

## Original Article

# Comparison of opponensplasty techniques in isolated low median nerve palsy

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**Abstract:** Background: Thumb opposition is a critical operation of thumb. Median nerve palsy interferes with a large number of ordinary activities such as opposition. Opponensplasty for low median nerve injury is performed with various techniques. The purpose of this study is to compare tendon transfer techniques of Riordan and Burckhalter. Methods: This study was a clinical trial performed on 120 patients who underwent Opponensplasty. Patients with traumatic low nerve palsy were divided into two equal groups of Riordan and Burckhalter operation. Demographic information, functional status, Kapandji score, and Pulp pinching method were recorded and compared for all patients 3 months and 8 months after surgery. Findings: Performance status, Kapandji score and Pulp pinching tests showed significant improvements in both groups after surgeries. The changes in pressure between the thumb and fifth finger were significantly greater in the Burckhalter method compared with Riordan method ( $P < 0.05$ ). The incidence of complications was significantly higher in the Riordan group ( $P = 0.01$ ). Conclusion: According to the present study, there was no differences between Burckhalter and Riordan methods in terms of opposition recovery, although Burckhalter's opponensplasty had better therapeutic results. Postoperative complications were also less in the Burckhalter method.

**Keywords:** Opponensplasty, median nerve palsy, riordan, burckhalter

## Introduction

Pinching is a unique feature of the thumb that depends on the ability to perform opposition. In the case of median nerve palsy, the ability of opposition may be completely or partially lost [1]. The Abductor pollicis brevis (APB) muscle, as one of the inner muscles of the thumb, plays an important role in opposition [2, 3]. The opposition is a complex motion that requires the cooperation of Abduction, Flexion, Pronation, proximal phalanges deviation to radial, and thumb movement toward the fingers. According to the main role of APB in opposition, this muscle should be considered in case of tendon transfer to the thumb [4].

Medical issues, comorbid anomalies, anatomical damage, and patient's satisfaction are important in choosing the right muscle for

thumb tendon transfer [5, 6]. Based on previous studies, APB is the best guide for opponensplasty because this muscle contributes to abduction, flexion and pronation in the first metacarpal bone, abduction and flexion in the proximal phalanx, as well as extension in the distal phalanx [7]. Azar and colleagues suggested to use the flexor digitorum superficialis (FDS) tendon as the first option and then the third finger FDS tendon as the second option for opponensplasty in the absence of a suitable flexor tendon [8].

Opponensplasty is performed by different surgical procedures [9]. Riordan method is commonly used for restoring the thumb function [10]. Some previous data have declared some complications for opponensplasty using Riordan. These complications included limitation in finger extension, flexion contracture in the prox-

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imal interphalangeal joint, deviation of the radial side of the FDS tendon following surgery, and poorly transmitted tendon function. Various studies also have shown the acceptable return of hand function in terms of abduction and opposition, and of course, other benefits such as the proper length of the tendon and its extensibility [11, 12]. Burckhalter procedure also involves the motor transfer to the radial side of the mid proximal phalanx, just distal to the attachment site of the lumbrical and also emphasizes the primary need to restore Metatarsophalangeal joint (MPJ) flexion [13].

There is still doubt about the effectiveness of these procedures and also possible complications followed by surgical methods. Therefore, regarding the importance of restoring thumb function in patients with traumatic isolated median nerve palsy, we aimed to compare the results and side effects of Riordan and Burckhalter surgical methods in patients.

### Methods and material

#### *Study design*

This study was a randomized clinical trial performed in Tehran, Iran in 2020. Eligible patients were patients who were candidates for opponensplasty and were referred for surgical treatments to our medical centers. The current study was approved by the research and ethical committee of Tehran University of Medical Sciences.

#### *Study population*

This randomized study was performed on 120 patients who were candidates for opponensplasty who had been referred to Imam Khomeini hospital and Aban clinic in Tehran in 2015-2020.

#### *Inclusion and exclusion criteria*

Our inclusion criteria include 1) Thenar muscle atrophy due to Median nerve injury, 2) Opposition dysfunction (approved by orthopedic specialist examinations), 3) Kapandji score  $\leq 4$ , 4) the proper function of Extrinsic muscle tendons of other fingers such as Flexor pollicis longus (FPL), FDS, flexor digitorum profundus (FDP), 5) a suitable range of motion for all metacarpophalangeal and Interphalangeal joints and 6) full passive range of motion in the thumb. 1)

Patient's reluctance to participate in the study, either at the beginning or at any stage of the study, 2) contracture in the first webspace, 3) contraindications for anesthesia, 4) history of injuries to fourth finger FDS and FDP and 5) injuries to the ulnar nerve (confirmed by orthopedic examinations) were considered as exclusion criteria. We should also note that the written patient's informed consents were obtained from all patients.

