# CORRECTION OF CLAW FINGERS IN LEPROSY BY THE BRAND FOUR-TAILED TENDON GRAFT OPERATION

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## SUMMARY

*Many operations have been described for the correction of claw hands following involvement in leprosy, from Sir Harold Stiles (1922) of Edinburgh, through Bunnell, Brand and many others in India and USA. Some of these procedures are classified "static" and attempt mainly to correct hyper-extension at the metacarpo-phalangeal joint, while the "dynamic" procedures employ a variety of tendon graft operations to restore the function of the paralysed lumbrical muscles. This study is an analysis of the four-tailed tendon graft operation of Paul Brand, carried out in the National Leprosy Control Centre, Sungei Buloh, Selangor, during the period 1965-175, by a host of surgeons, mainly by Dr M.K. Bhojwani, MRCP, FRCSEd, the Director of the Centre at that time. The analysis carried out during November-December 1976, was made on 36 hands in 33 patients; it revealed an average improvement in the metacarpo-phalangeal joint flexion of nearly 90% and in the proximal interphalangeal joint extension in nearly 80%, and an improvement in the grafted lumbrical voluntary motor tone of nearly 70%.*


## INTRODUCTION

Involvement by *Mycobacterium leprae* of the ulnar nerve in the hand produces paralysis of all the hypothenar and interosseous muscles and the lumbrical muscles to the ring and little finger. Median nerve involvement paralyses, amongst others, the lumbrical muscles to the index and middle fingers. The basic anatomical deformity produced by leprous involvement of the ulnar and median nerves in the hand, and designated "claw hand", is due to the paralysis of the four lumbrical muscles.

As a result of the lumbrical paralysis, there follows: hyperextension at the metacarpo-phalangeal (MCP) joint; loss of extension at the inter-phalangeal (IP) joint; loss of abduction and adduction of the digits, also due to interossei paralysis; flexion begins at the terminal joint instead of the MCP joint as in normal digits; and the effective part of the finger becomes the tip and nail rather than the pulp of the finger, as classically shown.[2] Because of these, the hand becomes "clawed" and functionally is unable to grasp large objects (Fig. 1).

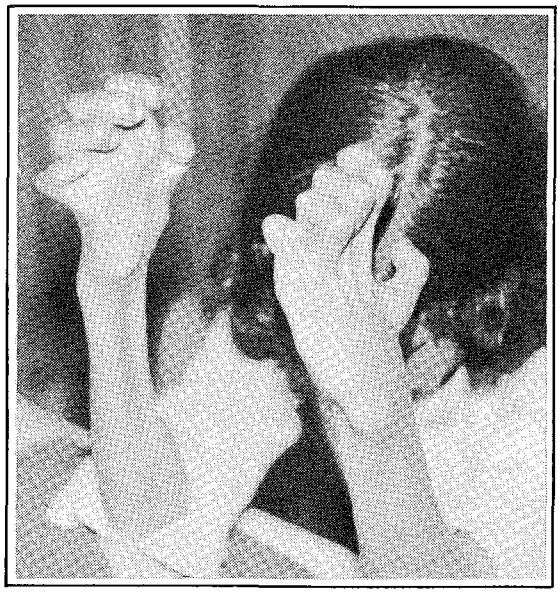

**Fig. 1 The anatomical deformities in claw hands of leprosy.**

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In 1954, Paul Brand worked in Vellore, South India. Upon finding the Stiles-Bunnel procedure of re-routing the flexor digitorum sublimis (FDS) tendon through the lumbrical canal unstable as it produced secondary deformities especially in the more mobile Indian claw fingers, Brand devised his technique of employing a wrist extensor to provide the motor power, using either the extensor route (Mark I) or the flexor route through the carpal tunnel (Mark II).

Corrective surgery for leprosy-clawed hands began modestly in the National Leprosy Control Centre, Sungei Buloh, Selangor, in 1958, mainly in the form of the Stiles-Bunnel and Fowler operations. From 1965 onwards, the Brand four-tailed operation became the procedure of choice.

## MATERIALS AND METHOD

An assessment of 36 hands (144 fingers) in 33 patients was carried out during November-December 1976. The surgery had been performed during the period 1965-1975 on patients who were inmates of the Centre at the time of review.

All the patients were afflicted with leprosy, confirmed by histopathology and serology and were on Dapsone therapy. They belonged to the tuberculoid, lepromatous or the intermediate forms; this did not influence the therapy, type of operation or the results thereof.

The patients selected for the operation had to fulfil strict criteria: skin smears should show no mycobacteria, must have had at least six months of anti-leprosy therapy, must be reaction-free for at least six months, and must have no focus of skin sepsis anywhere, more so on the limb to be operated on. In addition, the fingers must be supple in all the joints (Fig. 2).

