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Supporting the collateral ligament complex in radial polydactyly type Wassel IV☆

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Summary Despite anatomical metacarpophalangeal joint (MCPJ) reconstruction in radial polydactyly (RP) Wassel IV, the prevention of long-term deformity and instability is still an issue. We report on clinical results following our modified surgical procedure with additional support of the hypoplastic radial collateral ligament complex (RCLC) after musculoligamentous MCPJ reconstruction. Fourteen patients (male: 10, female: 4) with radial resection of isolated RP Wassel IV (1987–2006), average age at surgery 1.7 years (0.6–8.6) were included. Distribution to group A and B depended on the procedure for MCPJ reconstruction. In group A ($N = 7$), RCLC reinsertion + reinforcement using autologous tendon grafts was performed (follow-up: 4.6 years (1.4–6.9)). Group B (RCLC reinsertion without support) consisted of $N = 7$ patients; follow-up: 9.6 years (8.2–20.2). The healthy contralateral hand (control A/control B) served as a control. Results were evaluated using our modified Tada-score considering: range of motion (ROM), interphalangeal joint (IPJ) and MCPJ stability on stress examination, palmar abduction and grip strength. Better score results (maximum 10) were seen in A: 7.3 (6–9) compared to B: 6.6 (4–10). Subscore 'stability' A: 1.1 (0–2); B: 0.9 (0–2) and 'alignment' A: 0.86 (0–2); B: 0.57 (0–2) showed greatest influence on the score result. Ulnar angulation at MCPJ level compared to healthy thumbs (control A + B) was greater ($p < 0.05$), with 11.4° (10–20) in group A and 14.3° (−5 to 30) in group B compared to 0° in control A and 5.7° (0–17) in control B. MCPJ ulnar deviation in A + B: 25° (0–35) compared to healthy thumbs control A + B was higher ($p < 0.05$). Ulnar deviation was higher in B 45° (30–60) compared to 34° (20–50) in A. In B, instability was evident in four, in A, only in one patient. In B, one patient required two re-operations due to MCPJ instability. Equivalent results were recorded regarding pinch

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grip and palmar abduction. Anatomical MCPJ reconstruction in combination with autologous support of the hypoplastic RCLC to enhance long-term stability is recommended.

Radial polydactyly (RP) is one of the most frequent congenital malformations of the hand. Appearance depends on the level of bifurcation and number of phalanges.[1,2]

Although newer classifications[1,3–6] have been proposed, Wassel's classification (type I–VII) has gained wide acceptance.[7] The most frequent type is Wassel IV[2,4,8] presenting (Figure 1) with bifurcation at metacarpophalangeal joint (MCPJ) level including one common first metacarpal (MC).

Wassel IV is commonly associated with hypoplastic radial thumbs and a broadened first MC. Simple ablation resulted in unstable, malaligned thumbs.[2] Alignment and anatomical musculoligamentous reconstruction of the MCPJ need to be addressed initially to ensure unimpaired development.[9]

Stability is paramount for grip strength and prehensile function that develops within the first 24 months of age.[9,10] Primary surgery after 12 months has been advocated.[9]

Anatomical musculoligamentous repair of the MCPJ should include reinserting capsule, radial collateral ligament (RCL) and radial thenar musculature into the proximal phalanx.[2,9] These anatomical structures are highly interconnected and therefore should be regarded as one musculoligamentous 'collateral ligament complex' (CLC).

In the correction of Wassel type IV, it may be necessary to accommodate the presence of hypoplastic thenar musculature and RCL for reconstruction. Long-term studies have demonstrated high postoperative deformity and joint instability.[11–13] Due to our observations of MCPJ instability following RCLC reinsertion only, our reconstructive procedure was modified in 1999.

Aim of study

We report on our clinical results following a modified surgical correction of RP type Wassel IV with additional musculoligamentous support (reinforcement) of the RCLC in one group and conventional reconstruction of the MCPJ only in another.

Patients and methods

Patients

A total of 62 cases with RP were treated in our institution between 1987 and 2006, 52% of which were classified as Wassel type IV. Fourteen patients (male: 10, female: 4) who underwent surgical correction of Wassel type IV met our inclusion criteria. Average age at surgical procedure was 1.7 years (0.6–8.6). Nine patients had the right, and five the left thumb affected. Mean follow-up was 7 (1.4–20) years.

