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Review

Abductor digiti minimi opponensplasty and flexor digitorum superficialis opposition transfer: What are the main indications? A literature review

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Summary Thumb hypoplasia is a rare deformity of the hand. Type II and IIIA are the main indications for opponensplasty, together with thumbs with a residual weak opposition after pollicization. Our study operates a review of the current literature to establish which opponensplasty technique is the most appropriate for each patient. We conducted a systematic search using PubMed, Embase, and Web of Science databases. The keywords used were "thumb hypoplasia," AND "opponensplasty," "abductor digiti minimi opponensplasty," "thumb hypoplasia," AND "abductor digiti minimi," "opponensplasty," AND "hypoplasia," "flexor superficialis opponensplasty," "flexor digitorum superficialis opponensplasty." A minimum of 1 year of follow-up was required for inclusion. A total of 222 studies were recovered, of which only 9 articles satisfied our inclusion criteria. From the results obtained, the choice between abductor digiti minimi opponensplasty and flexor digitorum superficialis transfer should depend on the severity of the deformity and the main goal that should be achieved. Children with type IIIA hypoplasia characterized by more unstable joints should undergo flexor digitorum superficialis transfer to restore joint stability. On the contrary, when the instability is not of great concern,

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abductor digiti minimi opponensplasty, which aims at better defining the thenar eminence and restoring a better global hand function, should be preferred.

Contents

Thumb hypoplasia is a rare deformity of the hand associated with an abnormal development in the longitudinal radial axis.[1] It can occur isolated or in the context of a radial deficiency.[2] Blauth defined 5 grades of hypoplasia, subsequently modified by Buck-Gramko[3] and Manske et al.[4] According to this classification, thumb hypoplasia could range from a smaller but functioning opposable thumb (grade I) to a complete absence of the digit, the thenar muscles, and the carpometacarpal joint (grade V).[5] Since the thumb contributes to approximately 40% of the hand's function, a thumb deficiency could dramatically hinder the child's quality of life.[6] To restore opposition in type II and IIIA thumbs, there are 2 main opponensplasty techniques reported in the literature: the Huber-Littler opponensplasty[7,8] and the flexor digitorum superficialis (FDS) opposition transfer from the ring finger.[9,10] The prior goal is the restoration of an adequate opposition either in patients with thumb hypoplasia or patients with a residual weak opposition after index finger pollicization.[11] The Huber-Littler technique consists of the transfer of the abductor digiti minimi (ADM) muscle from the ulnar border of the hand to the thumb.[12] This technique may improve the thenar region appearance by increasing bulk in deficient hands.[11,12] In 1978, Manske and McCarroll performed ADM opponensplasty for 21 thumbs affected by hypoplasia, and this technique gained popularity.[13,14] The main concern is the postoperative instability of the metacarpophalangeal (MCP) joint, which often requires additional procedures to be performed.[12] For this reason, The FDS transfer has been introduced.[15] The flexor digitorum superficialis tendon of the ring finger is long enough to reconstruct the ulnar collateral ligament to stabilize the MCP joint.[15]

Since there is limited literature regarding both these techniques, we conducted a literature review to establish the main indications to prefer one technique over the other.

Methods

On March 19, 2024, a systematic search of all studies published in literature since then was conducted using PubMed, Embase, and Web of Science databases. The keywords used for this research were "thumb hypoplasia," AND "opponensplasty," "abductor digiti minimi opponensplasty," "thumb hypoplasia," AND "abductor digiti minimi," "opponensplasty" AND "hypoplasia," "flexor superficialis opponensplasty," "flexor digitorum superficialis opponensplasty." No filters were applied. Inclusion criteria were prospective or retrospective studies that reported functional long-term outcomes of ADM or FDS transfer in congenital thumb hypoplasia. We selected studies that focused on either patients with type II and IIIA thumb hypoplasia and studies in which patients underwent opponensplasty after index finger pollicization to improve a weak thumb opposition. A minimum of 1 year of follow-up was required for inclusion. The initial study selection was performed independently by 2 authors by screening titles