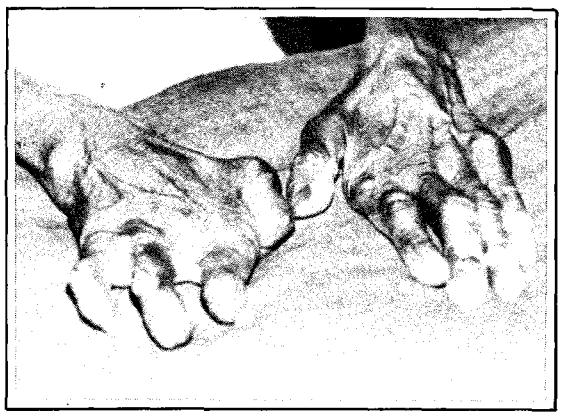

**Fig. 2 The left hand corrected by the Brand tendon graft operation; no tendon graft operation was performed on the right hand because of extreme claw deformity. Surgical amputation of the right index finger on account of chronic ulcers.**

### Operative procedure

The graft harvested was either the plantaris tendon from the leg or a strip of fascia lata, 13 cm long and 2.5cm wide. The extensor carpi radialis brevis (ECRB) was identified at its insertion, divided and withdrawn into the wound. The graft was anastomosed to the distal end of the ECRB by the Brand technique, in which a boat-shaped hollow was created, the graft drawn into it and sutured with 3/0 silk. The graft was then split into four equal slips. Longitudinal incisions, about 1.5 cm long were then made just dorsal to the mid-lateral line on the radial side of the fingers about 1 cm distal to the apex of the MCP joints of the respective digits. The lateral band of the extensor expansion was then displayed. Tunnels were then made through the lumbrical canal in the neuro-vascular plane, to emerge smoothly in the distal finger incisions. The graft slips were then drawn through these tunnels, volar to the deep transverse metacarpal ligament. Fingers and palm were then rested on a positioning frame (90° flexion at MCP joint and 45° extension at the wrist). The graft slips were then sutured in appropriate tension to the extensor expansion using 4/0 silk. Plaster dorsal slab was then applied to maintain fingers in lumbrical position (MCP flexion and IP extension), after routine skin closure. The plaster slab immobilisation was maintained for three weeks, after which re-education physiotherapy was commenced (Fig. 3).

In a full claw hand with thumb involvement, lumbrical function was restored prior to corrective thumb surgery which was usually re-routing the flexor digitorum sublimis tendon to the middle finger, around the pulley of flexor carpi ulnaris at the wrist, and inserting Y-fashion to the capsule of the thumb MCP joint.

**Fig. 3 The post-operative result: the restoration of lumbrical function, with the MCP joints in flexion and IP joints in extension.**

In assessing the results following Brand's four-tailed operation, the following methods were employed: measurement of range of MCP joint flexion; measurement of range of PIP joint extension; measurement of Voluntary Motor Tone (VMT) of the new lumbrical; and pulp-to-distal palmar crease distance.

The first two were measured using finger goniometer. The VMT was measured by the following method with the elbow flexed and rested on the table, the subject was directed to hold the fingers in the "lumbrical position" (MCP joint flexed 90° and IP joints in maximal extension). The examiner then applied upward force with his index finger against the volar surface of the test finger, while the subject resisted the force so applied. The ability to counter the force (Fig. 4) is then translated by the examiner to a grade on the Highet (modified) muscle power chart, from 0 to 5. The distance from pulp to distal palmar crease was measured using a ruler with metric graduation and the reading for the individual fingers recorded in a simple table.

**Fig. 4 Method of assessing the lumbrical voluntary motor tone in the individual fingers.**

## RESULTS

For the study, the youngest patient was 17-years-old, and the eldest 77, with a mean of 41.4 years. For surgery, the youngest patient was 13 and the eldest 67-years-old, with a mean of 32.4 years. There were 27 males and six females.

The shortest follow-up was one year and the longest 11 years, with an average of 6.3 years. Twenty-three of the patients had an average follow-up of nine years.

All the 36 hands in this study had combined median and ulnar nerves involved, the high ulnar nerve lesion occurring more frequently (19 hands) than the high median nerve lesion (12 hands). The radial nerve was affected in 11 hands, either partial or complete, primarily in the sensory distribution in the back of the hand.

Table 1 summarises the analysis (in percentage) of improvements in MCP joint flexion, limitation in extension of the IP joint and the Voluntary Motor Tone (VMT) of the grafted lumbricals.

**TABLE I**

**IMPROVEMENT IN MOTOR AND JOINT FUNCTION (IN PERCENTAGES)**

| Improvement in pip/joint extension | | | Improvement in MCP joint flexion | | | Improvement in lumbrical VMT | | | |
|---|---|---|---|---|---|---|---|---|---|
| Good | Fair | Poor | Good | Fair | Poor | Good | Satisfactory | Fair | Poor |
| 42 | 37 | 21 | 7.6 | 78.6 | 13.8 | 9 | 38.2 | 25.6 | 27.2 |

TABLE II

IMPROVEMENT IN THE DISTANCE FROM PULP TO DISTAL PALMAR CREASE OF OPERATED DIGITS

| Finger | Good | | Fair | | Poor | |
|---|---|---|---|---|---|---|
| | No. | % | No. | % | No. | % |
| Index | 24 | 66.7 | 7 | 19.4 | 5 | 13.9 |
| Middle | 27 | 75 | 6 | 16.6 | 3 | 8.4 |
| Ring | 27 | 75 | 6 | 16.6 | 3 | 8.4 |
| Little | 22 | 61.2 | 7 | 19.4 | 7 | 19.4 |

### Criteria for grading results

**GOOD** : an improvement to the absolute range – 90° improvement of MCP joint flexion and zero limitation of PIP extension.

