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Thumb reconstruction without formal pollicization in mirror hand deformity: a series of four cases

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Abstract
Thumb reconstruction in mirror hands is usually done by pollicization. However, objective pinch strength and power grip data in mirror hands following pollicization are lacking. Alternative thumb reconstruction techniques include doing nothing, rotation osteotomy or syndactylization of the radial digits. In this article, we report a series of four cases of mirror hand deformity where the thumb was not reconstructed by formal pollicization. Two cases had non-classic mirror hand deformity (the forearm contained a radius and an ulna) and the other two had classic ulnar dimelia. In all cases, thumb reconstruction was done by keeping one of the radial fingers in place (without pollicization) as the new thumb; and then (if required) performing a secondary osteotomy procedure to rotate the new thumb into pronation. The four cases were recalled back to the clinic for functional assessment at ages 20 years, 5 years, 4 years and 2 years, respectively. The overall hand function was considered 'fair' in the case with concurrent unique features, and was considered 'excellent' in the other three cases. It was concluded that the technique of thumb reconstruction used in the current series is an acceptable option. However, objective measurements, especially with regards to pinch strength and power grip, need to be compared with the pollicization technique.

Keywords
Thumb, reconstruction, mirror hand, ulnar dimelia

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Introduction

Mirror hand deformity is a rare congenital deformity in which there is an absent thumb as well as mirror image duplication of the fingers; and there is usually a deep cleft separating the ulnar fingers from the radial ones. Al-Qattan et al. (1998) classified the mirror hand deformity into two main types according to the bones of the forearm. In the classic type (also known as ulnar dimelia), the forearm contains two ulnae. In the non-classic type the forearm contains a radius and one or two ulnae.

One of the main goals of surgical correction of the mirror hand deformity is thumb reconstruction, which is usually done by pollicization of one of the radial digits.

In this article, a series of four cases of mirror hand deformity is reported. In all cases, thumb reconstruction was done by keeping one of the radial fingers in place (without pollicization) as the new thumb, and then (if required) performing a secondary osteotomy procedure to rotate the new thumb into pronation. Functional assessment of the limb with particular attention to the thumb is reported.

Patients and methods

The preoperative clinical and radiological features of all cases of mirror hand deformity treated by the senior author over the last 20 years were reviewed. Classification of the deformity was done as per Al-Qattan's classification (1998). The surgical procedures performed as well as their complications were reviewed. Patients were recalled back to the clinic for functional assessment of the affected limb with

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particular attention to thumb function. The following was documented: overall functional use of the hand in daily activities (subjectively rated by the patients/parents as excellent, good, fair or poor); ability to hold a key and a large object, ability to pick up a coin, ability to oppose the thumb to the remaining fingers, ability to hold a pen between the thumb and index finger, and the range of motion of limb joints. In older children and adults, pinch and power grips of the affected and unaffected hands were measured using a pinch gauge and a dynamometer (Jackson, MI, USA), respectively. The cosmetic appearance of the new thumb (with regards to length and position) was subjectively rated as good, acceptable or poor. Finally, the overall satisfaction was also subjectively rated as satisfied, somewhat satisfied and not satisfied.

This work was approved by the Fast-Track Ethics Review committee for CMED-304 Course at King Saud University.

Results

Over a 20-year period (1993–2012 inclusive), the senior author treated four cases of mirror hand deformity.

Preoperative clinical and radiological features (Table 1)

All four cases (Figures 1(a)–(b), 2(a)–(d), 3(a)–(c) and 4(a)–(c)) had the classic features of the mirror hand deformity: There were 7–8 fingers (with a deep cleft in the centre) and the thumb was absent. All cases were non-syndromic and unilateral: the left hand was affected in one case (Case 2) and the right hand was affected in the remaining three cases. Two cases (Cases 1 and 2) were non classic (i.e. the forearm had a radius and an ulnar) and the other two cases were classic (i.e. the forearm had two ulnae) mirror hand deformities as per Al-Qattan classification (1998). Case 3 had two additional features: the volar creases of the fingers and palm were poorly defined (and this was associated with restricted finger range of motion in the arc of flexion and lack of active abduction/adduction of the fingers), and shoulder dislocation. All cases had similar features at the wrist, forearm and elbow regarding posture and restriction in range of motion as shown in Table 1.