Inclusion criteria

Inclusion criteria were radial resection and a normal contralateral hand. Exclusion criteria were additional congenital malformations of the upper extremity, ulnar resection, Bilhaut-Cloquet procedures, primary surgery in

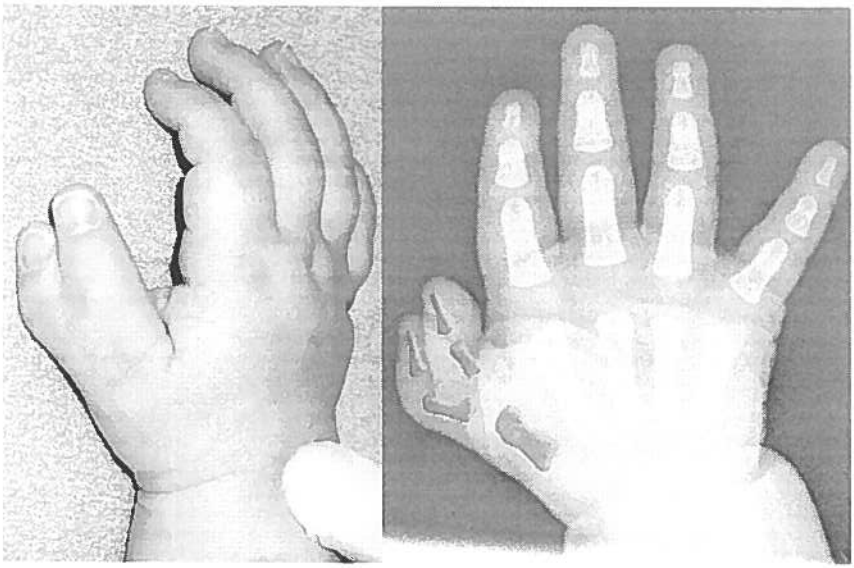

Figure 1 Right hand of a 14 months old boy presenting with Radial Polydactyly type Wassel IV (left); blue illustration of dorsopalmar radiograph of the hypoplastic radial and ulnar thumb.

adolescence or another institution and history of severe upper extremity trauma. Patients were distributed to group A and B, depending on type of reconstruction.

Group A

Following radial resection, a sophisticated anatomical reconstruction (1999–2006) with autologous musculoligamentous support (reinforcement) of the RCLC of the MCPJ was performed in group A ($N = 7$). Average follow-up in group A was 4.6 (1.4–6.9) years. Average age at time of procedure was 1.2 (1.1–2) years.

Group B

In group B ($N = 7$), radial MCPJ reconstruction consisted of distal musculoligamentous repair (1987–1999) only. Average follow-up was 9.6 years (8.2–20.2). Average age at time of surgery was 2.2 years (0.6–8.6).

Control group

The normal contralateral hand (control A/control B) served as control.

Surgical technique

Following a dorsal zigzag incision, both extensor pollicis longus (EPL) tendons were exposed. In cases with additional angular deformity of the interphalangeal joint (IPJ), distal insertions of both flexor pollicis longus (FPL) and EPL tendon were exposed and abnormal, eccentric insertions centralised. Hypoplastic ulnar FPL or EPL tendons were supported by transposing radial to ulnar tendons with absorbable polydioxanone (PDS) 4/0 interrupted sutures when necessary (Figure 2 above). The same manoeuvre was performed to correct imbalance of tendons and deviations not resulting from abnormal skeletal growth or joint incongruence.

After exposing the radial MCPJ, a proximally based flap consisting of periosteum, capsule, RCL including distal insertion of the abductor pollicis brevis muscle (RCLC) was raised (Figure 2 below). After FPL and EPL tendon tenotomy, the radial thumb was resected following dissection of neurovascular bundles.

Following anatomical reduction of the proximal phalanx, size of the first MC head was reduced using a 11 blade on the radial aspect (Figure 4) in an oblique fashion, when necessary, preserving the origin of the RCL.[9] This procedure has been given the term 'arthroplasty'. In cases with a dicephalad head, an axial aligned, central closing wedge resection may also achieve joint congruency.[14]

In both groups, the remaining RCLC, consisting of periosteum, capsule, RCL and distal insertion of abductor pollicis brevis muscle was inserted (Figure 3 above) to the radial/palmar aspect of the proximal phalanx using PDS 5/0 interrupted mattress sutures.