and abstracts, and the reasons for exclusion were recorded. The second check consisted of a full-text analysis to establish which articles could be included in the final review. The references of the selected studies were cross-checked to ensure every relevant study was included. Any disagreement between the 2 authors was discussed and solved. The quality of the studies and risk of bias were assessed by the same 2 authors independently using the Methodological Index for Non-Randomized Studies (MINORS) tool, focusing on the first 8 items specific for non-comparative studies[16] [Table 1]. The same 2 authors performed the extraction data from the selected studies independently. The collected data included gender, uni- or bilaterality, grade of hypoplasia according to Manske classification,[3] age at surgery, duration of follow-up, and qualitative or quantitative functional and aesthetic outcome at the last follow-up. All data were recorded using Microsoft Excel (Microsoft Corp., Redmond, Washington, Version 2210).

Results

Using the previously reported keywords, we recovered a total of 222 studies from the 3 databases. Of these, we removed 151 duplicated studies. By screening titles and abstracts, 46 studies were excluded since they did not focus on FDS or ADM opponensplasty or in which a substantial modification of the technique was proposed. Twenty-five studies underwent a full-text analysis. We excluded 1 case report, which contained only 1 case. We excluded 10 articles because they failed to meet our inclusion criteria. Ten articles were excluded since they did not meet our inclusion criteria. We excluded 5 studies because we could not retrieve them from online databases. Nine articles were included in the final review.[11,14,15,17-22]

Among them, 8 studies were recovered from the 3 databases, while 1 article was included after cross-checking the references of the included studies. All 9 studies that were included retrospectively analyzed final functional and aesthetic outcomes after ADM opponensplasty or FDS opposition transfer. The follow-up period is appropriate for this review.

ADM opponensplasty

Six included studies reported 91 cases of ADM transfer in 61 thumbs with grade II or IIIA thumb hypoplasia and 24 type V after index finger pollicization. One study[20] did not make a distinction between Manske et al.[4] type IIIA and type IIIB, reporting 6 type III thumbs. The same study included 3 type IV thumbs, which underwent opponensplasty after other surgical procedures. It was possible to make a clear distinction between male and female patients in only 5 studies,[11,14,18-20] with 48% being boys out of 69 patients. Among them, only 7 patients underwent a bilateral procedure.[11,14,18-20] The remaining study[17] focused on ADM and FDS opponensplasties and did not clearly explain sex, bilaterality, or grade of hypoplasia for each group of patients analyzed. Only 2 studies[18,20] clearly reported the grade of hypoplasia of each patient (n = 15, type II: n = 7, type III: n = 3, type IV, n = 5, type V). The earliest and oldest ages at

Table 1 Quality assessment of included articles using the MINORS tool.

Study	A clearly stated aim	Inclusion of consecutive patients	Prospective collection of data	Endpoints appropriate to the aims of the study	Unbiased assessment of the study endpoint	Follow-up period appropriate to the aim of the study	Loss to follow-up < 5%	Prospective calculation of the study size	Total score
Upton et al.[11]	2	2	2	1	0	2	2	0	11/16
Manske et al.[14]	2	2	2	1	0	2	2	0	11/16
Mende et al.[17]	2	2	2	2	0	2	2	2	14/16
Ogino et al.[18]	2	2	2	1	0	2	2	0	11/16
Oberlin and Gilbert[19]	2	2	2	1	0	2	2	0	11/16
Shibata et al.[20]	2	2	2	1	0	2	2	0	11/16
Kraker et al.[15]	2	2	2	2	0	2	0	0	10/16
Sletten et al.[21]	2	2	2	2	0	2	2	0	14/16
Vuillermin et al.[22]	2	2	2	2	0	2	2	0	12/16

surgery were from 13 months[20] to 30 years.[18] The average age at the time of operation was in the range of 2 to 7 years and 7 months.[11,14,17,18] Thirty-six hands (n = 36/91) had aplasia of thenar muscles in association with radial structure anomalies.[14,17,19] All the included articles reported no syndromes associated with thumb hypoplasia. The mean follow-up was in the range of 1 to 7 years and 6 months.[11,14,17,18,20]

