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Original Article

Functional Outcome by Evaluation of DASH Score on Drop Hand Patient Treated with Jones' Tendon Transfer: A Retrospective Study

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ABSTRACT

Background: Drop hand, resulting from radial nerve injuries, causes functional and structural disabilities. Tendon transfer becomes the last option when nerve repair fails to achieve restoration. The most popular method is the Jones tendon transfer to restore wrist dorsiflexion and extension of the thumb and fingers. The Disabilities of the Arm, Shoulder, and Hand (DASH) score measures functional outcomes in patients with upper extremity injuries. This study aimed to assess the functional outcome and evaluate the DASH score in drop hand patients who underwent Jones tendon transfer surgery at Prof. Dr. R. Soeharso Orthopaedic Hospital Surakarta.
Methods: Data collected from medical records between January 2014 and June 2016 were evaluated based on functional outcome and DASH score. Eleven patients were included, comprising ten male patients (90.9%) and one female patient (9.1%). The mean age of the patients was 27.4 years. The right arm was the most frequently injured, accounting for eight patients (72.7%), while the left arm was injured in three patients (27.3%).
Results: The DASH score evaluation indicated minimal disability in ten patients (90.9%) and moderate disability in one patient (9.1%). The average score was 12.48, indicating that most patients could cope with most daily living activities postoperatively.
Conclusions: Surgical intervention for drop hand due to radial nerve palsy using the Jones tendon transfer technique yielded a satisfactory functional outcome based on the DASH score.

Keywords: DASH score; Drop hand; Jones' tendon transfer; Retrospective study; Traffic accidents

INTRODUCTION

Radial nerve injury significantly impairs hand function, leading to a substantial decline in a patient's activities of daily living (ADLs). A common clinical manifestation of this injury is drop hand, which can arise from a fracture of the humeral diaphysis. The radial nerve's close proximity to the periosteum of the middle third of the humerus makes it particularly vulnerable to injury during such fractures. This vulnerability is underscored by the fact that approximately 10% to 17% of humeral fracture cases are accompanied by radial nerve injury.[1-3]

In cases of closed humeral diaphysis fractures, the nerve injury may present as neurapraxia, a condition that often resolves spontaneously without the need for surgical intervention. However, if the injury involves nerve crush or transection, recovery may be delayed. In such cases, nerve exploration is typically performed if spontaneous recovery does not occur within three months.[1-3]

In instances where the injury results in contusion, laceration, or neurotmesis, healing may not occur even after surgical intervention in the form of radial nerve reconstruction. When this occurs, tendon transfer is considered a viable option to maintain wrist and finger extension.[1–3] Approximately 10% to 17% of humeral fracture cases are accompanied by radial nerve injury.[4,5] In closed humeral diaphysis fractures, the nerve injury may manifest as neurapraxia and heal spontaneously, allowing for non-surgical management.[6] However, delays in recovery can occur due to nerve crush or transection during the injury. Therefore, nerve exploration is conducted in cases where spontaneous recovery does not occur within three months. In other instances where contusion, laceration, or neurotmesis are identified, healing may not occur even after surgical intervention in the form of radial nerve reconstruction. In these cases, tendon transfer is considered to maintain wrist and finger extension.[6,7] Tendon transfer procedures must adhere to several principles and requirements, involving a multidisciplinary team, including the orthopedic surgeon, medical rehabilitation physician, physiotherapist, and the patient. One of the most popular and commonly used tendon transfer techniques is the Jones tendon transfer. This technique is employed to restore wrist dorsiflexion and extension of the thumb and fingers.[7]

A scoring system is essential for measuring extremity function after therapeutic intervention, assessing the influence of modalities on the patient, and determining injury progression. The Disabilities of the Arm, Shoulder, and Hand (DASH) score is frequently used to assess the functional outcome and range of motion of the upper extremity, especially in patients with radial nerve injuries.[8]

MATERIAL AND METHODS

Study Design

This study retrospectively evaluated functional outcomes in patients diagnosed with humeral fracture associated with drop hand who underwent Jones tendon transfer at Prof. Dr. R. Soeharso Orthopedic Hospital Surakarta between January 2014 and June 2016. Functional outcomes were assessed using the DASH score (Table 1).