In angular deformities greater than 30°, we prefer a closing wedge osteotomy at the neck of the first MC and temporary k-wire fixation. Opening wedge osteotomy with bone graft interposition from the resected thumb may also

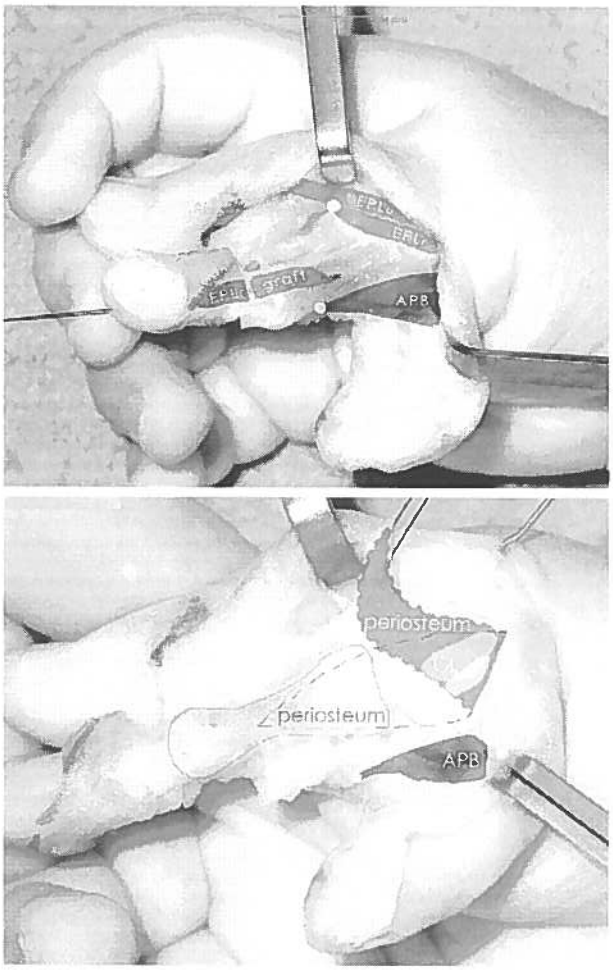

Figure 2 Illustrated intraoperative view of dissection and ulnar transposition of the radial (r) EPL-tendon (blue) to the extensor tendon of the ulnar (u) thumb, leaving a tendon graft distally for further articular reconstruction (above). Illustrated Intraoperative view following exarticulation of the hypoplastic radial thumb at MCPJ level and desinsertion of abductor pollicis muscle (red). A large proximally attached flap including periosteum/capsule (blue) and RCL (white) is raised (below).

be effective in restoring length and alignment. In severe zigzag deformities (MCPJ ulnar and IPJ radial angulation), correction osteotomy of the proximal phalanx may also become necessary.[2] In our series, there was no necessity for correction osteotomies (Table 1).

Postoperative treatment consisted of splinting including the MCPJ for 4 weeks. In both groups, k-wire transfixation was unnecessary due to stable reduction following RCLC repair.

Group A (autologous RCLC support)

In group A, additional musculoligamentous support of the RCLC using an autologous tendon graft from resected EPL tendons was performed. Grafts were inserted into the remaining hypoplastic proximal radial RCLC at the level of the first MC head dorsally and attached to the radiopalmar