FDS opponensplasty

Three included studies reported 82 cases of FDS opposition transfer in 94 thumbs with grade II or IIIA thumb hypoplasia.[15,17,21,22] Among these, 1 study focused on both ADM and FDS opponensplasties[17] and did not specify demographic data or average follow-up for each group of patients analyzed. Forty-five patients were boys, and 33 were females.[15,21,22] In 18 cases, a bilateral procedure was performed.[15,21,22] One study did not clearly report the grade of hypoplasia for each patient.[21] The remaining 2 studies[15,22] performed the FDS opponensplasty in 31 thumbs affected by type II hypoplasia and 36 type IIIA.

The earliest and oldest ages at surgery were from 2[22] to 32 years.[15] The average age at the time of operation was in the range of 4.9 to 18 years.[15,21,22] Twelve hands (n = 12/94) had radial dysplasia.[15,21,22] Sletten et al.[21] reported 12 cases of thumb hypoplasia associated with a specific syndrome or congenital disease.

Vuillermin et al.[22] performed opponensplasty in 25 patients affected by other diseases or syndromes. The mean follow-up was in the range of 6.4 to 11.9 years.[15,21,22]

Thumb function after ADM opponensplasty

Manske et al.[14] reported an optimal ADM contraction and thumb opposition after opponensplasty in 95% (20/21) of patients. The unsuccessful transfer occurred in only 1 patient who developed a flexion contracture and a limited extension of the MCP joint due to a failure in performing the surgical technique.

Mende et al.[17] used the Rotterdam Intrinsic Hand Myometer to assess thumb flexion strength at the MCP joint, opposition, and palmar abduction strength. All parameters for strength were reported to be lower than age-related normative values. However, reduction in opposition strength was the only one with a statistically significant difference ($p \leq 0.01$; opposition strength in affected thumb—mean: 30.3 kg; contralateral thumb: 36.8 kg; % of age and sex-matched normative data: 51%). Furthermore, Mende et al.[17] reported a reduction in grip strength as compared to the opposite normal thumb and the age-related normative values in the absence of a statistically significant difference.

Oberlin and Gilbert[19] reported functional results as "very good," "good," or "fairly good" related to the degree of antepulsion and rotation reached by the thumb. All children had an improvement in antepulsion and rotation of the thumb function.[19] Nine thumbs were rated as "very good," 4 thumbs as "good," and 1 thumb as "fairly good." Shibata et al.[20] reported an improvement in thumb opposition in 100% of cases. The reconstructed thumb was opposable to the little finger at 67% and to the ring finger at 100%. Ogino et al.[18] did not report any limitations in the performance of daily activities. Manske et al.[14] reported a qualitative improvement in the usefulness of the thumb. In their study, Upton et al.[11] reported a complete integration of the new thumb into hand function, without any apparent correlation between hand dominance or functional preferences for one side or the other. In the Mende et al.[17] study, the ABILHAND-Kids questionnaire was dispensed, and parents reported a majority of activities that their child could perform without the help of others. Only 1% of activities could not be completed independently and were scored as "impossible."

Thumb function after FDS opponensplasty

Kraker et al.[15] measured the range of motion of flexion, extension, radial and palmar abduction, and opposition of the thumbs both actively and passively. They distinguished 2 groups of patients: the operated type II thumbs and the contralateral non-operated type II thumbs. All the parameters analyzed were lower in the operated group than the other, but only the reduction in retroposition had a statistical significance ($p = 0.004$). In both groups, the range of motion was reduced compared with normative data. A good opposition was found after the FDS opposition transfer, with mean Kapandji scores of 7.7 in operated type II thumbs and 6.8 in operated type IIIA thumbs.

