



## Is Simultaneous Bilateral Pollicization a Viable Option?

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### Abstract

**Background:** We hypothesize that a simultaneous bilateral pollicization may have equivalent or better functional outcomes while subjecting the patient to the risks of only one anesthetic exposure and requiring only one rehabilitation period.

**Methods:** Through a retrospective chart review, we sought to compare the outcomes of patients who had undergone simultaneous bilateral thumb pollicization to those who had undergone unilateral procedures at a dedicated children's hospital. We identified eleven patients (22 hands) who underwent simultaneous bilateral pollicization and twelve patients (14 hands) who underwent unilateral or staged bilateral pollicization. Functional data was obtained as well as patient and parent satisfaction scores. We also obtained data on comorbidities, surgical time, and complications. Data was compared by assessing standard deviation and calculating significance with student's T-test.

**Results:** There were no adverse outcomes related to prolonged surgical time. Average time between surgery and functional evaluation was 60 months (Range 25 months to 12 years). Average surgical time was 337 minutes and 222 minutes for the bilateral and unilateral patients, respectively. There was no significant difference in functional outcome between the unilateral and simultaneous bilateral pollicizations ( $P=0.195$ ). When compared to age adjusted normal means, pollicized patients performed significantly worse in all modalities ( $P=0.0001$ ), as has been reported previously in the literature.

**Conclusions:** With similar functional outcomes and total surgical time averaging under 6 hours for bilateral simultaneous pollicization, we believe the benefits of limiting surgery to one anesthetic exposure and one period of rehabilitation outweigh the risks of a longer surgery.

### Introduction

Thumb hypoplasia accounts for nearly 16% of all congenital hand malformations and is bilateral in 12-63% of patient [1-7]. The role of the thumb in the function of the hand cannot be underestimated. Without a thumb, it is estimated that the hand loses 40% of its function [1]. Children born with hypoplastic thumbs become quite adept at using the remaining digits in side-to-side pinch for functional activities but large object grasp is difficult [2, 8-11]. Congenital thumb hypoplasia can also have profound effects on the cosmetic appearance of the hand and on the self-image of the child.

The most commonly used classification scheme to describe thumb hypoplasia was introduced by Blauth in 1967 [3] and modified by Buck-Gramcko to include five grades reflecting the progression of deficiency. Type IIIB, IV, and V thumbs are most commonly treated by ablation and pollicization given the lack of sufficient underlying structures to support reconstruction [4, 6]. Alternative reconstructive options such as free vascularized metatarsophalangeal joint transfer, arthrodesis, and allograft have been described for Type IIIB thumbs [7, 8].

To our knowledge, the topic of simultaneous bilateral pollicization has not specifically been addressed in the literature. Historically, bilateral thumb hypoplasia has been addressed in separate surgical settings, as it was believed that simultaneous bilateral pollicization was too much surgery for a young patient to endure in one setting. Modern pediatric anesthesia has become safer and longer surgeries are becoming commonplace. We hypothesize that simultaneous bilateral pollicization is safe, limits the anesthesia exposure to one induction, is more cost effective, and may be less psychologically taxing for the children and the parents than undergoing two separate pollicization procedures.

Functional data following pollicization is difficult to accurately capture, especially in young children, and there is no consensus on how best to assess outcome of pollicization. Authors have relied heavily on subjective recall to test strength and range of motion to determine a measure of functionality [10, 12, 13]. In addition to several other testing modalities, we have chosen the Humphry-Jewell In-Hand Manipulation Test as a method to assess function in children for whom pollicization has been performed [14, 15]. To our knowledge, no other study has utilized this assay to evaluate children with pollicized digits and we would therefore like to present our preliminary functional data.