Management and surgical procedures

All cases had splinting of the wrist to treat the flexion deformity soon after birth. All surgical procedures were completed before 20 months of age. Table 2 shows a summary of the surgical procedures. No pollicizations were done. Instead, thumb reconstruction was done by keeping one of the radial fingers as the new thumb. A secondary osteotomy procedure was felt to be needed to rotate the new thumb into more pronation in all cases, but performed in only Cases 1, 2, and 3. A secondary osteotomy procedure was also offered to Case 4 but the parents refused because they thought that the new thumb had attained a more pronated position spontaneously and the child was using the hand well. Splinting improved the flexion deformity at the wrist in the two cases with the non-classic deformity (Cases 1 and 2); while surgery was required to improve wrist extension in the other two cases with classic mirror hands (Cases 3 and 4). Surgery at the elbow was required in Cases 2 and 4. No surgery is currently planned for the shoulder in Case 3. No postoperative complications occurred in any of the patients.

Functional assessment at final follow-up

Functional assessment was done for all four cases at ages 20 years, 5 years, 4 years and 2 years, respectively (Figures 1(c)–(h), 2(e) and (f), 3(d) and (e) and 4(d) and (e)). The affected hand was the non-dominant hand in all cases. The overall functional use of the hand in daily activities was rated as excellent by the patient in Case 1 and the parents in Cases 2 and 4. The child with poor range of motion of all digits and concurrent shoulder deformity (Case 3) mainly used the affected hand as a 'helper' and hence, the overall function was rated as 'fair'. On testing, however, all patients could hold a key and a large object easily. The ability to pick up a coin was easy in Cases 1, 2 and 4 and difficult in Case 3. The new thumb could reach the tip of the little fingers in Cases 1, 2 and 4 and the tip of the ring finger in Case 3. The ability to hold a pen between the thumb and index was only possible in Cases 1, 2, and 4. The range of motion of limb joints as well as pinch/power grips are shown in Tables 3 and 4, respectively. The cosmetic appearance was rated by the patient/parents as 'good' in one case (Case 1), and 'acceptable' in the remaining three cases. The reconstructed thumb in the latter three cases appeared 'too long', but the length was acceptable in the first case because of excision of the delta middle phalanx. Finally the overall satisfaction was subjectively rated as 'satisfied' in Cases 1, 2 and 4 and 'somewhat satisfied' in Case 3.

Discussion

Our review of the literature revealed that most authors have reconstructed the thumb in the mirror hand

Table 1. Preoperative clinical and radiological features.

Case number	The hand	The wrist	The forearm	The elbow	The shoulder
1*	Seven metacarpals and eight fingers with a deep cleft between the ulnar four and radial four fingers. The radial four fingers were smaller. The first two digits had syndactyly. The fourth digit had clinodactyly and a delta middle phalanx. All fingers had good ROM	The hand is held in severe flexion and radial deviation which was not passively correctable (no active extension)	One radius and one ulna, with 10° of forearm rotation	Limited ROM (0-20°)	Normal
2	Identical to Case 1 but there was no clinodactyly in any of the digits	The hand is held in mild flexion and radial deviation which is passively correctable (no active extension)	Identical to Case 1	Zero ROM	Normal
3	Seven metacarpals and seven fingers, with a deep cleft between the third and fourth fingers. The first and seventh fingers were hypoplastic. All fingers had restricted ROM in the arc of flexion and lack of abduction/adduction. The volar creases were poorly defined	The hand is held in severe flexion but mild radial deviation, and both deformities were passively correctable (no active extension)	Two ulnae with no active or passive forearm rotation	Limited ROM (20–50°)	Inferior dislocation of the shoulder with hypoplastic glenoid. Abduction to 90°. External rotation ROM = 20°
4	Eight metacarpals and eight fingers; with a deep cleft between the fourth and fifth fingers. The radial four fingers were slightly hypoplastic. All fingers had good ROM	Identical Case 3	Identical to Case 3	Zero ROM	Normal

*The clinical features of Case 1 were previously reported (Al-Qattan et al., 1998).
ROM, range of motion.
Note that fingers are numbered from radial to ulnar.