With a mean Kapandji score of 8, both type II and type IIIA thumbs showed a moderate loss in hand strength when there was good opposition. This was also shown by Sletten et al.[21] and Vuillermin et al.[22] Vuillermin et al.[22] reported a greater arc of motion at the interphalangeal (IP) joint in type II thumbs than in type IIIA (33° versus 12°, $p = 0.01$). On the contrary, there was not a significant difference in the arc of motion at the MCP joint (60° vs 24°, $p = 0.24$). When comparing ADM and FDS transfer, Mende et al.[17] reported a lower Kapandji score for the second one, but the difference was not significant.

Grip and pinch strength after ADM opponensplasty

Ogino et al.[18] reported a qualitative comparison of pinch function preoperatively and postoperatively. A total of 89% (8/9 patients) improved after the operation, moving from an absent, poor, or good pinch to an excellent pinch. One patient showed an absent pinch before surgery and moved to a satisfactory pinch function. Upton et al.,[11] described a standard quantitative method of key pinch strength measurement, which showed a remarkable reduction in the average of 40% of normal. Mende et al.[17] assessed the tip, tripod, and key pinch strength by using a pinch dynamometer. In all patients, these measurements were lower in comparison with the normal contralateral thumb ($p < 0.01$; tripod pinch in affected thumb—mean: 2.5 kg; contralateral thumb: 4.3 kg; tip pinch in affected thumb—mean: 1.3 kg; contralateral thumb: 1.8 kg; key pinch in affected thumb—mean: 2.7 kg; contralateral thumb: 5.3 kg) and with age-related normative values with a statistically significant difference. Finally, Manske et al.[14] reported a qualitative evaluation of dexterity and strength of the thumb, describing an improvement in all the operated digits. Shibata

et al.[20] evaluated key pinch and pulp pinch. While the pulp pinch was equivalent to the other hand, the key pinch was 125% of the opposite.

There was no significant loss of little finger abduction following ADM opposition transfer in Manske et al.[14]'s study. Mende et al.[17] measured the abduction strength of the little finger, resulting in a reduction after the ADM transfer compared with a normal thumb and normal age-matched values in the absence of a statistical significance.

Grip and pinch strength after FDS opponensplasty

Kraker et al.[15] evaluated hand strength between operated and non-operated type II thumbs. For the operated group, the average of grip strength measurements was approximately 48% of normal thumbs, versus 60% in the non-operated group. On the contrary, the opposition strength after surgery was increased compared with contralateral hypoplastic thumb with a statistical significance ($p = 0.01$, 72% of normal strength in operated thumb type II; 33% of normal strength in contralateral not operated thumb type II).

Little finger strength abduction after FDS opposition transfer was increased in the operated group in comparison with the non-operated group. In operated type II thumbs, pinch strength and key pinch strength were significantly greater than in type IIIA operated thumbs.

Vuillermin et al.[22] reported a greater grip and lateral pinch strength in patients with type II thumbs than in the type IIIA group. Tripod pinch, key pinch, and grip strength were 2 SD below the average of normal thumbs in both groups. Finally, Sletten et al.[21] evaluated hand strength, obtaining results comparable to previous studies.[15,22] Mende et al.[17] reported greater grip, tripod pinch, and tip pinch strengths in patients who underwent ADM opponensplasty than in the FDS opposition transfer group. However, the difference was not statistically significant. On the contrary, patients who underwent FDS transfer had a greater little finger abduction strength than others.