Surgical Technique

The surgical procedure was performed under general anesthesia with incisions made on the volar and dorsal aspects of the forearm (Figure 1) using a tourniquet. Three tendons served as donors, and several tendons acted as recipients:

Table 1. Interpretation of DASH score

Score (%)	Category	Interpretation
0 - 20	minimal disability	Patients can cope with most living activities; usually, no treatment is indicated apart from advice on lifting sitting exercise.
21 - 40	moderate ability	Patient experiences more pain and difficulty with sitting, lifting, and standing; travel and social life are more difficult. They may be disabled from work; personal care, sexual activity, and sleeping are not affected and can usually be managed conservatively.
41 - 60	severe disability	Pain remains the main problem, and activities of daily living are affected; these patients require a detailed investigation.
61 - 80	crippled	Back pain impinges on all aspects of the patient's life, positive intervention is required.
81 - 100		Patients either bed-bound or exaggerating their symptoms

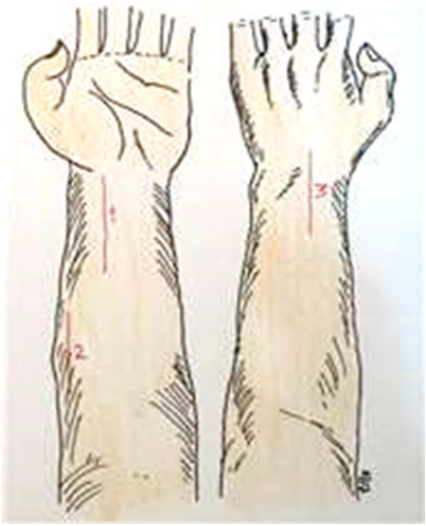

Figure 1. Operative Technique

The pronator teres (PT) tendon was transferred to the extensor carpi radialis brevis (ECRB) and longus (ECRL) to restore wrist dorsiflexion. The flexor carpi radialis (FCR) tendon was transferred to the extensor digitorum communis (EDC) to extend the fingers. The palmaris longus (PL) tendon was transferred to the extensor pollicis longus (EPL) to extend the thumb. In three patients, an alternative technique was used to extend the wrist and fingers simultaneously: the FCR tendon was transferred to the ECRL, ECRB, EDC, and extensor indicis proprius (EIP). FCR-based tendon transfer was performed in all patients in this study.

Tendon Transfer and Repair

The PT tendon was sutured end-to-side to the ECRB and ECRL tendons at maximum tension (with the wrist fully extended), and the FCR tendon was sutured to the EDC tendons with the metacarpophalangeal (MCP) and interphalangeal (IP) joints fully extended, using non-absorbable 4/0 sutures. The PT tendon was harvested with a strip of periosteum. The four EDC tendons were divided just distal to their musculotendinous junction. The PL tendon was sutured to the EPL tendon, which was divided proximally near its musculotendinous

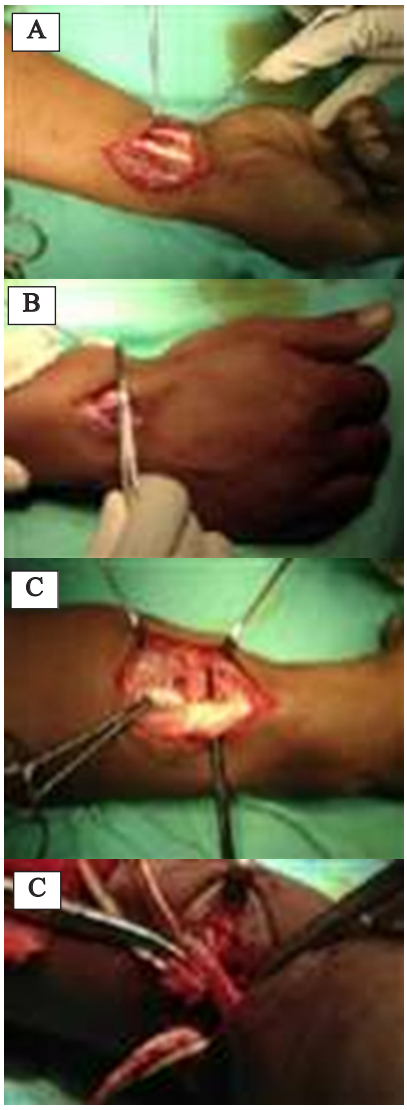

Figure 2. (A) volar approach to explore PL (black arrow) and FCR tendon (white arrow), (B) dorsal approach for exploring ECRL-ECRB (blue arrow) and EPL tendon (green arrow), (C) approach for exploring PT tendon (yellow arrow), and ECRL+ECRB tendon (red arrow), and (D) stitch FCR tendon (grey arrow) to EDC tendon (white arrow).

