

Reconstruction for Wassel Type III Radial Polydactyly With Two Digits Equal in Size

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Purpose To report the surgical outcomes for Wassel type III radial polydactyly thumbs of equal or nearly equal size treated by excising the radial thumb with augmentation.

Methods We have reconstructed 15 cases of Wassel type III radial polydactyly, in which the duplicated digits were equal or almost equal in size, by ablation of a radial digit. The distal articular surface of the radial proximal phalanx was preserved in order to maintain stability of the interphalangeal joint. The stability of the retained thumb was further augmented by tendon repositioning, restoration of the radial collateral ligament, and transfer of soft tissues from the radial digit. Eleven of 15 cases were followed up for more than 2 years and were available for assessment using the Japanese Society for Surgery of the Hand evaluation form. The average age at follow-up was 8 years and 3 months. The size of the nail and distal phalanx was measured to assess the growth of the thumb.

Results An average functional point was 12 points (maximum 14 points), and restricted interphalangeal joint motion and extension lag were the disadvantages of this technique. The width of the distal phalanx was increased from 62% of the size of the metacarpal before surgery to 78% at the final follow-up. The cosmetic score averaged 3.6 (maximum 4 points), and slightly small nails without a central ridge were deemed acceptable.

Conclusions Our technique can provide a functionally good thumb for Wassel type III radial polydactyly. (*J Hand Surg* 2009;34A:1802–1807. © 2009 Published by Elsevier Inc. on behalf of the American Society for Surgery of the Hand.)

Type of study/level of evidence Therapeutic IV.

Key words Bilhaut technique, congenital hand, duplicated thumb, polydactyly.

THE AIM OF SURGICAL reconstruction for radial polydactyly is restoring a nearly normal thumb; however, hypoplasia in the original thumbs compromises this aim. The long-term results show that nearly 20% of patients required revision surgeries.^{1,2} Overall, 10% of the patients were not satisfied with the cosmetic results.³ The prognosis differs depending on

the bifurcation types.^{4,5} Wassel type III polydactyly, in which 2 digits are equal or almost equal in size, is one of the difficult types for reconstruction. Tada reported that one third of patients experienced a fair or poor outcome.⁶ The Bilhaut⁷ procedure is one of many procedures performed to reconstruct the hypoplastic radial polydactyly. However, the original technique has often resulted in nail deformity, stiff joint, and recurrence of the deformity.^{1,2,8–11} Several modifications for the Bilhaut procedure have been introduced.^{1,12–15}

On the other hand, the simple ablation of 1 digit for the Wassel type III polydactyly has resulted in an unstable small thumb. Manske¹¹ reported a reconstruction technique using a ligamentous periosteal flap with osteotomy, which is technically simple and does not potentially interfere with bone growth. However, the narrowed interphalangeal (IP) joint had a tendency to lose