MCP motility and stability after ADM opponensplasty

Upton et al. (2008)[11] reported a marked limitation of motion at both MCP and IP joints in 3 thumbs following pollicization and 3 hypoplastic after ADM opponensplasty. Ogino et al. (1986)[18] reported stability of the MCP joint in 67% of thumbs (6/9). Four of the 9 thumbs were unstable at the MCP joint preoperatively and required an adductorplasty. During the follow-up, the MCP joint was stable in all 4 thumbs, but 3 of these had a radial deviation when pinching. In 1978, Manske et al.[14] found that the MCP joint was unstable and the ulnar collateral ligament was loose in 11 thumbs before surgery. However, 82% of these thumbs (9/11) had stable MCP joints after surgery. In 1 of the 2 unstable joints, additional surgery was required. In the Mende et al.[17] study, the instability rate of the MCP joint was 93% (14/15) after ADM transfer. Among these, 4 patients (29%) were unstable at 30° of MCP deviation, whereas 8 patients (57%) were both at 0° and 30°. Finally, Oberlin and Gilbert[19] reported MCP instability in t2wo cases, which required temporary pinning of the joint.

MCP motility and stability after FDS opponensplasty

In Kraker et al.[15] study all type II thumbs had a stable MCP joint, whereas 3 of the 5 type IIIA thumbs were unstable with a range of instability between 31° and 34°. Only 1 type II thumb had instability in the IP joint.

In the Sletten et al.[21] study, all MCP joints were stable on the ulnar side deviation, whereas 9 were unstable radially in the absence of a reduction in thumb function in daily activities (4 type II thumbs and 5 type IIIA thumbs). None needed additional surgeries. All IP joints were stable, but 5 type IIIA thumbs had a positive dorsal shift.

Mende et al.[17] compared the instability of the MCP joint between the group that underwent ADM opposition transfer and the group in which FDS opponensplasty was performed. No statistically significant differences were reported. Instability of the UCL of the MCP joint was found in 2 of 4 patients following reconstruction with an FDS tendon slip. In total, 75% of thumbs were unstable after FDS opposition transfer, and 93% after ADM opponensplasty.

Thenar region appearance after opponensplasty

Patient satisfaction scores after ADM transfer were reported in 1 study.[17] Parents rated the aesthetic outcome 7.4 out of 10, ranging from 3.2 to 10. According to patients, appearance was rated 7.3 out of 10 in a range of 4.6 to 9.8. All 5 remaining studies[11,14,18-20] reported an improvement in the hand's appearance by adding mass to the thenar eminence.

As concerning FDS transfer, Kraker et al.[15] asked parents and their children to evaluate appearance. Appearance was rated by parents higher in non-operated type II thumbs than in operated type II thumbs but lower in comparison with the operated type IIIA thumbs group.

Complications after ADM opponensplasty

In 1978, Manske et al.[14] reported only 1 unsuccessful ADM transfer (5%) in which the patient developed a limited extension at the MCP joint of the thumb. Five studies have described the supplementary procedure.[11,14,17-19] Upton et al.[11] performed the first web release with or without the MCP joint's ulnar collateral ligament reconstruction. Manske et al.[14] performed an ulnar MCP capsular imbrication on 1 patient to increase the stability of the joint. In 2022, Mende et al.[17] released the pollux abductus in 4 thumbs and performed an MCP corrective rotational osteotomy in 1 thumb. Oberlin and Gilbert[19] performed a Z-plasty of the first web space in 6 cases.

Complications and additional procedures after FDS opponensplasty

Vuillermin et al.[22] reported 1 case in which a muscular imbalance was developed and required extensor indices to extensor pollicis longus transfer 18 months after primary surgery. Three patients with type IIIA thumb hypoplasia underwent a subsequent radial collateral ligament reconstruction due to MCP instability. In the Sletten et al.[21] study, none of the children underwent additional surgeries. Kraker et al.[15] reoperated on 1 patient due to wound

healing problems. Another child underwent secondary surgery to regain sufficient tension in the FDS tendon transfer and stabilize the CMC joint.