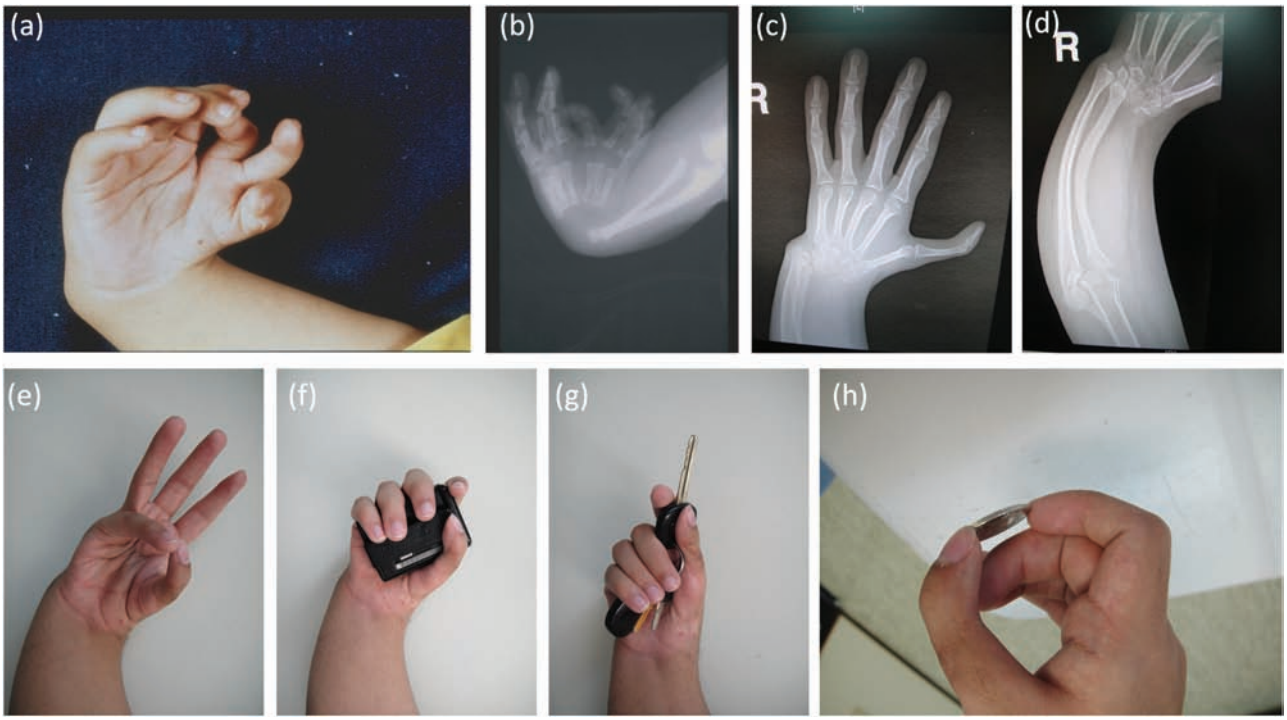

Figure 1. Case 1: (a) and (b) preoperative clinical and radiological appearance (reproduced with permission from Al-Qattan et al. (1998)); (c)–(h) postoperative radiological and clinical functional views at age 20 years.

Figure 2. Case 2: (a)–(d) preoperative clinical and radiological appearance; (e) the secondary osteotomy procedure; (f) the healed osteotomy.

