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Objective Assessment of Function in a Two-Digit Hand – A Comparison of the Functional Outcome between the Little Finger and the Index Finger as the Ulnar Post

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Background: In mutilated hand reconstruction, the choice between index or little finger as the sole ulnar post to oppose a functional thumb remains controversial. This study objectively compares functional outcomes between these two configurations in basic two-digit hand.

Methods: This retrospective study (2013–2020) evaluated 11 patients with a functional two-digit hand. Inclusion criteria included an uninjured thumb and the presence of only one uninjured digit serving as an ulnar post, either little finger (group 1) or index (group 2), characterised by good web space, sensate perception, painlessness and the ability to oppose each other in movement. Assessments included pinch and grip strength measurements, Jebsen–Taylor Hand Function Test (JHFT) and disabilities of arm, shoulder and hand (DASH) score. Non-parametric tests (Mann–Whitney *U*) compared continuous variables with significance at $p < 0.05$.

Results: Objective testing revealed superior function in group 2 patients (index finger ulnar post) patients versus group 1 patients (JHFT: 1.39 vs. 1.91 minutes; grip: 4 vs. 1.2 kg; pinch: 2.5 vs. 0.4 kg). DASH scores favoured group 2 patients (25.2 vs. 37.4), though not statistically significant ($p = 0.144$).

Conclusions: Our findings challenge traditional ulnar-digit preference, demonstrating the index finger provides significantly better strength and functional outcomes as the ulnar post in basic two-digit hands. These results support prioritising radial-digit reconstruction when the first web space is uncompromised, though individual patient factors and occupational demands should be considered.

Level of Evidence: Level III (Therapeutic)

Keywords: *Hand injuries, Reconstructive surgical procedures, Finger injuries, Thumb, Microsurgery*

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INTRODUCTION

Reconstructing mutilated hands, especially when all fingers are affected, poses a significant challenge for surgeons. The decision on the ideal location for finger reconstruction becomes pivotal, and this dilemma extends to cases requiring toe transfers for metacarpal hand reconstruction. A '*useful hand*' comprises four essential elements: a working thumb, opposable fingers

(a minimum of two fingers), sufficient web space and a stable wrist.[1–4] However, in cases of severe mutilation, reconstructing two opposable fingers may be challenging, leading to the emergence of the concept of a *'basic functional hand'*. This refers to a hand with a stable wrist, a sensory and mobile radial digit and at least one finger on the ulnar side, separated by a deep cleft, enabling meaningful prehensile movements.[5,6] The thumb, with its pivotal contribution encompassing over 40%–50% of the entire hand's functionality, naturally assumes the paramount position in the hierarchy of replantation priorities.[1–3] In instances where the thumb remains intact, or has been successfully reinstated, the subsequent choice of finger for replantation/reconstruction becomes a nuanced decision.

The ongoing debate between the little finger and the index finger as the preferred ulnar post further complicates this decision, with conflicting views on their respective advantages. Traditionally, surgeons have lacked objective evidence in making this decision, relying on subjective beliefs. While replantation prioritisation is well-discussed, the functional outcomes of intact digits (thumb + index/little finger) in mutilating injuries remain understudied. This study objectively compares functional outcomes between these two configurations in basic two-digit hand.

METHODS

Our retrospective analysis encompassed a 7-year period from January 2013 to December 2020. The inclusion criteria were patients with a two digits hand – an uninjured thumb and one uninjured digit either index or little finger serving as an ulnar post, Additionally, these patients were pain-free, had a good web space, sensate perception and the ability to oppose to each other. Eleven patients fulfilled the inclusion criteria. These included six that had the little finger as the ulnar post (Group 1) (Fig. 1), while the remaining five had the index finger as the ulnar post (Group 2). Mechanisms of injury included crush ($n = 7$), avulsion ($n = 3$) and saw injury ($n = 1$). Occupations included labourers ($n = 6$), farmers ($n = 3$) and students ($n = 2$). All patients underwent the following as assessments – (1) Pinch strength (kg); (2) Grip strength (kg); (3) Jebsen–Taylor Hand Function Test (JHFT) and 4) Disabilities of arm, shoulder and hand (DASH) score. Statistical analysis was performed using the Mann–Whitney–Wilcoxon test, a non-parametric test that compared continuous variables with significance set at $p < 0.05$.

Fig. 1. Clinical photograph demonstrating residual digits following a mutilated injury, with preserved thumb and little finger only.

RESULTS

Patients with the index finger as the ulnar post (group 2) exhibited superior performance across various metrics. The JHFT (Table 1) indicated greater effectiveness in group 2 (1.39 minutes average) compared to group 1 patients (1.91 minutes average). Grip strength (Table 2) and pinch strength (Table 3) measurements further corroborated these results, with the group 2 patients showing higher values – 4 kgs for grip strength and 2.5 kgs for pinch strength – compared to 1.2 and 0.4 kgs, respectively, in group 1. These were statistically significant for both grip strength ($p = 0.0076$; effect size $d = 3.07$) and pinch strength ($p = 0.0226$; effect size $d = 2.41$). The DASH score (Table 4) revealed a better score (25.2) in group 2 patients in contrast to group 1 patients (37.4). However, this was not statistically significant ($p = 0.1443$).