Discussion

Thumb hypoplasia is marked by significant anatomical variability, which poses challenges in determining the most suitable treatment approach. In type II and IIIA thumb hypoplasia, the main goal should be the restoration of opposition by performing a muscle transfer to provide adequate strength without interfering with muscle function itself.[22]

The ideal age for surgery is controversial. Riordan et al.[23] suggested performing surgery when the child is between 3 and 6 months of age to promote a better cortical representation of the thumb. In this review, the average age at the time of operation was in the range of 2 to 18 years,[11,14,15,17-22] but the delay was not correlated with increased difficulties in developing new abilities for both techniques.

Since it is challenging to evaluate pinch strength and grip strength in children, most of the articles focus on a qualitative analysis rather than a quantitative one.[11,14,18-20] However, when the results after ADM opponensplasty were objectively assessed, it was demonstrated that operated hypoplastic thumbs are weaker than normal thumbs.[17] Opposition and pinch strength were significantly reduced when functional outcomes were compared with the opposite thumb and age-related normative values.[17] Nevertheless, the same operated children could perform a vast majority of manual activities without external help.[17] Consequently, while objective measures have highlighted strength limitations in providing quantifiable data, patient-reported outcomes have offered a more practical perspective, demonstrating that opponensplasty remains effective in ensuring functional independence.

The same strength reduction was observed in children who underwent FDS transfer,[15,21,22] since it could be attributable to the congenital disease itself. However, when Kraker et al.[15] compared the group of operated type II thumbs with the non-operated type II group, the first one was found to be even weaker than the other, demonstrating that this technique affects the overall hand strength. In addition, reduction in strength appears to be proportional to the severity of the deformity, since pinch and key pinch strengths were greater in the operated type II hypoplasia group than the operated type IIIA group.[15]

Both ADM and FDS opponensplasty have been shown to achieve good opposition, but a lower Kapandji score was reported for FDS transfer, although no statistically significant difference was found.[17] Kapandji scores after the FDS technique were similar between type II and IIIA, or better in the first one.[15,22] Overall ADM transfers have demonstrated a globally better function score and long-term strength.[17]

In the Vuillermin et al.[22] study, patients have shown a reduction in the range of motion of the IP joint, with type II hypoplasia performing better than type IIIA. The same trend was not demonstrated at the MCP joint, although a reduction was still reported.[17,22] Failure to produce IP flexion could be attributed to the congenital deformity itself and, likely, to a malposition in flexor pollicis longus (FPL) "pollex abductus" condition.[24,25] Mende et al.[17] reported 4 cases of pollex abductus managed by the release of FPL and its relocation.

For all the studies analyzed, MCP instability after ADM opponensplasty is the main concern, affecting the final functional outcome. The cause of such instability could be often attributed to an ulnar collateral ligamentous instability,[15] and it has frequently required additional procedures. On the contrary, studies on FDS transfer have shown that the less frequent instability of MCP and IP joints did not often require additional surgical intervention.[21] Therefore, this review reveals that FDS transfer can achieve superior long-term stability compared with ADM opponensplasty. However, it has been demonstrated that the more severe the deformity, the higher the likelihood of requiring an additional stabilization procedure.[15,22] Furthermore, to prevent this complication, some modifications to the Huber-Littler technique have been reported. Among these, Takayama et al.[13] proposed anchoring the ADM tendon to the adductor pollicis insertion on the ulnar side of the MCP joint, while Yamaguchi et al.[26] proposed anchoring the abductor pollicis brevis tendon by its rerouting. Both techniques aim to ensure that the transferred tendon acts as a UCL in a single-stage procedure.

All the included studies[11,14,17-19] concerning ADM opponensplasty showed an improvement of the thenar eminence, and both patients and parents were satisfied when they were asked, indistinctly between type II and IIIA thumbs. On the contrary, in the Krake et al.[15] study, the appearance of the operated hand after FDS surgery in type II thumbs was rated by parents as lower in comparison with non-operated type II thumbs but higher in comparison with the operated type IIIA thumbs group.