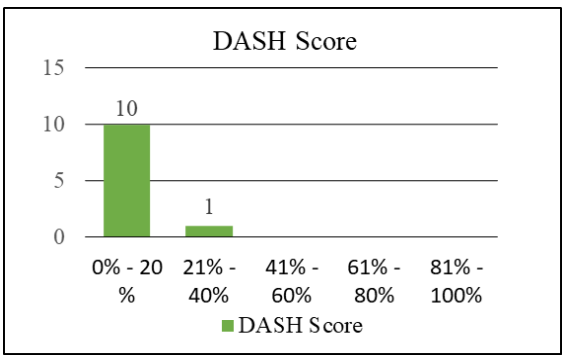

Figure 3. Diagram of the DASH score

Table 2. The patients' data

No	Name	Sex	Age	Side	Tendon Transfer	DASH Score	Interpretation score	Date
1.	SOD	M	31	R	PT → ECRL+ECRB PL → EPL FCR → EDC	10.8	minimal disability	Feb 2014
2.	AZH	M	30	L	PT → ECRL+ECRB PL → EPL FCR → EDC	8.3	minimal disability	Jun 2014
3.	WID	M	62	R	PT → ECRL+ECRB PL → EPL FCR → EDC	15.8	minimal disability	Jun 2014
4.	AHD	M	21	R	PT → ECRL+ECRB PL → EPL FCR → EDC	9.2	minimal disability	Sep 2014
5.	SUW	M	38	L	PT → ECRL+ECRB PL → EPL FCR → EDC	15	minimal disability	Apr 2015
6.	DES	F	25	R	PT → ECRL+ECRB PL → EPL + APL FCR → EDC	10	minimal disability	May 2015
7.	FRE	M	20	R	FCR → ECRL + ECRB + EDC + EIP PL → EPL	11.6	minimal disability	Oct 2015
8.	IRH	M	23	L	PT → ECRL+ECRB PL → EPL FCR → EDC + EDM	9.1	minimal disability	Nov 2015
9.	MIS	M	20	R	FCR → ECRL + ECRB + EDC PL → APL + EPB	14.2	minimal disability	Jan 2016
10.	MIR	M	16	R	FCR → ECRL + ECRB + EDC PL → EPL	10.8	minimal disability	Feb 2016
11.	ALF	M	15	R	PT → ECRL+ECRB PL → EPL FCR → EDC	22.5	moderate disability	Mar 2016

junction (Figure 2). All of these procedures were performed using the Pulvertaft technique.

Postoperative Management

Postoperatively, all patients were placed in a forearm slab with the wrist in 60 degrees of dorsiflexion and the thumb and fingers in full extension. The slab was maintained for three weeks.

This revised structure provides a clearer presentation of the methods by grouping related information under relevant subheadings. However, it's important to note that without further information on the data analysis procedures, it's not possible to create a separate section for that aspect.

RESULTS

Eleven patients met the inclusion criteria (Table 2), with a gender ratio of 10 male patients (90.9%) and one female patient (9.1%). The right arm was the most affected site, with eight patients (72.7%) experiencing injury to this extremity, while the remaining three patients (27.3%) sustained injuries to the left

arm. Operative treatment for drop hand patients using the Jones tendon transfer at Prof. Dr. R. Soeharso Orthopedic Hospital Surakarta between January 2014 and June 2016 demonstrated a good functional outcome.

Evaluation using the DASH score indicated minimal disability in ten patients (90.9%) and moderate disability in one patient (9.1%), with an average score of 12.48 (minimal disability). These results are presented in Figure 3.

