.05**	24	17	**<0.05**
MCP Joint	42	10	**<0.05**	−10	7	0.86	53	15	0.04
Non – Returning Participants									
IP Joint	32	6	**<0.05**	−12	6	0.42	43	6	**<.05**
MCP Joint	41	11	**<0.05**	−14	19	0.58	55	24	0.27

IP = interphalangeal. MCP = metacarpophalangeal. SD = standard deviation.

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Table 2

Post-Operative Data for Returning Participants

	Mean	SD	P Value to Normals
Palmar Abduction	46	9	0.78
Radial Abduction	36	15	**<0.05**
Key Pinch (lbs)	8	3	**<0.05**
Tripod Pinch (lbs)	7	3	**<0.05**

SD = standard deviation

Table 3

VAS scores

VAS	N	Pain	SD	Deformity	SD	Function	SD
Patient	10	0.3	0.4	1.4	.6	1.4	3
Parent	8	0.2	0.4	4.6	3	4.3	3
P Value		0.40		**<.05**		0.18	

VAS = visual analogue scale. N = number. SD = standard deviation.

Table 4

PODCI Scores

PODCI	N	Upper Extremity (range)	SD	Pain (range)	SD	Happiness (range)	SD	Global Function (range)	SD
Patient	4	81 (50–96)	22	85 (56–100)	20	80 (70–100)	14	78 (60–97)	20
Parent	7	82 (50–96)	16	89 (74–100)	11	81 (50–100)	20	89 (69–96)	11

N = number. SD = standard deviation.

Table 5

PROMIS Scores

PROMIS	N	Pain (range)	SD	Anxiety (range)	SD	Depression (range)	SD	Peer Relations (range)	SD	Physical Function (range)	SD
Patient	8	44 (34–52)	6	46 (34–69)	12	44 (35–67)	11	52 (41–64)	9	47 (32–57)	9
Parent	7	45 (38–58)	8	47 (35–67)	14	46 (36–65)	13	47 (36–62)	11	39 (30–55)	9

N = number. SD = standard deviation.