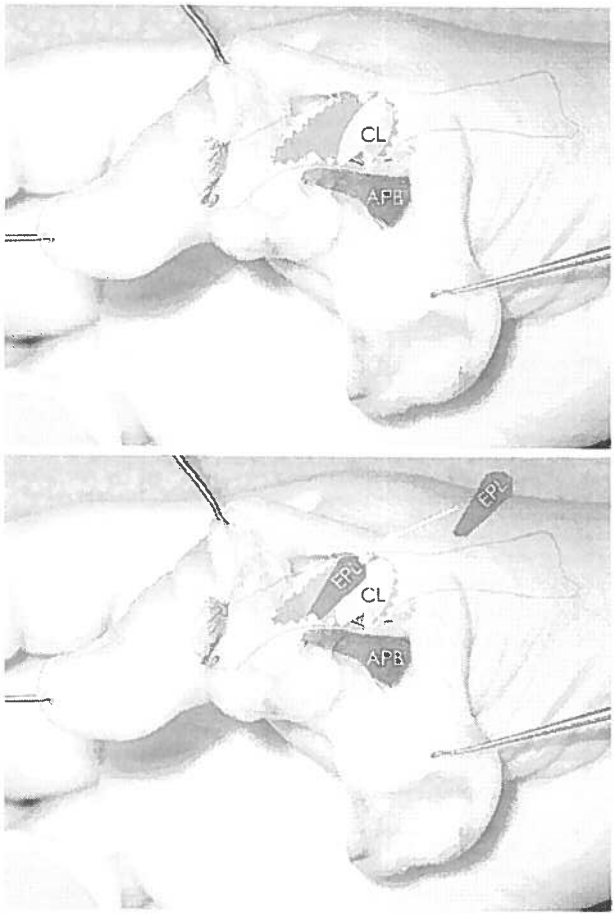

Figure 3 Illustrated intraoperative view. Musculoligamentous articular reconstruction following osteotomy of radial aspect of first metacarpal head by reattaching the remaining RCLC consisting of periosteum/capsule (blue), including CL (white) and reinsertion of abductor pollicis muscle (red, above) Additional support of RCLC following musculoligamentous reconstruction as illustrated in Figure 8 using an autologous tendon graft (dark blue) from the harvested radial EPL tendon (Figure 4). Reinsertion into CL (white) from the dorsal aspect of first MC head to the palmar aspect of the base of the middle phalanx (below).

periosteum of the proximal phalanx (Figure 3 below) using PDS 5/0 interrupted mattress sutures.

Group B

In group B, conventional musculoligamentous reconstruction of the MCPJ without support as described was preferred.

Clinical evaluation

Active range of motion (ROM) of MCPJ/IPJ (goniometer (°)), grip strength (Jamar Dynamometer (kg)), pinch grip (pinch gauge (kg)), joint stability (goniometer (°)) and active palmar abduction (goniometer (°)) of both hands were considered for evaluation. ROM was recorded as sum of active ROM of the MCPJ- and IPJ starting at neutral (0°) with phalanges and MC axially aligned.

MCPJ and IPJ stability was analysed on radial/ulnar stress examination recording passive radial and ulnar deviation starting at 20° MCPJ flexion. Absolute values as well as differences to the contralateral hand were recorded for higher comparability. Unstable MCPJ at the ulnar or radial aspect was defined as more than 20° difference to the unaffected hand. A difference of 10–20° was considered as laxity, less than 10° as stable.

Palmar abduction was examined by measuring the maximum angle between first and second MC. Angles were measured using dorsal lines drawn from base to head of first and second MC. The difference to the contralateral hand was recorded.For reasons of inter-observer variability, mean values of two different observers were used for clinical analysis.

Radiological examination

Skeletal growth and alignment of both thumbs were examined with plain radiographs (goniometer). Negative values were recorded for radial, positive for ulnar angulations.

Score evaluation

Postoperative results were evaluated using Innsbruck Radial Polydactyly (IRP) Score (Table 2), a modification of the Tada score.[2] MCPJ stability was set into correlation with the contralateral thumb. We added palmar abduction as a parameter evaluating opposition of the reconstructed thumb as well as pinch compared to the contralateral hand.

Alignment was rated from 0 to 2 points, 0 points indicating deviation of more than 20° at either MCPJ or IPJ level, 1 point indicating deviation of 20–30° of both joints, 2 points indicating deviation of less than 20° of both. Score parameters including analysis for evaluation are shown in Table 2. Scores of 8–10 were regarded as good, 5–7 as fair, less than 4 as poor results.

Statistical analysis

Non-parametric Mann–Whitney testing and Wilcoxon-W testing, including Spearman-Rho testing for the evaluation of non-parametric correlations, were applied. Statistical analysis was focussing on significant differences between operated thumbs (group A + B) and all healthy thumbs (group A + B) as well as correlations within group A and B.