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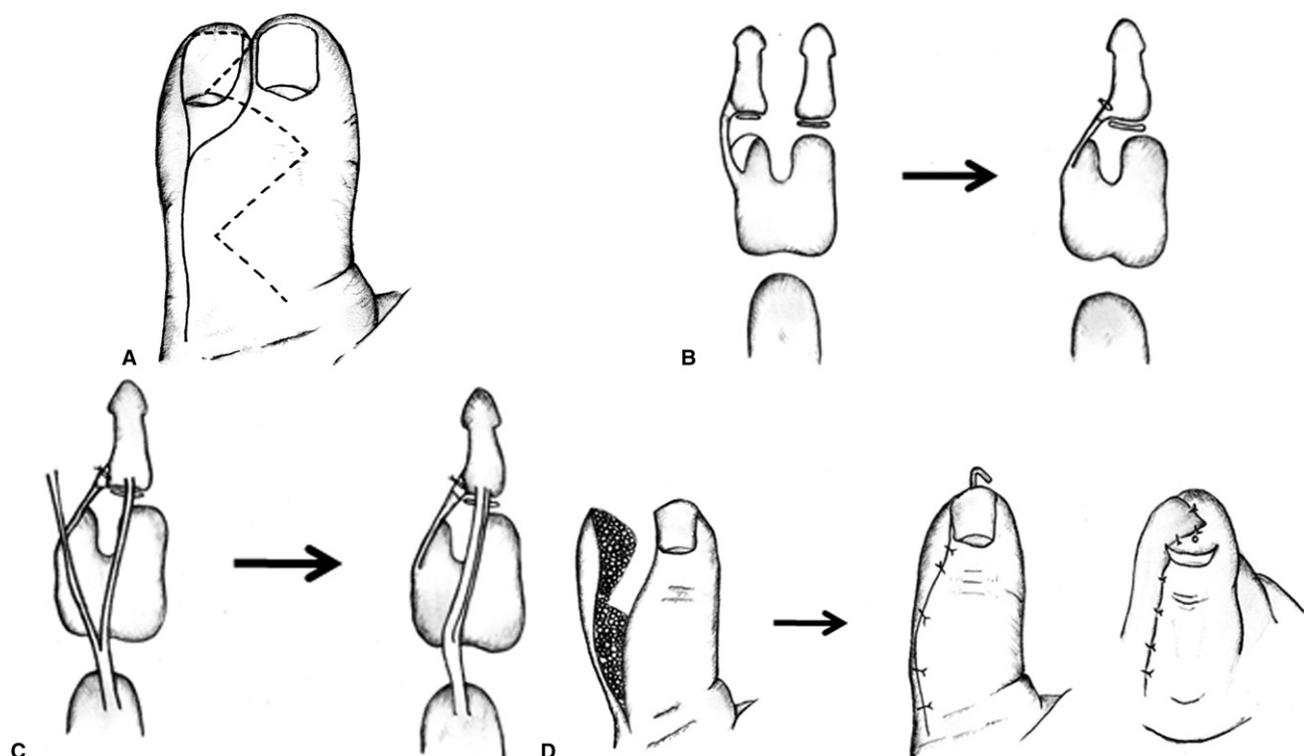


FIGURE 1: Surgical techniques. **A** A curved incision on the dorsal and a zigzag incision on the volar were used for exploration. **B** A part of the distal articular surface of the radial proximal phalanx was excised, but enough joint surface to support the distal phalanx was preserved. The radial collateral ligament along with the cartilage was sutured to the ulnar distal phalanx. **C** The extensor pollicis longus (EPL) tendon of the retained thumb was augmented by the EPL tendon of the excised thumb. **D** Soft tissue augmentation was performed by the skin fillet from the radial thumb. The radial paronychium was also reconstructed by soft tissue from the excised thumb. The IP joint was temporarily fixed by a K-wire.

joint stability in follow-up. We have extended Man-ske's techniques for reconstructing Wassel type III polydactyly with equal size. Instead of narrowing the distal articular surface, we preserved it in order to maintain stability of the IP joints. Tendon repositioning was also done for good alignment. The aim of this paper was to introduce our technique and report the surgical outcomes.

MATERIALS AND METHODS

Surgical technique

The principle of surgery was excision of the radial thumb and reconstruction of the ulnar thumb. A dorsal curved incision and volar zigzag incision were made for exploration (Fig. 1A). In earlier cases, the dorsal incision was also zigzag in configuration, but it was later changed to a radial curved incision. Tendon excursion of both the extensor pollicis longus (EPL) and flexor pollicis longus (FPL) was examined in order to determine the tendon balance in reconstructing the thumb. The IP joints of both thumbs were explored. The radial collateral ligament of the radial IP joint with its carti-