### Materials and Methods

#### Chart Review

After obtaining IRB approval, a retrospective chart review was carried out on pediatric patients who had undergone pollicization of

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Received: December 18, 2017; Accepted: January 06, 2017; Published: January 08, 2018.

the index finger at a single institution between 1997-2014. To be included in the study, the children must have had pollicization performed by a single surgeon (the senior author, MS). Twenty-two patients met this criteria with 11 patients (22 hands) undergoing simultaneous bilateral pollicization and 12 patients (14 hands) undergoing unilateral pollicization. Two of the 12 patients undergoing unilateral procedures were affected bilaterally and underwent each pollicization as separate staged procedures.

### Functional Data

A single experienced pediatric occupational therapist (JB) completed the functional examination of each patient. Informed consent was signed by the parent or guardian before initiation of functional testing. The Humphry-Jewell In-Hand Manipulation and Complex Activity Items was used as an observation protocol to assess function hand skills [14, 15]. This assay is composed of eight in-hand tasks along with five complex activities for which age-adjusted means have been previously determined [Table 1]. The Child Health Assessment Questionnaire (CHAQ) was used as a disability measure. The CHAQ described by Singh et al as a modification of the original HAQ [16]. It is a measure of the impact of the patient's disease/disability on activities of daily living and yields a number from 0 to 3, where 0 signifies no disability and 3 signifies severe disability. Pinch and grip strength were measured using standard pinch (Baseline Hydraulic Pinch, FEI, White Plains, New York) and grip dynamometers (Hydraulic Hand Dynamometer, Preston, Jackson, MI). Grip and pinch strength Z-scores were calculated using normative data from Mathiowetz et al. for ages 6-19 years. Total passive range of motion with a theoretical maximum of 260° in a normal index finger and 185° in a normal thumb [17, 18] were evaluated. Assessment of stability of the thumb metacarpophalangeal joint and determination of the ability to touch the pad of the thumb to the index finger were also recorded. Visual Analog Scale scores were assessed for both the patients and the parents and recorded.

Operative data obtained including time under anesthesia, operating time, and tourniquet time for bilateral and unilateral pollicizations were compared using the student's t-test. Functional data from unilateral and bilateral patients was compared to established norms for the functional assay as well as for grip and pinch [15, 19]. Statistical analysis was carried out with the student's t-test.

### Operative Technique

The operative technique utilized for pollicization has been previously well described, notably by Buck-Gramcko [4, 11]. A racket type incision is made over the index finger. Dorsal veins are carefully preserved and the dissection is carried volarly where the digital bundles are isolated. The radial digital artery to the middle finger and the ulnar digital artery to the index finger are carefully delineated and the radial artery to the middle finger is ligated with 9.0 nylon. The dorsal and volar interossei to the index finger are identified and the tendinous portion transected and tagged with suture. The intermetacarpal ligament is then cut. The metacarpal head is transected and the metacarpal shaft is removed. The extensor tendons (extensor indices proprius and extensor comminis) are identified and transected at the level of the metacarpophalangeal joint. An incision is then made distal to the PIP joint and the lateral bands thus exposed. The A1 and A2 pulleys are transected to avoid tethering of the flexor tendons [20].

The metacarpal head is flexed 90 degrees in order to hyperextend the MCPJ and avoid hyperextension deformity of the newly created thumb and then secured with nonabsorbable suture after recession of the index finger. The index finger is rotated about 130-140 degrees to obtain optimal functional positioning. The extensor indicis proprius tendon is shortened and sutured to the distal extensor tendon communis to create an extensor pollicis longus. The extensor communis is inserted at the radial base of the proximal phalanx in order to create an abductor pollicis longus. The previously tagged volar interosseous muscle is sutured to the ulnar lateral band to form an adductor of the new thumb and the dorsal interosseous muscle is sutured to the radial

**Table 1:** Humphry and Jewell Evaluation.

Category	Assessment
<b>Rotation</b>	Number of times out of ten observations, a child spontaneously rotates an object correctly in their hand to perform a task with a pen (5 tasks) or bead peg (5 tasks). Score: 0-10.
<b>Translation in Palm (TINP)</b>	Ability of child to translate objects from fingers into the palm and hold them. Average subscore number of objects that could be held in the palm (3 lima beans, 5 nickels, and 5 bead pegs) Score from 0-13.
<b>Translation out of Palm (TOUTP)</b>	Child's ability to translate objects from the palm into the fingers and hold them. Average subscore number of objects that could be held in the fingers (3 lima beans, 5 nickels, and 5 bead pegs). Score from 0-13.
<b>Functional Score</b>	Series of complex functional tasks such as scooping with a spoon, feeding cookie monster, grasping spoon, buttoning/unbuttoning shirt, or coloring in a triangle. Score from 0-50.