DISCUSSION

In our retrospective analysis, patients with the index finger as the ulnar post showcased superior performance across various metrics. The JHFT indicated greater effectiveness in this group compared to patients with the little finger as the ulnar post (Fig. 2). Grip strength and pinch

Table 1. Jebsen–Taylor Hand Function Test Results (Time in Minutes) Comparing Functional Task Performance between Groups 1 and 2. Values Represent Group Averages

	Average time taken to complete the task (minutes)	
	Thumb and little ($n = 6$)	Thumb and index ($n = 5$)
Writing	1.00	0.60
Card turning	1.58	1.46
Small common objects	4.54	2.15
Simulated feeding	1.16	1.57
Checkers	1.48	1.25
Large light objects	1.55	1.35
Large heavy objects	2.06	1.37
Average (minutes)	**1.91**	**1.39**

Table 2. Grip Strength Measurements (in kg) Comparing Group 1 to Group 2

Group 1 (little finger)		Group 2 (index finger)	
Patient ID	Grip strength (Kgs)	Patient ID	Grip strength (Kgs)
1	1.8	7	6.0
2	1.2	8	4.0
3	1.2	9	3.0
4	1.0	10	3.0
5	1.4	11	4.0
6	0.6	-	-
Average	**1.2**	**Average**	**4.0**

Table 3. Pinch Strength (in kg) between Group 1 and Group 2

Group 1 (little finger)		Group 2 (index finger)	
Patient ID	Pinch strength (Kgs)	Patient ID	Pinch strength (Kgs)
1	0.5	7	2.5
2	1	8	3
3	0.5	9	3.5
4	0	10	0.5
5	0	11	3
6	0.4	-	-
Average	**0.4**	**Average**	**2.5**

strength measurements further substantiated these findings, with the index finger group demonstrating higher values – 4 kgs for grip strength and 2.5 kgs for pinch strength – compared to 1.2 and 0.4 kgs, respectively, in the little finger group (Fig. 3). Moreover, the subjective evaluation through the DASH score revealed a better score (25.2) for patients with the index finger as the ulnar post, contrasting with those with the little finger (37.4). Though, this difference did not reach statistical significance (p-value 0.1443). However, while interviewing, patients expressed that the index finger was more

Table 4. Postoperative DASH Score between Group 1 and Group 2 (0–100 Scale, Higher = Greater Disability)

Group 1 (little finger)		Group 2 (index finger)	
Patient ID	DASH score	Patient ID	DASH score
1	37.6	7	41.6
2	31.3	8	12.1
3	23.2	9	21
4	33.9	10	23.2
5	62.5	11	28.1
6	35.9	-	-
Average	**37.4**	**Average**	**25.2**

Fig. 2. Jebsen–Taylor Hand Function Test performance: Patient retrieving small common objects (Marbles) using thumb-to-little finger.

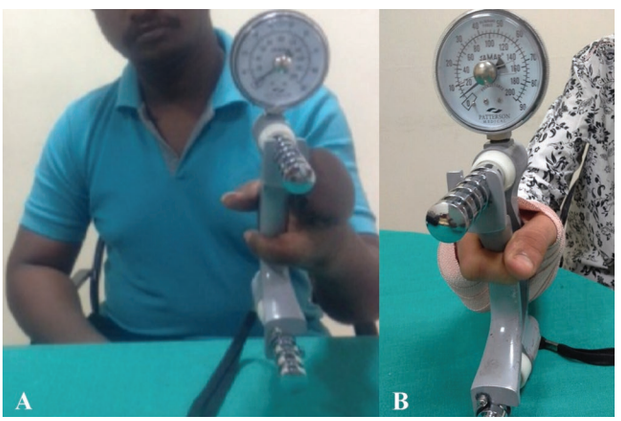

Fig. 3. Grip strength measurement using Jamar dynamometer: (A) Thumb-little finger. (B) Thumb-index finger.

'natural' for use and allowed writing and holding a spoon with greater ease. It also allowed a useful grasp of the objects they required to handle in their daily activities. None felt that the gap between the index and thumb was small for holding any object in their daily activities; however, most agreed that a large size ball may better fit the hand with the intact little finger. Patients with little finger as the only ulnar post on the other hand were quite comfortable in manoeuvring the objects and grasping them well, but felt the power of their grasp lesser and the little finger 'a bit far' to comfortably use for writing or eating with a spoon.