Results

a) Alignment

In group A, ulnar angulation at MCPJ level was 11.4° (10–20) on average (control group A: 0°). In group B, mean ulnar angulation of 14.3° (−5 to 30) with 5.7° (0–17) in control group B was recorded. In groups A and B, no radial angulation was present at MCPJ level. Ulnar alignment at MCPJ level in operated thumbs compared to all healthy

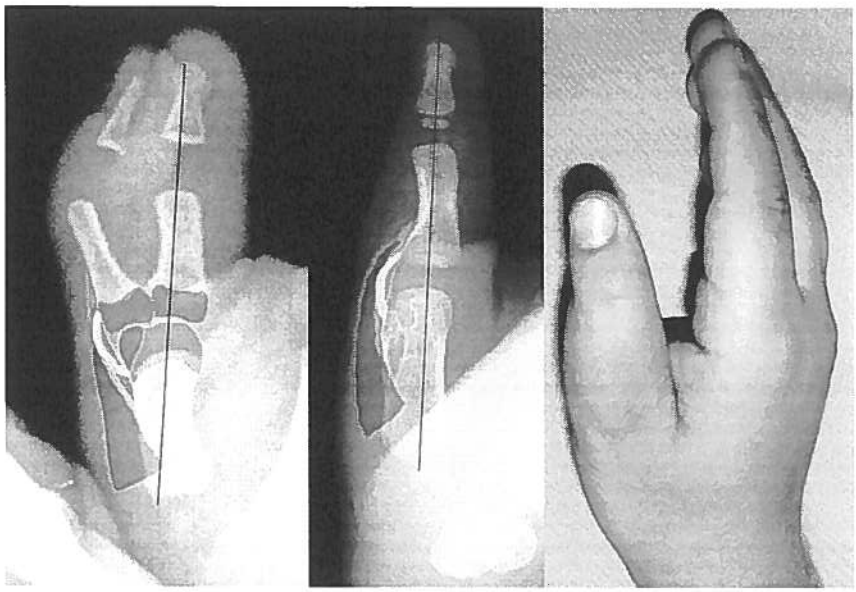

Figure 4 Illustration of dorsopalmar radiograph of right RP type Wassel IV before (left) and following musculo-ligamentous reconstruction (middle) with reinsertion of the RCLC consisting of periosteum (blue), CL (white), and reattachment of abductor pollicis muscle distally (red) Stable right thumb following surgical correction of RP (36 months postoperative) of right thumb (Figure 1) and musculo-ligamentous reconstruction of the MCPJ including additional support of RCLC (left).

thumbs in control group A and control group B with 3° (0–17) was statistically significant ($p < 0.05$). At IPJ level, there was an average radial angulation of 15.4° (–49 to 0) in group A with 0.7° (–5 to 0) in control group A. In group B, 12.1° (–60 to 0) average radial angulation of the IPJ was seen with 1.2° (–5 to 0) in control group B. In both groups, no ulnar angulation was detected at the IPJ level (Table 3).

b) Joint stability

Average ulnar deviation at MCPJ level was 45° (30–60) in group B compared to 33.6° (20–50) in group A with autologous musculo-ligamentous support.

Joint mobility of the unaffected hand was greater in group B than in A with average ulnar deviation of 29.3° (20–35) and radial deviation of 31.4° (25–40) in B and 27.1° (10–50), 21.4° (10–30) in A, respectively. For reasons of inter-individual variability of joint mobility, comparison of the difference to the contralateral hand between both groups was also used for analysis.

Comparing ulnar deviation to the unaffected hand, a difference of +15.7° (–5 to 30) on average was found in group B. Following musculo-ligamentous support, a difference to the contralateral hand of 12.1° (0–30) on average was noted in group A. In group B, four patients showed radial MCPJ instability one of which required two re-

Table 1 Surgical treatment in Group A and Group B. Anatomical reduction of size and shaping of broadened first MC head was given the term "Arthroplasty".

Patients group A	Resection	CLC reconstruction.	Osteotomy first MC	Reoperation (N)
A	Radial	Reinsertion + support	–	0
B	Radial	Reinsertion + support	Arthroplasty	0
C	Radial	Reinsertion + support	Arthroplasty	0
D	Radial	Reinsertion + support	Arthroplasty	0
E	Radial	Reinsertion + support	Arthroplasty	0
F	Radial	Reinsertion + support	Arthroplasty	0
G	Radial	Reinsertion + support	–	0
Patient group B				
H	Radial	Reinsertion only	Arthroplasty	0
I	Radial	Reinsertion only	–	0
J	Radial	Reinsertion only	–	2
K	Radial	Reinsertion only	–	0
L	Radial	Reinsertion only	–	0
M	Radial	Reinsertion only	–	0
N	Radial	Reinsertion only	–	0

Table 2 Innsbruck radial polydactyly score criteria and score analsysis for postoperative evaluation of surgical correction of RP.