laginous insertion was carefully detached in continuity with the adjacent periosteum. The stability of the IP joint of the ulnar thumb was examined. A part of the proximal phalanx of the radial thumb was preserved to augment supports of the small distal phalanx (Fig. 1B). The metacarpophalangeal (MCP) joint itself was left untouched. The retained distal phalanx was centralized and longitudinally aligned. The radial collateral ligament of the radial thumb was resutured to the radial side of the distal phalanx for stability of the IP joint. Chondrodesis of the IP joint was performed for 2 cases with an extremely unstable IP joint. In the majority of cases, both of the EPL tendons were extremely thin, so the radial one was detached and used for augmentation of the ulnar EPL (Fig. 1C). The FPL tendon in the radial digit was excised, and that of the ulnar digit was centralized, if necessary. The radial part of the FPL insertion was cut and then resutured to the ulnar side of the distal phalanx. Soft-tissue augmentation was done using tissue from the radial digit. The skin flap from the radial thumb was trimmed to cover the paronychium and part of the pulp of the reconstructed thumb (Fig. 1D). The IP

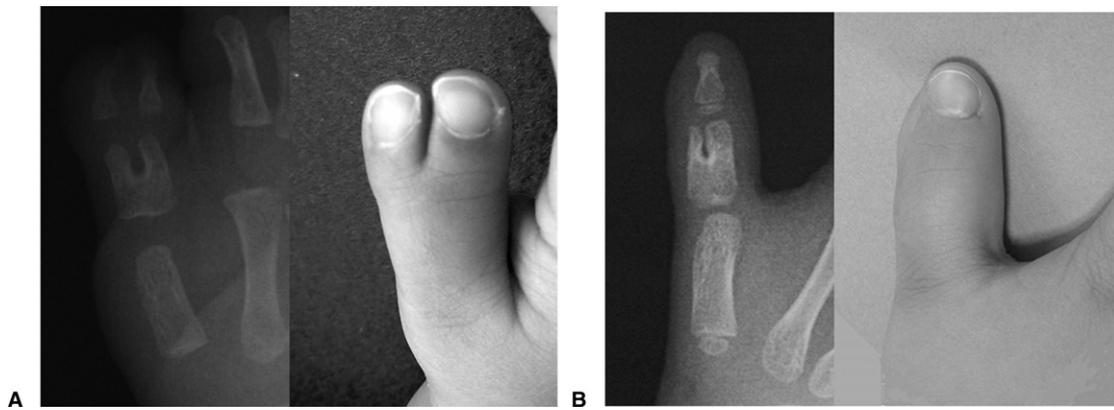


FIGURE 2: **A** Preoperative x-ray of Wassel type III polydactyly, in which 2 thumbs were almost equal in size. The width of the distal phalanx was 61% of that of the first metacarpal. **B** At age 5, the width of the distal phalanx increased to 78%.

joint was temporarily fixed by a K-wire for 4 weeks. The thumb was protected within a bulky dressing for 3–4 weeks after surgery. All procedures were performed by 1 surgeon.

Patient study

Since 1991, 21 Wassel type III duplicated thumbs have been treated in our hospital. Six cases with one digit obviously smaller than the other were treated by an ablation of the smaller digit with soft tissue reconstruction. They were excluded from this study. There were 15 patients, 9 boys and 6 girls, and the average age at the time of initial surgery was 10 months (range; 7–16 months). Four patients, who were under age 3, were excluded from the final assessment. Inclusion criteria for the present study were patients with a type III polydactyly in whom the 2 digits were equal or almost equal in size (Fig. 2A) and who were followed up more than 2 years.

Eleven patients were directly examined (Table 1). Average age at follow-up for those 11 patients was 8 years and 3 months (range, 4 years and 1 month to 15 years and 5 months). The stability of joints was examined by manual stress, compared with the other side. The range of motion was measured with a goniometer.

Anteroposterior x-rays of the thumb were obtained in order to evaluate the bone size and alignments of the thumb. The x-rays were scanned, and bone size was measured on the computer. The width of the distal phalanx was measured at the base (maximum width of the distal phalanx). The width of the first metacarpal was measured at the midpoint of the bone. The size of the distal phalanx was expressed in comparison to the size of the first metacarpal.