#### *Measuring tools*

Before surgeries, patients completed a checklist of demographic information, as well as Pulp pinching tests (with lb measurement unit) and performance status tests. The performance status tests included 8 questions about the difficulty in writing, the difficulty in holding objects, the problem in closing the buttons of shirts, doing daily activities, the problems of bathing and moving objects. Each question was rated from 1 (lowest incidence of problem) to 5 (highest incidence of problem). Then the average of all scores was calculated. Kapandji scores were also calculated for all patients. Kapandji score is a useful tool for assessing the opposition of the thumb. Based on this score, the opposition of the thumb is scored from 1 to 10 based on the ability to touch with the tip of their thumb.

#### *Surgeries and follow-up*

Patients were then randomized into 2 groups for their surgeries. Group 1 underwent opponensplasty by Burckhalter method and group 2 underwent opponensplasty using the Riordan method [13]. Patients and clinical assessors were unaware of the surgical procedures performed for each patient. Pulp pinching tests, performance status tests and Kapandji scores were then performed for each patient 3 months and 8 months after surgeries.

#### *Statistical analysis*

Then, the data were analyzed using SPSS software (version 20, IBM Corporation, Armonk, NY). Descriptive data were reported as mean  $\pm$  standard deviation. For analytical data  $t$ ,  $\chi^2$  and ANOVA tests were used.  $P < 0.050$  was considered as a significance level.

### Results

In this study, a total number of 128 patients were included but 8 patients excluded due to

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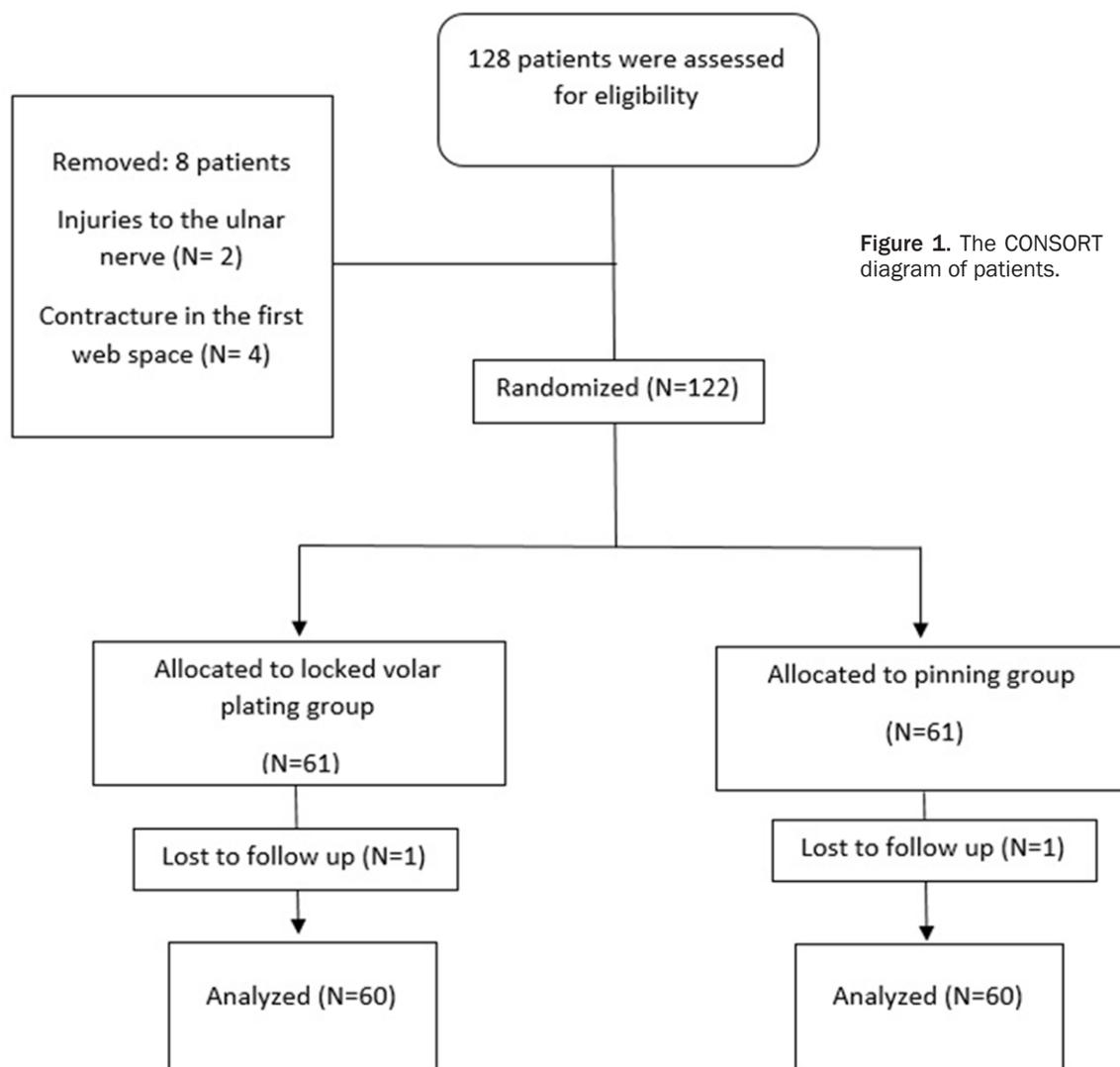


