

Results of Modified Bunnell's Technique in Management of Claw Hand Deformity Caused by Leprosy

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Leprosy primarily affects peripheral nerves and skin. Isolated ulnar nerve is most commonly involved, causing partial clawing with the involvement of ring and little fingers. Additional involvement of median nerve causes total clawing with involving all four fingers, with loss of action of intrinsic muscles of hand. Various procedures like capsulodesis, tenodesis, arthrodesis, or tendon transfers like Littlers, Fowlers, and Brands are recommended for correction of claw hand deformity. In this study we evaluated the results of modified Bunnell's procedure in patients with leprosy with ulnar or ulnar-median claw hand deformity. 42 claw hands in 30 patients with ulnar or ulnar-median claw hand deformity secondary to leprosy were operated with modified Bunnell's technique between January 2013 and July 2018. Functional assessment of the hand was done using modified Brand's criteria which includes three basic manoeuvres i.e. opening the hand fully, making a closed fist and flexing the phalanges sequentially and graded as poor, fair, good, and excellent. Among these 30 patients included in the study there were 21 males and 9 females. Average age of involvement was 31 years (range 18-54 years). Complete claw hand was seen in 14 and partial claw hand was seen in 28 cases. All patients had improvement in grip strength. As per Brand scoring system the results were excellent 18 (43%) cases, good in 21 (50%) and 3 (7%) hands had fair results. None of the patients had poor results. All the patients were satisfied with the results. Modified Bunnell's technique is safe, effective and technically non-demanding procedure for surgical correction of claw hand deformity of leprosy irrespective of joint condition. The only prerequisites for the Bunnell's procedure include availability of Flexor digitorum superficialis (FDS) along with working Flexor digitorum profundus (FDP).

Keywords : Leprosy, Claw Hand, Modified Bunnell's Technique, Correction, Brand's Criteria

Introduction

Leprosy caused by *Mycobacterium leprae* is a public health problem in Central Africa, Southeast Asia including India and Latin America, and had a recorded incidence of 219,075 cases in 2012.

Worldwide, approximately 15 million people have been treated with Multi-drug Therapy (MDT) (WHO 2102). Leprosy primarily affects nerves by infiltration of the peripheral nerves by *Mycobacterium leprae* initiates a cascade of

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destructive events with intense intraneural oedema and destruction of Schwann cells and axons (Job 1994) this if left untreated leads to various deformities.

Isolated ulnar nerve is most commonly involved, causing partial clawing with the involvement of ring and little fingers. Additional involvement of median nerve causes total clawing with involving all four fingers, with loss of action of intrinsic muscles of hand, thumb opposition and abduction, lateral movement of fingers, flattening of carpal arches (Srinivasan 1979) thus severely affecting the hand function. When the intrinsic muscles are paralysed, because of loss of flexor force, the metacarpophalangeal joint goes in to hyperextension. This prevents long extensors of the fingers from extending the interphalangeal joints, which are then flexed by the unopposed action of the long flexors. The result is claw deformity (Palande et al 1976).

Preventive surgical decompression of peripheral nerves and reparative tendon transfer surgeries along with adequate control of infection by multi-drug therapy is a standard modality of treatment for patients with leprosy. Intrinsic replacement operations utilizing Flexor digitorum superficialis (FDS) are the most commonly done procedure for treatment of patients with claw hand deformity. This tendon was first used by Stiles in 1922 where the FDS was split, passed dorsally and one half of each sutured to Extensor digitorum communis of finger 1 (EDC1). Bunnell modified this procedure where the split FDS was passed to the transverse fibers of intrinsic apparatus of each finger (Bunnell 1949).

In this study we evaluated the results of modified Bunnell's procedure in patients with leprosy, who had partial or complete claw hand deformity.

Materials and Methods

42 claw hands in 30 patients with ulnar or ulnar-median claw hand deformity secondary to leprosy were operated with modified Bunnell's technique at our hospital between January 2013 and July 2018. Patients with partial or complete claw hand with mobile fingers and positive Bouvier-Beevor phenomenon and who had disease control with at least 6 months of MDT were included in the study. Patients with joint contractures were excluded from the study.

Surgical Procedure

All patients were operated under general anaesthesia in supine position under a pneumatic tourniquet. Volar transverse incisions were made over the PIP joint of the middle and ring fingers. The radial and ulnar slips of the FDS tendon were transected near its insertion. A second transverse incision was made across the palm at the distal palmar flexion crease and the FDS tendons of the ring and middle fingers were withdrawn into the palm. The two tendons were split longitudinally into five tails (The slip from ring finger was split into 2 slips and slip from middle finger was split into 3 slips) (Fig. 1a & b). Thereafter, dorsolateral incisions were made at the proximal ulnar side of the ring and little fingers and the radial side of the index and middle finger. Four of the five slips were passed through the lumbrical canal of each finger. With the wrist in 45 degrees of dorsiflexed position, the MP joints at 70 degrees of flexion and the IP joints completely extended, the slips were inserted into lateral bands of extensor expansion of respective fingers. Fine artery forceps to make the tunnel and the slips were passed through the tunnel using the same artery forceps and fixed to the dorsal expansion.