A cosmetic evaluation was performed in terms of

nail deformity and surgical scar. Photographs of the bilateral thumbs were taken, and then the maximum width and the length of the nail were measured on the photograph and expressed in comparison to the other side. The thumb was assessed functionally and cosmetically by an evaluation form for radial polydactyly provided by the Japanese Society for Surgery of the Hand (Table 2).

RESULTS

Surgical outcomes for 11 patients are listed in Table 1. The functional point score averaged 12 (maximum 14 points). Stability and alignment of the MCP joint and abduction of the thumb were good in all cases. Less than 20° of malalignment at the IP joint was observed in cases 6 and 7. Less than 20° of instability of the IP joint was observed in cases 6 and 11. Flexion motion was restricted to 60% of the other side in 7 cases (cases 2, 3, 7–11). In another 6 cases (cases 1, 4, 6, 8, 9, 11), less than 30° of extension lag was observed. None of the patients complained of any pain or difficulties in daily life. The cosmetic point score averaged 3.6 (maximum 4 points). No severe nail deformity was observed, and the surgical scar was acceptable, but a small thumb was present in 4 cases (cases 6–9). The average nail size in comparison to the other side was 84% in width and 103% in length.

The average width of the distal phalanx in the affected side was 62% of the size of the metacarpal before surgery, which increased to 78% at the final follow-up (Fig. 2). The average width of the distal phalanx on the other side was 80% before surgery and 86% at the final follow-up. The average length of the distal phalanx on the affected side was 52% of the ipsilateral metacarpal before surgery and 47% at the final follow-up; on the

TABLE 1. Patient Data

Case	Gender	Affected Site	Age at Surgery (mo)	EPL	FPL	Chondrodesis	Follow-Up Age (y)	Functional Points (14 points)	Cosmetic Points (4 points)	Pain and Satisfaction (2 points)	Total (20 points)	Nail Width (%)	Preoperative Distal Phalanx Width	Postoperative Distal Phalanx Width
1	F	L	12	+	-	-	15.5	13	3	2	18	0.82	66	88
2	M	R	8	+	-	-	15	11	4	2	17	0.84	55	95
3	M	R	8	+	+	-	8.2	13	4	2	19	0.93	85	105
4	M	R	9	+	-	-	11.5	13	4	2	19	0.93	70	85
5	M	L	7	+	-	-	9	13	4	2	19	0.82	73	74
6	M	R	9	+	+	-	6.5	10	4	2	16	0.82	63	66
7	F	R	16	+	+	-	6.4	12	3	2	17	0.78	54	72
8	M	L	10	+	+	-	6	12	3	2	17	0.81	50	59
9	F	R	12	+	+	-	4.8	12	3	2	17	0.82	61	79
10	F	R	14	-	+	+	4.1	12	4	2	18	0.83	60	72
11	M	L	12	+	+	-	4	11	4	2	17	0.84	52	64

EPL: (+) indicates that the EPL augmentation was done, (-) indicates that the EPL augmentation was not performed. FPL: (+) indicates that the FPL reinsertion was done, (-) indicates that the FPL reinsertion was not performed. Chondrodesis: (-) indicates that chondrodesis was not performed.

normal side, it was 53% before surgery and 50% at the final follow-up.

One patient (case 2) had had 2 revision surgeries owing to instability and malalignment of the IP joint. At age 15, he had less than 20° of instability and radial bending at the IP joint but satisfactory appearance. This patient showed good results at final follow-up. No other patients have required revision surgeries to date.