The observation research protocol reliability has a previously determined level of greater than 0.70 for all components<sup>14</sup>.

lateral band to form an abductor. The flexor is not shortened, but is left to contract on its own. The skin flaps are then sutured with meticulous care taken to recreate an anatomic appearing web space. If insufficient skin exists for the closure of the flaps, then full thickness skin graft is taken either from the ablated thumb or from the wrist crease.

## Results

Of the patients who met the inclusion criteria, 12 patients (14 hands) underwent unilateral pollicization (two had the procedure done bilaterally but at separate settings), and 11 patients (22 hands) underwent simultaneous bilateral pollicizations. The average age at surgery for the unilateral and bilateral groups was 25 months old (range 12-36 months) and 28 months old (range 12-67 months), respectively with no statistically significant difference ( $p=0.28$ ). Average follow-up for all patients was 60 months (Range 25 months to 12 years). Average follow up for the unilateral group was 42 months (range 24-96) and for the bilateral group was 51 months (range 25 months to 12 years) with no statistically significant difference ( $p=0.17$ ).

Out of the 14 thumbs that underwent unilateral pollicization, five had grade IV hypoplasia and the remaining nine were grade V. Out of the 22 thumbs that underwent bilateral pollicization, four thumbs had grade IIIB hypoplasia, five were grade IV, nine were grade V, two were five fingered hands, and two were triphalangeal thumbs [Figure 1].



**Figure 1:** A patient prior to pollicization with type 5 thumb hypoplasia of the righthand.

A considerable association with other congenital abnormalities was seen in our patient population. Only five of the patients had isolated thumb hypoplasia, two in the unilateral group and three in the bilateral group. Three of the patients had a diagnosis of VACTERL syndrome, one in the bilateral group and two in the unilateral group. Three patients had VATER syndrome in the unilateral group. Other associated findings in the unilateral group were CHARGE syndrome, tracheo-esophageal fistula, ALL, torticollis, and Klippel-Feil syndrome. Along with the VACTERL syndrome, patients in the bilateral group were also diagnosed with fetal alcohol syndrome, bilateral eye colobomas, and one with an unknown syndromic condition.

Local malformations were also common and included radial club hand in four patients in the unilateral group and in ten extremities of the bilateral group. Other conditions in the unilateral group included

camptodactyly, syndactyly, radioulnar synostosis, and constriction band. Local malformations in the bilateral group included camptodactyly, clinodactyly, hypoplastic webspaces, and radioulnar synostosis.

Complications occurred in 14 of the subjects requiring 12 surgical procedures to address the complications. The most common complication was web space contracture, followed by malrotation. There was one flexion contracture, and one case of triggering of the thumb after pollicization. The bilateral group required 8 surgical procedures to correct complications and the unilateral group required 4 surgical procedures to correct complications.

Average time under anesthesia was 337 minutes for simultaneous bilateral pollicization and 222 minutes for unilateral pollicization. Tourniquet time for each hand was not significantly different with 107 minutes each for bilaterals and 101 minutes for unilaterals ( $p=0.25$ ). All patients regardless of group had one single overnight stay postoperatively.

The Humphry Jewell Scores for each study subject were compared to normative data based on age. There was no statistical difference in any parameter of functional performance between unilateral and bilateral patients. When comparing pollicized thumbs to the normative data, however, the functional performance was statistically different in all functions assessed [Table 2].