Figure 1. The CONSORT diagram of patients.

injuries to the ulnar nerve (2 patients), contracture in the first web space (4 patients) and lack of proper follow-up visits (2 patients). The CONSORT diagram of the study is illustrated in **Figure 1**. The results of 120 patients were analyzed. We indicated that the mean age of patients was  $35.1 \pm 2.4$  years. Patients were divided into two groups of 60 people. Initial analysis of demographic data showed no significant differences between two groups in terms of age, gender, damaged hand, prevailing hand injury and in terms of Kapandji score before surgeries ( $P > 0.05$ ) (**Table 1**).

Improvements in patients' recovery and performance were evaluated based on performance status test, Kapandji score and Pulp pinching before surgeries, 3 and 8 months after surgeries. The Pulp pinching test showed that the

measured pressure between the thumb and fifth finger improved significantly in both groups. These pressure changes were significantly greater in the Burckhalter method compared with the Riordan method, but no significant pressure changes were observed between the thumb and other fingers in both groups (**Table 2**).

We should note that 3 patients in the Riordan group gained 10 points by Kapandji, while 15 patients from the Burckhalter group had this score ( $P < 0.001$ ). There were no significant differences between the two groups in terms of gaining 9 points of Kapandji score ( $P = 0.42$ ).

Evaluation of surgical complications were as follows; Twenty-four patients (40%) from Burckhalter and six patients (10%) from Riordan

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**Table 1.** Demographic data of patients

Demographic variables		Group		P-value
		Burckhalter (N=60)	Riordan (N=60)	
Age (mean ± SD)		35.4±2.7	34.8±2.2	0.144
Time interval between injury and surgery (months) (mean ± SD)		12.4±3.3	11.5±2.1	0.137
Gender	male	48 (80%)	42 (70%)	0.333
	Female	12 (20%)	18 (30%)	
The injured hand	Right	48 (80%)	36 (60%)	0.133
	Left	12 (20%)	24 (40%)	
Matching the injured hand with the prevailing hand	Yes	48 (80%)	42 (70%)	0.333
	No	12 (20%)	18 (30%)	

**Table 2.** Comparison of thumb function tests among patients

Variable	Time	Groups		P-value**	P-value*	
		Burckhalter (N=60)	Riordan (N=60)			
performance status test (mean ± SD)	Before	33.4±2.5	31.5±2.8	0.08	0.14	
	After 3 months	20.4±3.9	19.5±3.1	0.42		
	After 8 months	15.2±4.7	13.8±3.3	0.23		
	P-value***	>0.001	>0.001			
Kapandji score (mean ± SD)	Before	2.8±0.7	2.9±0.3	0.73	0.10	
	After 3 months	8.2±0.4	7.9±0.5	0.03		
	After 8 months	9.5±0.8	8.9±0.4	0.02		
	P-value***	>0.001	>0.001			
Pulp pinching (mean ± SD)	Thumb-index	Before	4.9±1.0	5.2±0.8	0.62	0.88
		After 3 months	19.2±3.0	19.5±2.4	0.83	
		After 8 months	25.2±4.4	25.1±3.9	0.77	
		P-value***	>0.001	>0.001		
	Thumb-third finger	Before	1.9±0.5	2.2±0.7	0.63	0.88
		After 3 months	15.5±3.6	16.2±4.8	0.74	
		After 8 months	20.5±4.1	20.8±3.7	0.88	
		P-value***	>0.001	>0.001		
	Thumb-fourth finger	Before	0	0	-	0.58
		After 3 months	12.7±2.4	13.4±3.2	0.78	
		After 8 months	17.2±3.3	17.8±4.6	0.42	
		P-value***	>0.001	>0.001		
Thumb-fifth finger	Before	0	0	-	>0.001	
	After 3 months	11.2±2.7	10.3±3.1	0.01		
	After 8 months	15.8±3.8	13.7±3.3	>0.001		
	P-value***	>0.001	>0.001			