DISCUSSION

When radial polydactyly is equal in size and shape, both digits are often hypoplastic and thus difficult to reconstruct. The Bilhaut procedure is often applied for these cases. Dobyns et al.¹⁶ stated that the retained thumb should be at least 80% of the normal size. Tonkin et al.¹² recommended this procedure when the size of the nail was less than 70% of that of the contralateral nail. Despite being a well-known technique, the details of surgical outcomes by the Bilhaut procedure have not been described. The results are not always as cosmetically pleasing as the drawings and illustrations in the reports. The procedure is technically challenging and carries the potential for bony deformities resulting from damage to the physis in a growing child, as well as a deformed nail with a longitudinal ridge or a thumb that is too wide.⁸⁻¹¹

In order to overcome these disadvantages, several modifications have been reported.^{1,12-15} Baek's technique was especially aimed at preserving IP joint motion.¹⁴ His extra-articular technique seems effective in type II polydactyly. However, it seems difficult to solve the problem for type III duplication, which often has an inherently unstable IP joint. Regarding nail deformity, Iwasawa et al.¹⁵ reported excellent results in 6 of 8 cases using their own technique. They recommended meticulous suturing of the nail bed and using only a small piece of cortex from the excised phalanx. Combining the 2 nail beds was still technically demanding. Once damaged, it was rarely revised.

Manske reported a reconstruction technique that used a ligamentous periosteal flap from the proximal bone to stabilize the retained thumb.^{11,17} He recommended narrowing the proximal phalanx by excision. However, exploring the IP joint revealed that the IP joint of the retained thumb was often narrow and had poor joint congruity. So we preserved the proximal phalanx from the excised digit to provide support for the distal phalanx. In addition, we meticulously reconstructed soft tissue to balance good alignment. Not only the hypoplastic tendon but also realignment of the joint might have caused restricted IP joint motion. However,

TABLE 2. Assessment for Duplicated Thumb (Japanese Society for Surgery of the Hand)

Function		Point	Appearance	Point		
Abnormal alignment	IP joint	<5°	Size	Acceptable	1	
		6–20°	2	Unacceptable	0	
		>20°	0	Finger pulp/nail	Acceptable	1
MCP joint	MCP joint	<5°	2	Unacceptable	0	
		6–20°	1	Surgical scar	Acceptable	1
		>	0	Bulging	None	1
Instability	IP joint	<10°	2	Outstanding	0	
		11–19°	1	Subjective Assessments	Pain	
		>20°	0			
MCP joint	MCP joint	<40°	2			None
		41–59°	1	Painful	0	
		>60°	0	Satisfactory	1	
Active flexion	IP and MCP joint	90° <	2	Unsatisfactory	0	
		60–90°	1	Total Assessments	Points	
		<60°	0			
Extension lag	IP and MCP joint	0°	2			Excellent
		<30°	1			
		>30°	0			
Palmar abduction	MCP and carpometacarpal joint	60° <	2	Good	17–19	
		31–59°	1	Fair	14–16	
		<30°	0	Poor	0–13	

all thumbs had had good MCP and carpometacarpal joint motion, which maintained near total mobility of the thumbs.

We had hypothesized that if an extra thumb was removed at an earlier age and the retained thumb had good function for the patient's use, the thumb would grow by so-called "catch-up growth."¹⁸ The width of the distal phalanx increased from 62% to 78% on the affected side, whereas that of the normal side changed from 80% to 86%. The average width of the nail in comparison to the normal side reached 84%, which was quite acceptable for a thumb. In addition, the radially oriented surgical scar improved the cosmetic results. In 4 patients, the reconstructed thumb was visibly small only when the patients compared bilateral thumbs side by side. Goldfarb reported that the appearance scores were more frequently lowered because the reconstructed thumbs were "too wide."¹⁹ It was important to

reconstruct a stable thumb for the patient's use as early as possible.

The limitations of our technique were slightly restricted IP motion and extension lag in IP joint. The motion of the retained thumb is partly inherited from the original tendon excursion. The EPL tendon was thin and had poor excursion in the majority of this patient group. Despite great efforts to preserve tendons, the obtained excursion was not as good as on the unaffected side.

An important feature of our technique is reconstructing a functionally stable thumb without fear of nail deformity. In addition, the learning curve is not as steep as with the Bilhaut technique.

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