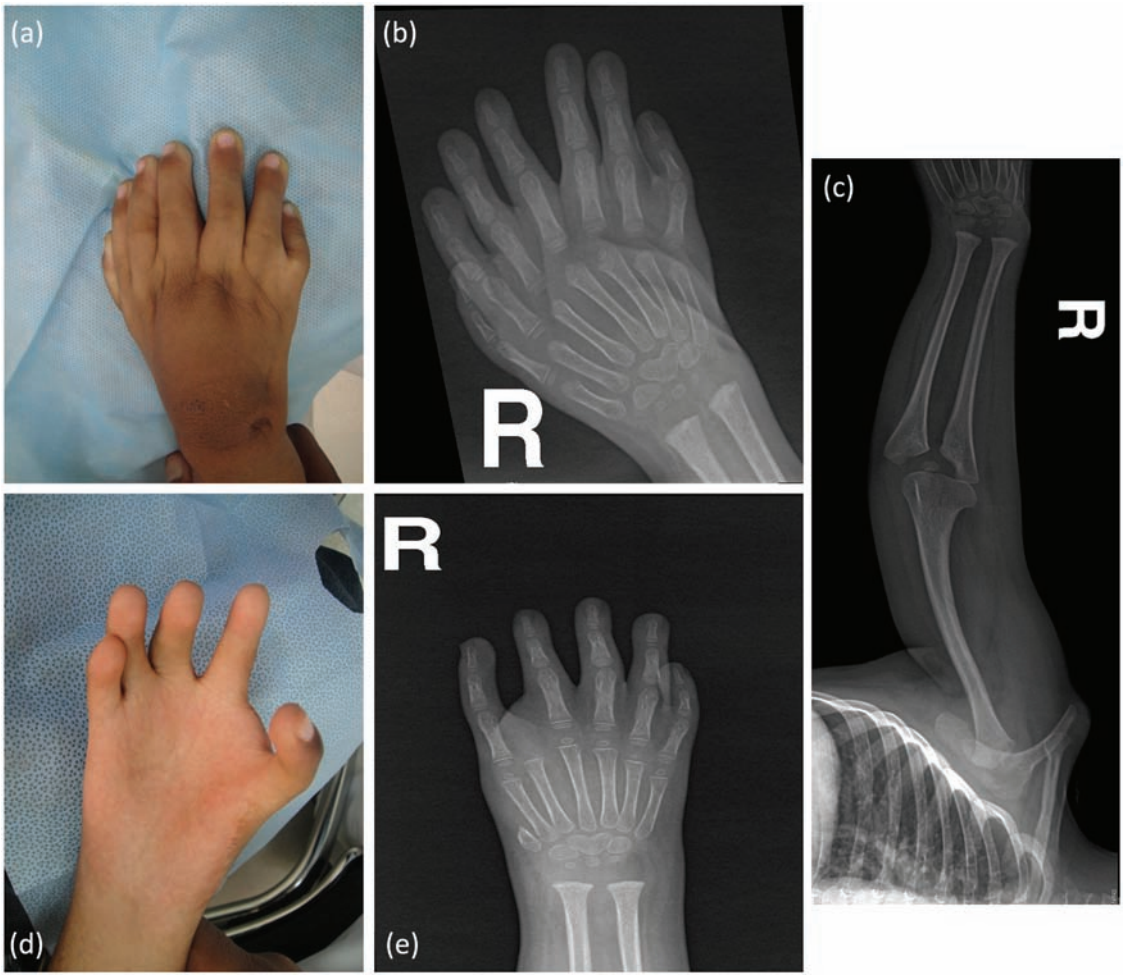

Figure 3. Case 3. (a)–(c) preoperative clinical and radiological appearance – note the shoulder dislocation; (d) and (e) postoperative clinical and radiological appearance at age 4 years. Note the poorly defined volar creases.

deformity by pollicization (Afshar, 2010; Barton et al., 1986; Gropper, 1983; Harpf and Hussl, 1999; Irani, et al., 2007; Jafari and Sharifi, 2005; Manske et al., 1992; Tsuyuguchi et al., 1982). Other techniques reported were either syndactylization of two radial digits to produce a strong thumb (Davis and Farmer, 1958; Mukerji, 1957) or leaving one radial digit (without pollicization) as the new thumb (Entin, 1959; Jameel et al., 2011; King and Hoyes, 1982). However, data regarding thumb function following these latter procedures were not provided. Our study shows that leaving one of the radial digits as the new thumb (without formal pollicization) with or without rotation osteotomy is an acceptable option in mirror hands. The main advantage of this technique is that it is simpler than the pollicization procedure and hence it carries minimal risk of major complications such as vascular compromise. Pilkington et al. (2000) reported on a case of mirror hand deformity with vascular compromise of the operated digit following pollicization. Deficiency of the new first web has not been a problem in our series because there is usually a wide cleft between the ulnar and radial fingers, and owing to the option of finger selection. Disadvantages of our technique of reconstruction include the excessive length of the new thumb. All previous reports on mirror hands did not document pinch strength or power grip and hence we are unable to compare our results regarding these measurement with others.