Conclusion

This review was able to demonstrate that opponensplasty should not be considered as a solution to restore a normal opposable thumb but as a procedure that can improve functional outcomes. Functional limitations after surgery could often be attributable to the congenital disease itself. However, the final decision on the most appropriate technique should take into account patient-specific factors and specific goals of each surgical procedure to optimize outcomes. The ADM opponensplasty aims to restore opposition and improve the thenar eminence appearance, placing less emphasis on joint stability. On the contrary, FDS opponensplasty prioritizes stability at the expense of aesthetic appearance and strength. For this reason, factors such as the type of hypoplasia and the risk of joint instability are essential in the selection of the correct technique. Type IIIA hypoplasia has, by definition, a more unstable MCP joint than type II, and, consequently, a technique that addresses this instability is essential to achieve good functionality. Therefore, for these children, FDS transfer could be the most appropriate. On the contrary, patients with type II hypoplasia, in whom the risk of instability is minimal, are better suited to the ADM technique. The same considerations should be made for children with an associated radial anomaly where instability is of great concern.

Nevertheless, some modifications to the Huber-Littler technique reported in literature seem to achieve the same

goals of ADM transfer while simultaneously correcting joint instability by transferring a tendon that simulates a UCL ligament.[13,26] These results may suggest that these variations may ensure a superior opposition transfer in patients affected by type IIIA hypoplasia than FDS opponensplasty.

This review suffers from the limitation of a paucity of studies in literature and their retrospective nature. The heterogeneity of surgical procedures and methods for choosing which technique to use in the absence of a standardized protocol could have influenced the varying outcomes across different studies, as well as the heterogeneity of methods used to analyze functional and aesthetic outcomes. The same outcomes could have varied depending on the analyzed sample and whether it included patients with other congenital diseases such as radial club hand. Moreover, qualitative assessment methods have often been used rather than quantitative ones, which are influenced by a subjective evaluation. Many results were not clearly documented, as well as complications and additional surgical procedures.

For future studies, surgical and rehabilitative protocol homogeneity followed by a unique standardized quantitative method focused on grip strength, dexterity, and stability assessment scales as well as patient-reported functional scores could better define ADM and FDS opponensplasty long-term outcomes for thumb hypoplasia.

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Conflict of interest statement

Authors have no conflict of interest to declare.