Mean CHAQ score was 0.87 for the unilateral group and 1.03 for the bilateral group ( $p=0.3$ ), signifying mild disability. The mean patient visual analog scale for satisfaction (1-10) for the unilateral and bilateral groups was 7.9 and 7.3 respectively ( $p=0.19$ ) and 8.7 and 8.2 respectively for the parents ( $p=0.49$ ) [Figures 2 and 3].

## Discussion

Although simultaneous bilateral pollicization required approximately twice the operative and anesthetic time in one setting (337 versus 222 min), performing the procedures simultaneously did limit the anesthesia to one exposure. There was no significant difference found between the mean tourniquet times for bilateral simultaneous and unilateral pollicizations, which is an indicator that physician fatigue was not a significant factor and allowed the bilateral procedures to be individually done in the same amount of time. A significant benefit of the simultaneous procedure was the reduction in the number of hospitalizations as this was reduced in half by performing the needed operations in one setting and the hospital stay was no longer for the bilateral vs. unilateral patients. Anecdotally, the parents of children whose surgeries were performed simultaneously expressed satisfaction that the procedures could be done in one setting so that they could “get it over with and get on with life”, and that the parents were required to take less time off of work when done simultaneously.

The total cost is difficult to ascertain due to the wide range of payers. The cost of simultaneous bilateral pollicization compared to staged bilateral pollicization is likely less, given that only one surgery is required with one hospitalization and less therapy overall. The parents are thus required to take less time off of work, further lessening the economic impact for the family.

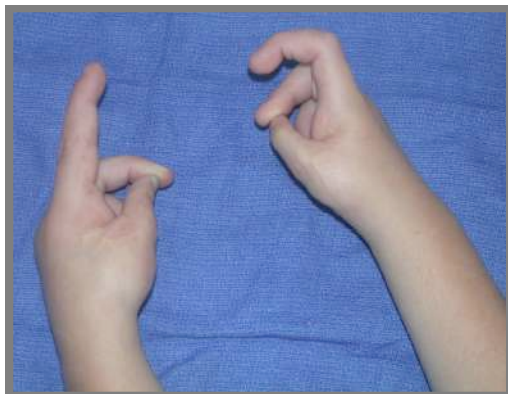
The observations for our group of patients were similar to those that have previously been reported in the literature. As has been described in the literature, our patients had a high percentage of associated syndromes and anomalies including a large number with radial club hand and VACTERL [5, 7, 9, 16]. Our overall distribution of classifications of deficiency, aside from the preponderance of IIIB thumbs in the bilateral group, was also similar to that previously

**Table 2:** Humphry-Jewell Assay

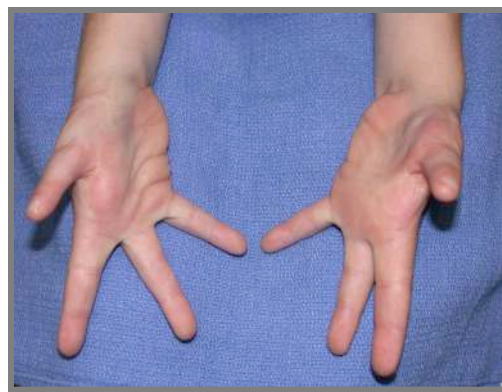
Case	Avg Age at Funct. Eval. (years)	Rotation [Norm]	TINP* [Norm]	TOUTP* [Norm]	Function [Norm]	Grip [norm]	Pinch
Unilateral	7.15	5.8 [4.7]	4.8 [12.9]	3.6 [9.6]	37.2 [27.4]	7.0[35]	2.0 [7.7]
Simultaneous Bilateral	5.89	6.9 [4.1]	7.7 [12.7]	6.6 [7.8]	36.6 [24.1]	8.8[32.2]	2.7 [8.1]
T test unilateral vs bilateral		p=0.17	p=0.09	p=0.06	p=0.19	p=.32	p=0.19
T test all vs norm		p<0.001	p< 0.001	p<0.001	p<0.001	p<0.001	p<0.001

TINP-Translation into palm

TOUTP-Translation out of palm



**Figure 2:** A patient after simultaneous bilateral pollicization.



**Figure 3:** A patient showing range of motion after simultaneous bilateral pollicization.

reported in the literature with Type V being the most common, followed by Type IV and Type III [5, 6, 9]. Sykes et al. found a reoperation rate of 36%, which was comparable to our rate of 32% [10].