The treatment choice of thumb reconstruction in the current series was not pollicization but leaving one of the radial fingers as a thumb. The argument behind this choice is not only the lower risk of vascular compromise, but also the fact that all our mirror hands had a wide cleft separating the ulnar from radial digits. This wide cleft will form an adequate first web space without pollicization. Furthermore, the function (such as flexion/extension and intrinsic

Figure 4. Case 4: (a)–(c) preoperative clinical and radiological views; (d) and (e) post-operative radiological and clinical views of age of 2 years. The hand was decorated using traditional 'Arabic Henna'.

Table 2. Summary of the surgical procedures done in four cases of mirror hand deformity.

Case number	Thumb reconstruction procedures	Surgery at the wrist	Surgery at the elbow	Surgery at the shoulder
1	Excision of digits one, two and three. The fourth digit (with clinodactyly) was left in place as the new thumb. In a second stage, the middle delta phalanx was excised and the distal phalanx was rotated into pronation.	Not required (improved with splinting alone)	Not required (improved with physiotherapy)	Normal shoulder
2	Excision of digits one, two and three. The fourth digit was left in place as the new thumb. In a second stage osteotomy of the proximal phalanx to rotate the new thumb into more pronation was done.	Not required (improved with splinting alone)	Arthrolysis amd partial excision of the head of the radius	Normal shoulder
3	Excision of digits one and three. Digit two was left in place as the new thumb. In a second stage, osteotomy of the proximal phalanx was done	Plication of dorsal wrist capsule and plication of the extensor tendon of the new thumb was done at the wrist level	Not required (Improved with physiotherapy)	Not planned
4	Excision of digits one, two and three. Digit four was left in place as the new thumb. The parents refused the osteotomy procedure	Flexor carpi ulnaris transfer to improve wrist extension is planned	Excision of the olecranon of the pre-axial ulna is planned	Normal shoulder

Table 3. Range of motion at final follow-up.

Case number	Range of motion of the IP/MP joints of the new thumb (extension – flexion)	Wrist extension – flexion	Forearm rotation (range)	Elbow extension – flexion	Shoulder abduction and external rotation
1	IP joint: 0–50° MP joint: 0–60°	–10 to +50°	10°	+10 to +70°	Normal
2	DIP joint: 0–40° PIP joint: 0–80° MP joint: 0–70°	–10 to +45°	10°	+10 to +35°	Normal
3	DIP joint: 0–15° PIP joint: 0–15° MP joint: 0–5°	+20 to +40°	Zero	+20 to +60°	Abduction 0–90°. External rotation ROM = 20°
4	DIP joint: 0–40° PIP joint: 0–70° MP joint: 0–70°	+25 to +40°	Zero	+10 to +20°	Normal

IP, interphalangeal; PIP, proximal interphalangeal; DIP, distal interphalangeal; MP, metacarpophalangeal; ROM, range of motion.

Table 4. Pinch and power grip at final follow-up.

Case	Age at time of testing	Pinch strength			Power grip		
		Affected hand	Normal hand	%*	Affected hand	Normal hand	%*
1	20 y	2 kg	8 kg	25%	8 kg	43 kg	19%
2	5 y	1 kg	3 kg	33%	2 kg	5 kg	40%
3	4 y	0.5 kg	3 kg	17%	0.5 kg	6 kg	8%

*% = affected ×100.
Normal.
Note: Case 4 was too young for testing.

function) of the radial digits is frequently not normal in mirror hands. Leaving a finger as a 'long' thumb may be an advantage in these cases since a 'long' thumb will have a better 'reach'.

In conclusion, we found that thumb reconstruction by leaving one of the radial fingers is an acceptable option in mirror hands. However, objective measurements, especially pinch strength and power grip, needs to be compared with the pollicization technique.

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Conflict of interests

None declared.

Ethical approval

This work was approved by the Fast-Track Ethics Review committee for CMED-304 Course at King Saud University.

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