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Original article

# Results and complications of superficialis-to-profundus tendon transfer in brain-damaged patients, a series of 26 patients

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ABSTRACT

*Introduction:* In hemiplegic patients with a spastic clenched fist deformity, one of the goals of surgery is to address the hygiene, nursing and appearance problems. Transfer of the flexor digitorum superficialis (FDS) to the flexor digitorum profundus (FDP), initially described by Braun and colleagues, opens the non-functional hand in these patients. The primary objective of our study was to confirm the effectiveness of this technique for correcting these deformities. The secondary objectives were to demonstrate potential functional gains and to identify potential complications.
*Material and methods:* A Braun procedure was performed in 26 patients (9 women, 17 men, ranging in age from 36 to 79 years). The overall appearance of the hand was graded using the Keenan classification system. Complications related to the surgery were documented. The hand's function was evaluated with the House score.
*Results:* The average follow-up was 47 months. Preoperatively, all patients had a class V hand: severe clenched-fist deformity with zero pulp-to-palm distance. Postoperatively, 10 patients had a type I hand (open hand, with less than 20° spontaneous extension deficit of the metacarpophalangeal (MCP) and proximal interphalangeal (PIP) joints) and 12 patients had a type II hand (20° to 40° spontaneous extension deficit of the MCP and PIP joints). The mean House score for all patients went from 0 to 0.88, and seven patients had functional improvements. Four patients had a forearm supination posture, 10 had intrinsic deformity with spontaneous MCP flexion and 6 had a swan-neck deformity.
*Conclusion:* Superficialis-to-profundus tendon transfer (STP) provides satisfactory outcomes in terms of hand opening, with some patients also experiencing improved hand function. However, the complications cannot be ignored.
*Level of evidence:* IV–retrospective or historical series.



## 1. Introduction

Hand spasticity in brain-damaged adults contributes to sensory, muscle tone and motor control problems. Lance defined spasticity as a "motor disorder characterized by a velocity-dependent increase in tonic stretch reflexes (muscle tone) with exaggerated tendon jerks, resulting from hyperexcitability of the stretch reflex, as one component of upper motor neuron syndrome" [1]. The main causes of this spasticity are vascular hemiplegia and severe traumatic brain injury (TBI). The spastic hand is typically labelled as "functional" or "non-functional" [2]. Patients with non-functional hands are unable to grasp objects because their hand is closed (clenched fist) and their wrist flexed; this leads to hygienic problems and has a psychosocial impact because the hand is unaesthetic. Surgery has a palliative objective: opening the hand helps to resolve the hygienic and nursing care problems and to improve the hand's appearance. Among the various surgical treatment options, transfer of the flexor digitorum superficialis (FDS) to the flexor digitorum profundus (FDP), initially described by Braun et al., allows opening of the hand in these patients [3,4].

The primary objective of our study was to confirm the effectiveness of this technique for reducing the trophic disorders and the pain caused by these deformities. The secondary objectives were to demonstrate potential functional gains and to identify any complications.

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**Table 1**
Classification for hand position developed by Keenan et al. [5].

| Type of hand | Wrist | MCP | PIP | Poor local metabolism | Appearance |
|---|---|---|---|---|---|
| I  | Neutral to 20° extension | 20° flexion | 20° flexion | – | Very good |
| II  | Neutral | 40° flexion | 40° flexion | – | Good |
| III  | 0° to 20° extension | Complete extension | Complete extension | – | Good |
| IV  | 20° to 30° extension | Hyperextension | Flexion | – | Not acceptable |
| V  | Flexion | Flexion | Flexion | ++ | Not acceptable |

## 2. Patients and methods

### 2.1. Preoperative evaluation

All our patients underwent a combined medical and surgical consultation. The multidisciplinary team consisted of physical medicine and rehabilitation physicians, orthopedic surgeons, physical therapists and occupational therapists. Photographs or videos were taken. The appearance of the hand and position of the fingers and wrist were evaluated. The hands were described using the five levels (I to V) classification system developed by Keenan et al. [5] (Table 1). Class V hands have a severe clenched-fist deformity with zero pulp-to-palm distance and may have severe trophic disorders.

Complications of the spasticity were documented: trophic disorders of the palm of the hand (maceration, odors), hygienic problems, and pain. Hygiene maintenance was classified as follows: Stage 0–no problems, stage 1–moderate problems (maceration, odors) that make hygienic care difficult, stage 2–major problems (skin lesions, nail prints in the palm) that make hygienic care impossible. Pain was graded as follows: stage 0–no pain with visual analog scale (VAS) for pain less than 1, stage 1–VAS for pain between 1 and 5, stage 2–VAS for pain between 6 and 10. In patients without hygienic problems the indication was to improve the hand's appearance by opening it. The House score was used to evaluate the hand's grasping ability (Table 2) [6].

Preoperatively, all patients received botulism toxin injections and a more specific evaluation with nerve blocks to refine the indication for associated surgical procedures.

**Table 2**
Functional classification developed by House et al. [6].

| | | |
|---|---|---|
| 0 | Does not use | |
| 1 | Poor passive assist | Uses as stabilizing weight only |
| 2 | Fair passive assist | Can hold onto object placed in hand |
| 3 | Good passive assist | Can hold onto object and stabilize it for use by other hand |
| 4 | Poor active assist | Can actively grasp object and hold it weakly |
| 5 | Fair active assist | Can actively grasp object and stabilize it well |
| 6 | Good active assist | Can actively grasp object and then manipulate it against other hand |
| 7 | Spontaneous use, partial | Can perform bimanual activities easily and occasionally uses the hand spontaneously |
| 8 | Spontaneous use, complete | Uses hand completely independently without reference to the other hand |

### 2.2. Surgical technique

The surgical program consisted of superficialis-to-profundus tendon transfer (STP) in all patients and wrist stabilization for the 20 patients who had a hyperflexion deformity (more than 20° flexion). Other procedures were performed as needed: neurectomy of the deep branch of the ulnar nerve to combat spasticity of the intrinsic muscles; tenotomy of the wrist flexors to correct wrist flexion deformity, and procedures for thumb-in-palm, if present pre-operatively, to open the first web space (tendon lengthening and transfer, arthrodesis) (Table 3). The wrist procedures were performed before the STP transfer.

An "en masse" transfer of the FDS tendons to the FDP was performed as described by Braun et al. [3,4] and modified by Botte et al. [7,8] (Fig. 1). The procedure was performed under general anesthesia. A tourniquet was placed at the root of the arm and inflated for the duration of the procedure. A curvilinear incision was made at the forearm. After careful dissection and hemostasis, the FDS and FDP tendons were synchronized by suturing them together using a single stitch. During this synchronization, particular care was taken to ensure all the fingers had the same flexion. The synchronization point was proximal on the FDP and distal on the FDS. The two points had to be separated by at least 5 cm because complete finger extension requires 7 cm of excursion. The tendons were transected relative to the synchronization point distally for the FDS and proximally for the FDP. End-to-end suturing was performed with tension adjusted by recutting as needed. The two ends were sutured using a Kessler pattern combined with a peripheral running suture. This

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