Parameter	Definition	Pts.
Alignment	mcp + ip-joint < 20°	2
	mcp + ip-joint 20°–30°	1
	mcp or ip-joint > 20°	0
	mcp + ip-joint > 40°	
Range of motion (ROM)	mcp + ip-joint > 100°	2
	mcp + ip-joint 70°–100°	1
	mcp + ip-joint < 69°	0
Stability mcp-joint (difference to contralteral hand)	<10° (stability)	2
	10°–20° (laxity)	1
	>20° (instability)	0
Palmar abduction (difference to contralteral hand)	<10°	2
	10°–20°	1
	>20°	0
Pinch (% of contralateral hand)	>70%	2
	70%–50%	1
	<50%	0

operations. By contrast, in group A, signs of instability were evident in one.

Higher average ulnar deviation at MCPJ level in operated thumbs compared to all healthy thumbs in control group A and control group B: 25.4° (10–35) was statistically significant ($p < 0.05$). At IPJ level, a higher average radial deviation in operated thumbs compared to all healthy thumbs in A and B: 11.4° (5–15) was statistically significant ($p < 0.001$).

c) IRP-Score Results

IRP-score results including subscore parameter values are shown in Table 4. IRP-score evaluation revealed 'fair' results with an average score of 7.3 (6–9) points in patients with musculoligamentous support (group A) and an average score of 6.6 (4–10) in group B.

Subscore analysis: 'alignment' and 'stability' of the MCPJ

Comparing different average subscore parameters within group A and group B, stability (group A: 1.1; 0–2/group B: 0.9: 0–2) and alignment (group A: 0.86; 0–2/group B: 0.57; 0–2) demonstrated the greatest negative influence on the overall score result. In both groups, equivalent results were achieved on average regarding pinch (group A: 1.6; 1–2/ group B: 1.7; 0–2) and palmar abduction as well as ROM (group A: 2.0/group B: 2.0; 1–2).

Discussion

RP type Wassel IV most commonly presents with an unbalanced, hypoplastic, radial accessory thumb.[9] Under these circumstances, simple excising of the radial hypoplastic thumb without articular reconstruction was of poor functional benefit.[2] Salvage and blending of retained soft tissue have been suggested for reconstruction.[9] Joint stability, alignment, grip strength, size, ROM and aesthetic appearance are regarded as general principles (descending order). Besides choosing the most appropriate procedure, postoperative results are influenced by: size, alignment, articular development and morphology of musculo-ligamentous prerequisites of the remaining thumb.

There is common consensus that reconstruction of the MCPJ should consist of: exploration and centralisation of an eccentrical course of tendons, arthroplasty of first MC head and correction osteotomy of first MC, if necessary.

When a hypoplastic radial thumb is resected, reinsertion of the CL on the radial aspect of the MCPJ is required. Since radial thenar musculature serves as an MCPJ stabiliser, additional musculo-ligamentous reconstruction by reinserting abductor pollicis brevis muscle is crucial.[9] Despite better results, anatomical reconstruction of the MCPJ is associated with less ROM at IPJ level.[15]

In addition, in children, clinical results are affected by skeletal growth. Malalignment and instability of the IPJ and MCPJ and combinations of both are most common sequelae following surgical correction.[2,12,13,16]

It must be emphasised that zigzag deformities can be residual and may require corrective osteotomy of first MC in the first operation.[2] However, time of osteotomy is discussed controversially. Satisfying results have also been reported after late osteotomy at an age of 2–3 years.[17]

Malalignment may occur for reasons of untreated skeletal deformities or may be of articular origin. False tendinous insertion, imbalance of thenar musculature and insufficiency of the RCLC can lead to poor articular angulation and instability,[2,9] requiring consideration when planning the initial procedure.