Data analysis was performed using repeated measures test. \*: between groups, \*\*: paired, \*\*\*: inside groups.

complained of mild to moderate pain at the surgery site. Also, 12 patients (20%) who underwent Riordan surgery had hyperextension in the proximal interphalangeal fourth finger; while no restriction of extension was found in patients undergoing surgery using Burckhalter's method. The incidence of complications was significantly higher in the Riordan group (P=0.01).

### Discussion

The thumb is an important part of the hand that is responsible for most daily activities. The importance of the actions of this finger becomes clearer when we know that the usual daily activities are significantly lost in the absence of opposition. Therefore, patients who lose their ability to Pronation, Abduction, and Flexion due

to traumatic thumb injury are significantly limited in their daily activities [14]. To treat this condition, two methods of tendon transfer, including EIP (Burckhalter method) and FDS tendon (Riordan method) of the ring finger are recommended. Although both methods have been proposed, the number of studies comparing these two methods is limited. A comparison of the two groups showed no significant differences in terms of demographic information. Therefore, the possible variables of the intervention were eliminated and all the differences between the two methods after Riordan and Burckhalter surgery could be related only to the surgical method. Here we indicated that measured pressure between the thumb and fifth finger changed significantly in both groups. These pressure changes were significantly greater in the Burckhalter method compared with Riordan method. Our data also indicated that 3 patients in Riordan group gained 10 points by Kapandji, while 15 patients from the Burckhalter group had this score. We also showed that the incidence of complications was significantly higher in the Riordan group.

Based on our results, Burckhalter opponensplasty is more effective and beneficial with fewer complications compared to Riordan technique. We also suggest that orthopedic surgeons should pay more attention to choose a more effective surgical method for patients. There have been some studies comparing different opponensplasty methods. Other studies have examined several methods and reported a variety of results. In a study, the success of different methods was reported between 75-100% [15]. Skie and colleagues compared different methods and compared the strengths and weaknesses of Flexion, Extension, Abduction, and Pulp pinching. Finally, they concluded that the Riordan method was superior to all other methods [16]. These results are somehow in line with our findings indicating the effectiveness of Riordan technique in patients but on the other hand, they did not evaluate the Burckhalter method. Jafari and colleagues also compared the results of opponensplasty by Riordan and Burckhalter techniques. They reported the Burckhalter method was successful for all patients and 80.6% of them had excellent results. On the other hand, Riordan method brought excellent results for 60.4% of patients [17]. These results are also in line with

the findings of our study. A key point of our study was that we indicated a higher prevalence of surgical complications among patients operated by Riordan method. As mentioned, we believe that Burckhalter method is superior to Riordan technique due to better surgical results and fewer complications. So far, very few studies have compared these two techniques.

In another study by Lemonas and others in 2012, the success of Opponensplasty was assessed using the EIP method and it was reported that the results of the Burckhalter method acceptable for FDS tendon Opponensplasty [18]. Al-Qattan also reported that using Burckhalter's Opponensplasty surgery, 80% of patients had excellent results and the other 20% had good results [19]. These results are also in line with the finding of our study but here we evaluated the results of opponensplasty by pulp pinching tests, performance status tests and Kapandji scores. But previous studies evaluated their patients mostly using qualitative techniques.

The next factor to consider is the side effects of these two methods. Our data showed that the side effects of Burckhalter were significantly fewer than the side effects of Riordan. The number of studies examining the side effects of opponensplasty is limited. Anderson and colleagues did not report any significant complication following the FDS method of Opponensplasty [20]. In the study of Al-Qattan and others, they did not report any Extension lag or postoperative complications for Burckhalter technique [19]. These findings were similar to the present study.

### Conclusion

Taken together, we showed that there was no difference between Burckhalter and Riordan's methods in Opponensplasty in terms of recovery; however, Burckhalter's Opponensplasty had better therapeutic results. We also indicated that this method had fewer complications compared to Riordan technique. These results were in line with the findings of most previous studies but here we performed the current study on a larger population and believe that these results are more reliable.

### Disclosure of conflict of interest

None.

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