**FAIR** : an improvement in angle measurement but not reaching absolute range.

**POOR** : no improvement/further deterioration.

A similar method of grading was employed for VMT assessment. Improvement to Grade 5 motor power (Highest's scale) was **good;** Grades 3-4 was **satisfactory; no** improvement was graded **poor.**

In assessing results of distance from pulp to distal palmar crease, **good** was when the digit was able to reach the distal palmar crease with the pulp and to curl in the finger tips; **fair** was an improvement but not able to reach the palm with the finger-tip; and **poor** was status quo or worse than the pre-operative distance.

There was an average improvement in MCP joint flexion of fair-good in 87.5% and in the PIP joint extension fair-good was in 77.7% in all four fingers. Lumbrical Voluntary Tone (VMT) showed an improvement to fair-good in 67.5%.

In 68.1% of the fingers, it was possible post-operative to bring finger pulp to touch the distal palmar crease in normal anatomical sequence, thereby making it possible to make a fist with the tips of the fingers tucked into the base of each finger.

## DISCUSSION

The normal anatomy of the lumbrical muscles and their functions have been studied by many investigators in the field.[1,2,3,4] Their functions have been described in flexion of the MCP joint, extension of the IP joint, in neutralisation of the tendency of the extensor tendon to hyper-extend the MCP joint, as moderators of the action between the flexors and extensors of the fingers, and in the co-ordination of the movements between MCP and IP joints.

There is little doubt that the primary function of the lumbricals is to prevent hyperextension of the MCP joint, thereby evoking active flexion. This is supported by the finding that MCP joint flexion was definitely improved by the Brand's procedure.

Considerable scepticism has been expressed on the role of the lumbrical in IP joint extension. In this study, in which MCP joint flexion and IP extension had been measured before the operation and again after the operation, there is adequate evidence to show that there is concomitant albeit disproportionate improvement in **both** these movements by a **single** corrective procedure. The lumbircal, therefore, has an active role to play in IP extension by way of its insertion into the extensor expansion.

In the Brand operation,[5] there are two critical areas where adhesions may form to jeopardise the aims of a "dynamic" tendon grafting procedure: the point at which anastomosis between the motor tendon and the graft is constructed; and the tunnel in the lumbrical canal through which the graft slip is drawn proximo-distally.

It is hard to believe that the Brand's operation could ever be a dynamic procedure, in consideration of the stiffness and deformity caused by the disease and disuse, an opinion expressed also by Tubiana and Malek,[6] Tubiana[7] and Murley.[8] The Brand's procedure is more likely to function by tenodesis effect on the MCP joint by acting as a check ligament of the transverse metacarpal ligament, thereby preventing hyper-extension at that joint. The IP joint extension is probably brought about by the graft keeping the extensor expansion under tension so that the extrinsic extensors could extend them.

Brand[5] in his original account of 246 hands treated by his operation, found 98% fair-good-excellent results over a two-year follow-up. It is possible that a longer-term follow-up of his cases may yield a less imposing result.

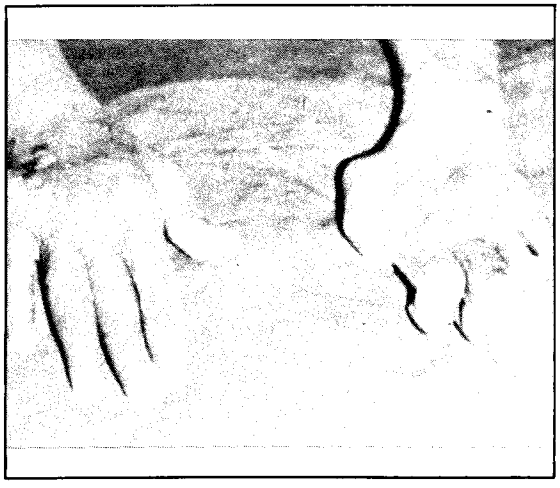

**Fig. 5 Good functional and anatomical result in the fingers of the right hand: poor functional result in the left hand, with some correction of MCP joint hyper-extension but residual IP joint flexion contractures.**

## CONCLUSION

Brand's four-tailed tendon graft operation, using a wrist extensor through the extensor route (Mark I), is a useful operation in the correction of the intrinsic-minus deformity of fingers. The operation is fairly simple, easily learnt and has few complications (Fig. 5).

The application of this operation in traumatic lesions of the ulnar nerve and in tardy ulnar neuritis presenting with ulnar claw, has also yielded encouraging results in our hands, and is the subject of a separate study.

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