Despite anatomical reconstruction, anatomical prerequisites to be reinserted may be hypoplastic in accessory thumbs. Additional musculoligamentous support to reduce radial MCPJ instability may be of long-term benefit. This is in agreement with Larsen and Nicolai, who documented high long-term MCPJ instability after various procedures.[11] In another long-term study, residual deformity in 49% of Wassel I–VII due to instability of the RCL of MCPJ or IPJ is reported.[13]

Evaluation of joint stability

Clinical data on MCPJ stability following correction of congenital malformations are commonly summarised as scores[2,11,16] rather than absolute values. However, since criteria defining paediatric joint instability have been inconsistent, comparison of different studies is hardly practical. In adults, MCPJ mobility >30° is generally considered as instability.[18]

In a large series, more than 20° passive mobility at MCPJ level was regarded as instability.[16] Tada et al. defined instability of the MCPJ with lateral instability of more than 5°.[2] In smaller series, definitions of instability were inconsistent ranging from >5°,[19,20] >20[11] to >40°[21,22] instability.

Own results

In our study, fair mid-term results in group A and group B were achieved. According to our scoring system, superior

Table 3 Postoperative alignment including stability of the MCPJ- and IPJ compared to the healthy contralteral hand. Absolute values of each patient including average values in group A/B/A + B in degree tested manually (stability) or using radiographs in dorsopalmar view (alignment) using a goniometer.

Group	Sex m = male f = female	Age	MCPJ alignment[a]		IPJ alignment[b]		MCPJ radial deviation		MCPJ radial deviation difference to healthy hand	MCPJ ulnar devation		MCPJ ulnar deviation difference to healthy hand	IPJ radial deviation		IPJ radial deviation difference to healthy hand	IPJ ulnar deviation		IPJ ulnar deviation difference to healthy hand
			Operated	Healthy	Operated	Healthy	Operated	Healthy		Operated	Healthy		Operated	Healthy		Operated	Healthy	
Group A																		
A	m	1.27	10	0	0	0	40	40	0	50	30	20	10	10	0	10	10	0
B	m	1.10	10	0	22	0	20	20	0	20	20	0	70	20	50	0	20	−20
C	m	1.10	10	0	−5.1	0	20	20	0	20	20	0	60	20	40	0	20	−20
D	m	1.04	20	0	−10	−5	20	30	−10	40	10	30	10	10	0	10	10	0
E	m	2.01	10	0	−49	0	10	10	0	30	20	10	60	10	50	10	10	0
F	m	1.01	10	0	−10	0	20	20	0	30	20	10	30	10	20	10	10	0
G	f	1.12	10	0	−12	0	30	50	−20	45	30	15	20	10	10	10	10	0
Mean		1.24	11.43	0		−0.714	22.86	27.15	−4.29	33.47	21.43	12.14	37.14	12.86	24.29	7.14	12.86	−5.71
Group B																		
H	m	0.70	0	8	0	0	20	35	−15	30	30	0	25	10	15	10	10	0
I	m	2.16	30	17	0	0	45	30	15	55	30	25	20	10	10	30	10	20
J	m	0.67	25	0	0	−4	30	40	−10	35	30	5	10	15	−5	10	15	−5
K	m	0.56	15	10	0	0	35	30	5	55	30	25	10	10	0	10	10	0
L	f	0.77	15	0	0	0	30	30	0	60	30	30	15	15	0	15	15	0
M	f	8.57	−5	5	−25	0	35	25	10	30	35	−5	30	5	25	0	5	−5
N	f	1.97	20	0	−60	−5	35	30	5	50	20	30	60	5	55	20	5	15
Mean		2.20	14.29	5.71	−12.14	−1.2	32.86	31.43	1.43	45	29.29	15.71	24.29	10	14.29	13.57	10	3.57
Group A + B																		
Healthy hand		1.72		2.86 ($p < 0.05$)*		−1		29.29			25.36 ($p < 0.05$*)			11.43 ($p < 0.001$**)			11.43	

*Significant ($p < 0.05$) difference to operated hand Group A.
**Significant ($p < 0.001$) difference to operated hand Group A.

[a] Positive = ulnar angulation.

[b] Negative = radial angulation.

Table 4 Overall Innsbruck radial polydactyly score results in group A and group B.