DISCUSSION

The radial nerve is the most vulnerable to injury among the upper extremity peripheral nerves, particularly in the context of humeral fractures. This vulnerability arises from the nerve's close proximity to the bone, making it susceptible to damage during fractures. The radial nerve plays a crucial role in controlling the muscles responsible for wrist, finger, and thumb extension. Consequently, injury to this nerve can lead to significant functional impairment, including the characteristic "drop hand" deformity, where the wrist and fingers are unable to extend.[1]

Treatment depends on the primary cause and severity of nerve damage. While type C and open fractures tend to be associated with more severe nerve damage, fracture type and trauma mechanism have no significant influence on the grade of nerve damage.[9] Most researchers contend that tendon transfer in patients with radial nerve palsy can yield good results when nerve repair is unsuccessful. If no improvement in radial nerve function is observed within one year, tendon transfer may be recommended.[10]

Over a 2.5-year period, between January 2014 and June 2016, eleven patients with humeral fracture and drop hand underwent Jones tendon transfer at Prof. Dr. R. Soeharso Orthopedic Hospital Surakarta and met the inclusion criteria for this study. Male patients outnumbered female patients. The average patient age was 28 years, with the highest vulnerability to humeral fracture associated with radial nerve injury occurring between 15 and 25 years of age. This finding is consistent with the literature, which indicates that the majority of fractures occur between 12 and 19 years of age due to high-energy trauma, such as that experienced in traffic accidents.[11] All patients who met the inclusion criteria were right-hand dominant.

The literature suggests that specific combinations of tendon transfers have proven successful and have become the standard in drop hand surgery. The currently accepted best tendon transfer combinations are:

- PT → ECRL + ECRB
- PL → EPL
- FCU → EDC

In this study, the most frequent techniques used by the amount of 8 times were:

- PT → ECRL + ECRB
- PL → EPL
- FCR → EDC

The tendon transfer technique, first described by Sir Robert Jones in his 1916 paper, involved transferring the pronator teres to the radial wrist extensors, the flexor carpi ulnaris (FCU) to the extensors of the third, fourth, and fifth digits, and the flexor carpi radialis to the extensor pollicis longus and extensor indicis. However, using both the FCR and FCU decreased wrist flexion power and resulted in excessive wrist dorsiflexion during finger extension.[12] Controversy surrounds the use of the FCU or FCR for transfer to motorize the extensor digitorum communis EDC for metacarpophalangeal joint extension. The authors preferred the FCR tendon to the FCU as the transfer option for finger extension based on several factors: [7,11,13]

- The FCU tendon has greater power, but its excursion is too short (3 cm) for use as a

finger extensor; the minimum requirement is 5 cm.
- The FCU is the primary ulnar stabilizer of the wrist joint, making it too valuable to sacrifice; its loss may decrease grip strength and impair activities such as hammering and dart throwing.
- The FCU cannot provide simultaneous wrist dorsiflexion and finger extension.

Other advantages of using the FCR as a tendon donor include:[7]
- Only one incision is required to perform both the PT and FCR transfers.
- Fewer incisions are needed compared to FCU tendon transfer.

Three patients underwent surgery using the following combination:
- FCR → ECRL + ECRB + EDC (+ EIP)
- PL → EPL (+ EPB)

This study investigated the functional outcomes of using the Jones tendon transfer technique for the treatment of drop hand. This "single tendon" transfer utilizes a single tendon to restore thumb and finger extension. While this technique does not demonstrate superior outcomes compared to other standard techniques, it offers the advantage of a simpler surgical procedure.

A study by Al-Qattan supports the finding that this technique allows for some independent finger and thumb function. The study found that patients who underwent the Jones tendon transfer were able to perform a variety of activities of daily living, including eating, dressing, and grooming, with reasonable function. This suggests that the Jones tendon transfer is a viable option for patients with drop hand who are seeking to improve their functional independence.[13]

This study has several limitations. The sample size was small (eleven patients), and the study was conducted at a single center, which may limit the generalizability of the findings. Additionally, the study did not include a control group, so it is not possible to definitively attribute the observed outcomes to the tendon transfer. Finally, long-term outcomes were not assessed.

Further research is needed to address the limitations of this study. Larger, multicenter studies with longer follow-up periods are needed to confirm the findings of this study and to determine the long-term efficacy of the Jones tendon transfer for the treatment of drop hand. Future studies should also include a control group to allow for a more rigorous evaluation of the intervention. Additionally, future research could explore the use of the Jones tendon transfer in combination with other treatments, such as nerve grafting or electrical stimulation.

CONCLUSIONS

The operative treatment using the Jones tendon transfer for drop hand patients at Prof. Dr. R. Soeharso Orthopedic Hospital Surakarta between January 2014 and June 2016 yielded satisfactory functional outcomes as assessed by the DASH score.

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