Most studies have found substantially decreased grip and pinch strength in the operative hand in these patients. Staines et al. in comparing the operated hand with the contralateral normal hand found on the affected extremity grip strength that was 36% and a pinch strength that was 50% of the normal side [26]. Likewise, Kozin et al. also compared the affected hand to the contralateral normal hand and found grip strength that was 67% and a pinch that was 56% of the normal side [27]. Manske et al. recognizing that the opposite “normal” hand is not always normal in these children and may also be affected by varying degrees of hypoplasia [28], instead compared the affected hands to norms. They found that the average grip strength was 21% of standard values and that the tip pinch was 26% of standard [16]. This is more along par with our results, which were also compared to norms and showed average grip strength that was 24% and pinch that was 32% of normal values.

Few studies have examined functional data in these patients. The Percival scoring system has been used in the literature to assess these patients but includes only pinch, opposition, grasp, mobility, sensibility and cosmesis as separate tested outcomes and does not measure competence at complex tasks [10, 13, 29]. Manske et al. had their patients perform an objective standardized timed-activity test as defined by Jebsen and modified by Taylor. They found that the children took an average of 22% longer to complete the tasks than normal subjects and also observed that these children did better at manipulating larger objects [16]. Staines et al. also used the Jebsen functional test, although instead of comparing to published norms, they

functional test, although instead of comparing to published norms, they compared to the contralateral unaffected hand. They found no overall statistically significant difference between the performances of the two hands except for checker-stacking, page-turning, and light lifting, for which the affected hand performed worse. Staines et al. also used a timed Functional Dexterity Test in their study to evaluate in-hand manipulation and found the operated hand performed worse than the nonoperated hand. Interestingly, they also found that the nonaffected hand also fared worse than published normal data, substantiating the assertion that the contralateral extremity in children with unilateral thumb hypoplasia is not necessarily normal [26].

In a prior study involving current authors, Lightdale- Miric et al. a novel strength and dexterity test was used in order to quantify finger to thumb dexterity as well as other strength and functional measures. Their findings support other studies in regards to strength and functional outcomes. Nearly all the study subjects were able to achieve close to normal control over low-magnitude fingertip forces. They concluded that children who undergo early pollicization are able to use altered control strategies in order to achieve dexterity despite low strength and motor skills [27].

Given the historically relatively poor performance of the affected hand with individual tasks, it was no surprise that the children performed poorly with the in-hand manipulation skills, specifically the palm to finger and finger to palm object transference skills. What was surprising was the high performance scores that the children displayed with the complex skills in comparison to published normal means. This coincides and supports the findings in the prior Lightdale-Miric et al. study in that children who have undergone early pollicization find ways to adapt and to perform necessary skills by



pollicization find ways to adapt and to perform necessary skills by using alternative strategies, such as stabilizing objects against a table or their body. It is known that children with congenital hand differences find ways to adapt and to perform necessary skills by using alternate devices, such as side-to-side finger pinch. The results of this functional study that involves complex activities underscore the importance of looking at function in its entirety and not as a sum of individually measured simple actions. This may in part explain the disparity between the positive subjective parental and patient evaluations attributed to the operative hand and the substandard strength and function that has been previously reported [12, 30]. These preliminary results are intriguing.

## Conclusion

For the experienced pediatric hand surgeon, simultaneous bilateral pollicization is a feasible and safe alternative to performing the procedures in a staged fashion. Functional evaluation for children who have undergone pollicization is difficult especially in this age group and we have introduced a previously unused method for doing so. The advantages to simultaneous bilateral pollicization include fewer anesthetic exposures, decreased time spent in the hospital, lower cost and less time off work for the parents.

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