Group A	Alignment (0–2)	ROM (0–2)	Stability (0–2)	Abduction (0–2)	Pinch (0–2)	IRP-Score (0–10)
A	2	2	1	2	2	9
B	0	2	2	1	1	6
C	2	2	2	1	1	8
D	0	2	0	2	2	6
E	0	2	1	1	2	6
F	1	2	1	2	2	8
G	1	2	1	2	2	8
Mean	0.86	2.0	1.1	1.6	1.7	7.3
Group B						
H	2	2	2	2	2	10
I	0	2	0	2	2	6
J	0	2	2	1	1	6
k	1	2	0	1	2	6
L	1	2	0	2	2	7
M	0	1	2	2	2	7
N	0	2	0	2	0	4
Mean	0.57	1.9	0.9	1.7	1.6	6.6

overall results were seen following anatomical articular reconstruction including musculoligamentous support of the RCLC.

Subscores 'stability' and 'alignment' provided lowest score contribution in group A (0.86 and 1.1) and B (0.57 and 0.9). This is in concordance with the literature as great influence of stability[12] and malalignment[2] in Wassel type IV on fair overall results has been mentioned in various studies.[2,12]

There is no denying the fact, that interpreting data on joint stability and alignment is nearly impossible, since demographic data, inclusion criteria, art of reconstruction and clinical evaluation exhibit great variability. Only few articles[2,16] provide clinical data of more than 25 patients. Fair results (22%), published by Tada et al., were mainly caused by malalignment including impaired ROM.[2] In their series, Wassel type IV ($N = 45$) were analysed following resection including musculo-ligamentous reinsertion, arthrodeses, arthroplasties or Bilhaut-Cloquet procedures Although occurrence of instability was negligible, follow-up in this young population consisted of 36 months.[2]

Published long-term results following anatomical reconstruction of the MCPJ on another study were excellent – without instability.[16] However, stable joints also presented impaired ROM. An explanation for less stability but unimpaired ROM of the MCPJ in our study may be given by the fact, that – in contrast to the authors – k-wire transfixation was excluded.

In addition, Larson and Nicolai documented long-term instability in all patients presenting with Wassel type IV. However, patients were treated with variable procedures.[11] Furthermore, high MCPJ instability is also reported in Wassel type IV in eight of 11 cases following anatomical reinsertion of the RCLC only.[12]

According to our work, analysis of absolute MCPJ stability values demonstrates superior results following anatomical reconstruction including musculoligamentous support in group A. Average passive ulnar deviation was less in group A (34°) compared to group B (45°).

It must not be neglected that mobility patterns of healthy MCPJs were greater in group B. We believe that we are able to confirm high inter-individual variability of joint mobility patterns in our smaller group of patients as is also reported in the literature.[23,24]

For these reasons, analysing differences to the contralateral hand has been recommended rather than comparing absolute values between individuals. MCPJ stress testing starting in moderate flexion has been recommended for biomechanical reasons of the RCLC.[25]

When comparing to the contralateral hand, the difference was greater in group B with +15.7° (−5 to 30) than in group A with +12.1°(0–30). MCPJ instability was present in only one patient in group A and four in group B.

A negative correlation between age and joint mobility patterns has been reported.[23,24] Despite lower average age on long-term follow-up in group A, we were able to describe superior stability. This is also true for alignment at MCPJ level as well as pinch grip following musculoligamentous support (group A), compared to reinsertion of the hypoplastic RCLC only in group B. Analysis revealed less ulnar angulation 11.4° (10–20) of the proximal phalanx at MCPJ level following support of the RCLC in group A compared to reinsertion only in group B 14.3° (−5 to 30).

Conclusion

According to our experience, stability and alignment have the greatest influence on the postoperative result. In the treatment of RP, it has become obvious that any effort to achieve stable thumbs should be attempted.

In the surgical correction of RP, use of best parts has been suggested.[26] Musculoligamentous support with reinforcement of the RCLC following articular reconstruction and resurfacing seems reasonable, since autologous tissue becomes available when resecting supernumerary thumbs. Our reconstructive approach is supported by clinical

experience in post-traumatic CL reconstruction where tendon grafts are routinely used.[27]

By autologous reinforcing, the RCLC including capsule and RCL, as well as thenar musculature for intrinsic balance stability, alignment and grip strength can be improved. The aforementioned should be regarded as fundamental aims in the treatment of congenital malformations of the thumb.

Disclosure

None of the authors has any conflicts of interest to declare.

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