Thumb is undoubtedly the most important digit of the hand. However, which finger position is the best location for it to oppose effectively to result in good function is unclear. This information, nevertheless, is critical in situations where only one finger is replantable (as in mutilated hand or multiple digit crush amputation) or reconstructible (as while performing a toe transfer). Existing conflicting views in the literature may result from the fact that all the studies report the outcome of the reconstructed hand with the remaining digits also being injured. The injured digit with variably limited range of motion, pain or instability may not provide a reliable estimate of the true functional value and surely will not be comparable to other similar looking studies in the literature. This is the main strength of our study, wherein, only the patients with uninjured thumb and one digit (either index or little-uninjured) have been taken and their function has been studied in detail to give a 'true' functional status of the index and the little fingers as the only opposable post to the functional thumb. The results observed in this study lay the foundation for our conclusions and shed light on the potential superiority of the index finger as an ulnar post in the context of a basic minimum functional hand.

In the intricate realm of hand surgery, when faced with the challenge of a mutilated hand, where the amputation claims all the fingers and all of them are not replantable, the surgeon confronts a complex decision-making juncture. Instead of doing a replantation at the anatomical location he could decide to do a heterotrophic replantation or transposition microsurgery,[7–9] wherein, apart from deciding which of the fingers is replantable, he also needs to decide at which location of the finger the replanted digit will serve as the best functional post for the thumb to oppose. Of course, a greater number of replantable digits could make the decision easy but even then, the digit with the best chance of survival should be given priority. Hence, the knowledge of the best functional position of the finger would be greatly useful to streamline the surgical process and yield superior functional outcomes.

A similar dilemma arises when choosing the toe transfer site for a type-1 metacarpal hand where the thumb is the only intact digit, and the surgeon is contemplating the best placement site for the toe transfer. Rose and Buncke in 1983 proposed the concept of ulnar translocation of the selective replantation.[10] They highlighted its efficacy in providing a robust flexion arc, facilitating a potent power grasp and maintaining palm breadth. The article underscores that imperfect index fingers, following ray amputation, can still yield functional and aesthetically acceptable hands, with patients naturally bypassing the index finger during pinch activities. Selective replantation with ulnar translocation in multidigital amputations was also emphasised by Elliott and this article showcases a series of cases illustrating the ulnar translocation principle.[11] Further insights into transpositional digital microsurgical indications are offered by Soucacos, proposing a classification that encompasses patients with multidigit amputations and an intact thumb.[12,13] The preference for replanting digits on the ulnar side was advocated, preserving palm width and augmenting the power grasp.

Divergent perspectives emerge on the optimal location for digit reconstruction, with proponents of radial translocation, such as Wayne Morrison and O'Brien, advocating for a radial pinch finger as the primary preference.[14] A case report by May et al. further complicates the discourse, proposing a sequential order of replantation favouring the middle finger in a seven-digit replantation scenario.[15] Morrison and O'Brien endorsement of radial translocation for precision pinch in fine activities counters the preference for ulnar translocation in labourers requiring a robust power grasp.[14] Apart from those already mentioned, many writers emphasise the significance of the pinch grasp, highlighting the crucial role played by the radial fingers.[16–19] Wei et al. found grip strength to be greater when replanting digits to the ulnar stumps of the hand, in contrast if the patient requires better dexterity for more delicate works, digits are best reconstructed on the radial side of hand.[20] Foo and Sebastin found that a toe positioned along the fourth or fifth rays provides wide hand span at the cost of prehension and strength. Toes positioned at the second or third rays provides strength and prehension while forgoing hand span.[21]

The observed superiority of the thumb-index configuration aligns with the innate functionality of the normal hand, where the thumb and index finger synergise for precision tasks (e.g. writing, pinch) due to their mobility

and cortical representation. In contrast, the thumb-little finger pair, though advantageous for power grasp, lacks the dexterity required for fine activities. This may explain why patients with an intact index finger reported greater ease in daily tasks (e.g. utensil use) despite comparable web space dimensions. These results offer valuable insights into the functional outcomes associated with the choice of ulnar post in a basic minimum functional hand. The preference for the index finger over the little finger as the ulnar post has been a subject of debate in literature, with conflicting views advocating for either ulnar or radial digits. Our study was motivated by this discourse, and our results distinctly contribute to this ongoing conversation.

While some literature suggests the superiority of ulnar digits, particularly the little finger, our study challenges this notion by presenting compelling evidence in favour of the index finger. The superior performance observed in patients with the index finger as the ulnar post, as evidenced by objective assessments and subjective evaluations, aligns with the literature advocating for radial digits in multiple digit amputations. However, we emphasise that this proposal is valid only when the first web space is uninjured and unscarred. A narrowed first web space would obviously limit the size of the grasp and in such situation shifting the reconstruction to ulnar side may be advisable. Furthermore, the occupation of the patient, especially in bilateral injuries, may influence one's decision of reconstruction. The injury to the thumb with limitation of its movements may further complicate the decision making, which are the limitations of the clinical use of information attained in our study.

In conclusion, our study provides insight into the selection of an ulnar post in the context of establishing a minimally functional hand. The small sample size ($n = 11$) limits the generalisability of our findings. While consistent trends favoured the index finger, multicentre studies with larger cohorts are needed to generate stronger evidence. This evidence-based approach contributes to the ongoing discourse and, in such situations, supports our preference for replantation and reconstruction of the radial finger rather than the ulnar one.

DECLARATIONS

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