References

1. Tonkin MA. On the classification of congenital thumb hypoplasia. *J Hand Surg Eur* 2014 Nov;**39**(9):948–55.
2. Soldado F, Zlotolow DA, Kozin SH. Thumb hypoplasia. *J Hand Surg Am* 2013 Jul;**38**(7):1435–44.
3. Buck-Gramcko D. Congenital malformations of the hand and forearm. *Chir Main* 2002 Jan;**21**(2):70–101.
4. Manske PR, McCarroll Jr H, James M. Type IIIa hypoplastic thumb. *J Hand Surg Am* 1995 Mar;**20**(2):246–53.
5. Blauth W, Schneider-Sickert F. *Congenital variations of the hand.* Berlin, Germany: Springer Science & Business Media; 1981. p. 120–1.
6. Emerson ET, Krizek TJ, Greenwald DP. Anatomy, physiology, and functional restoration of the thumb. *Ann Plast Surg* 1996 Feb;**36**(2):180–91.
7. Iba K, Takayama S, Kawabata H, Horii E, Kazuki K. Assessment of hand function using the functional dexterity test after opponensplasty in young children with Blauth type 2 hypoplastic thumb. *J Pediatr Orthop B* 2020 Jul;**29**(4):403–8.
8. Light T, Gaffey J. Reconstruction of the hypoplastic thumb. *J Hand Surg* 2010 Mar;**35A**:474–9.
9. Hostin R, James MA. Reconstruction of the hypoplastic thumb. *J Am Soc Surg Hand* 2004 Nov;**4**(4):275–90.
10. Smith P, Sivakumar B, Hall R, Fleming A. Blauth II thumb hypoplasia: A management algorithm for the unstable metacarpophalangeal joint. *J Hand Surg Eur* 2012 Jan;**37**(8):745–50.
11. Upton J, Taghinia AH. Abductor digiti minimi myocutaneous flap for opponensplasty in congenital hypoplastic thumbs. *Plast Reconstr Surg* 2008 Dec;**122**(6):1807–11.
12. Wall LB, Goldfarb CA. Tendon transfers for the hypoplastic thumb. *Hand Clin* 2016 Aug;**32**(3):417–21.
13. Takayama S, Nakao Y, Ikegami H, Nakamura T. Modified abductor digiti minimi opponensplasty in congenital hypoplastic thumb with laxity of metacarpophalangeal joint. *Tech Hand Extrem Surg* 2002 Dec;**6**(4):166–70.
14. Manske PR, McCarroll HR. Abductor digiti minimi opponensplasty in congenital radial dysplasia. *J Hand Surg Am* 1978 Nov;**3**(6):552–9.
15. de Kraker M, Selles RW, Zuidam JM, Molenaar HM, Stam HJ, Hovius SE. Outcome of flexor digitorum superficialis opponensplasty for type II and IIIA thumb hypoplasia. *J Hand Surg* 2016 July;**41E**(3):258–64.
16. Slim K, Nini E, Forestier D, Kwiatkowski F, Panis Y, Chipponi J. Methodological index for non-randomized studies (*MINORS*): Development and validation of a new instrument. *ANZ J Surg* 2003 Sep;**73**(9):712–6.
17. Mende K, Suurmeijer JA, Mason WTM, Smith BJ, Tonkin MA. A detailed analysis of long-term outcomes following reconstruction for congenital thumb hypoplasia. *J Hand Surg Eur* 2022 Mar;**47**(3):270–9.
18. Ogino T, Minami A, Fukuda K. Abductor digiti minimi opponensplasty in hypoplastic thumb. *J Hand Surg Br* 1986 Oct;**11**(3):372–7.
19. Oberlin C, Gilbert A. Transfer of the abductor digiti minimi (quinti) in radial deformities of the hand in children. *Ann Chir Main* 1984;**3**(3):215–20.
20. Shibata M, Ninomiya H, Maniwa K. Abductor digiti minimi myocutaneous opponensplasty for hypoplastic thumb. *Plast Reconstr Surg* 2008 Dec;**122**(6):1807–11.
21. Sletten IN, Jokihaara J, Stavenes AB, Winge MI. Satisfactory thumb metacarpophalangeal joint stability after ligament reconstruction with flexor digitorum superficialis in children with radial longitudinal deficiency. *J Hand Surg* 2023;**48**(11):1151–8.
22. Vuillermin C, Butler L, Lake A, Ezaki M, Oishi S. Flexor digitorum superficialis opposition transfer for augmenting function in types II and IIIA thumb hypoplasia. *J Hand Surg Am* 2016 Feb;**41**:244–9.
23. Riordan DC, Powers RC, Hurd RA. The Huber procedure for congenital absence of thenar muscle. Presented to Annual Meeting of American Society for Surgery of the Hand, San Francisco, 27 February 1975.
24. Tupper JW. Pollex abductus due to congenital malposition of the flexor pollicis longus. *J Bone Jt Surg* 1969;**51A**:1285–90.
25. Lister G. Pollex abductus in hypoplasia and duplication of the thumb. *J Hand Surg Am* 1991 Jul;**16**(4):626–33.
26. Yamaguchi S, Takagi T, Seki A, Takayama S. Opponensplasty with abductor pollicis brevis rerouting for types II and IIIA hypoplastic thumbs. *J Hand Surg Am* 2024 Apr. S0363-5023(24)00072-8.