Thumb opposition was restored by using Riordan's procedure in which one strip from FDS tendon slip is passed through the loop made of



Figure 1 a and b : Intra-operative tendon harvest.

- # **White arrow** : 2 slips from FDS of ring finger.
- # **Black arrow** : 3 slips from FDS of middle finger.
- # **Thin arrow** : Slip from FDS of middle finger used for correction of thumb.

flexor carpi ulnaris tendon and is inserted in to proximal phalynx of thumb on volar aspect. Following wound closure, this position was maintained for 4 weeks in a dorsal plaster slab.

For isolated ulnar claw without median nerve involvement, only FDS of ring finger was used and made into two slips and inserted into extensor expansion of ring and little finger, wound sutured and hand put in dorsal plaster slab.

Suture removal was done after 2 weeks and dorsal slab was removed after 4 weeks. In 1st week after slab removal, elbow, wrist and MCP joint mobilization exercise began and a knuckle bender splint for each finger with IP joint in full extension was given to prevent the hyper-extension of MCP joints. Post operatively, counting from next day of surgery the patients were called for follow-up after 4 weeks, 6 weeks, 12 weeks, 6 months & then at yearly interval.

Functional assessment of the hand was done using modified Brand's criteria (Brand 1958) which includes three basic manoeuvres i.e opening the hand fully, making a closed fist and flexing the phalanxes sequentially and graded as poor, fair, good, and excellent (Table 1).



Fig 2 : Pre operative : Combined ulnar and median claw hand.

Results

42 claw hands in 30 patients of leprosy were included in the study. There were 21 males (70%)

Table 1 : Brand's criteria for functional assessment

	Open Hand	Closed Fist	Mechanism of closing
Excellent	No residual contracture at PIP joint	Full tight fist	Complete MP flexion before IP joints begin to flex
Good	Unassisted extension at PIP joint, no flexion at DIP joint	Fingers closes tightly but not enough to hold a needle	IP joints begin to flex just before MP joint completes flexion
Fair	Unassisted extension at PIP joint, slight flexion at DIP joint	Visible gap between base and tip of finger	MP and IP joints flexion simultaneously
Poor	Any hand that does not score fair	Any hand that does not score fair	MP flexion delayed beyond IP flexion

**Fig 3 : Post operative results of combined ulnar and median claw hand showing good grip and pinch**

and 9 females (30%). Average age of involvement was 31 years (range 18-54 years). Left hand involvement was seen in 11 cases (36%) whereas 7 (23%) had right hand involvement and 12 patients (40%) had bilateral involvement making total number of cases to 42. 22 (52%) patients

had lepromatous leprosy whereas 20 (48%) had tuberculoid leprosy. Complete claw hand (ulnar and median) was seen in 14 (33%) and partial claw hand (ulnar nerve) was seen in 28 (67%) cases. The results are being generalized for both ulnar and ulnar-median claw as same technique is used



Fig 4 : Postoperative results - Complete Hand grip with knuckle bender applied

for correction of both deformities. Mean follow-up was 15 months (range 12-36 months).

All patients had improvement in grip strength, though grip strength was not objectively assessed in our study. The grip strength was assessed subjectively by the operating senior surgeon and was compared to the pre operative grip strength. As per Brand's scoring system the results were excellent 18 (43%) cases, good in 21 (50%) and 3 (7%) hands had fair results. None of the patients had poor results. Satisfaction was not quantified in the study but was assessed using direct question "Are you satisfied with the surgery" at the end of 6 months post surgery, all the patients were satisfied with the results. Functional improvement in claw hand (Fig. 2) is shown (Figs. 3, 4).

Discussion

Ulnar nerve is the most commonly involved peripheral nerve in the leprosy, causing clawing of ulnar two digits. Additional involvement of

median nerve causes total clawing with involving all four fingers, with loss of action of intrinsic muscles (lumbricals, interossei, thenar, and hypothenar) of hand, thumb opposition and abduction, lateral movement of fingers, flattening of carpal arches, and unopposed action of long flexor and extensors. Thus, the patient is unable to simultaneously flex the metacarpophalangeal joint and extend the interphalangeal (IP) joint, greatly affecting the hand's ability for fine movements, grip, and skillful use along with loss of tactile sensation of hand, which usually precedes the motor weakness (Chaise 2004). In the present study isolated ulnar nerve involvement was seen in 67% patients while both ulnar and median nerves were involved in 33% patients.

Procedures for correcting the claw hand deformity are based on the fact that, the long finger extensors can extend IP joints, provided that hyperextension of the MCP is prevented. This can be archived by capsulodesis, tenodesis, arthro-

desis, or tendon transfers that actively extend the IP joints and flex the MCP (Riordan 1953, Zancolli 1979). Procedures such as capsulodesis, tenodesis or arthrodesis are done only when no tendons are available for transfer or in conjunction with some tendon transfer procedures. Though these are simpler procedures with success in correcting claw deformity and increasing synchronous movement between fingers when no muscle is available for transfer, they do not improve the grip strength (Calandruccio & Jobe 2008). Thus, if the suitable tendons are available for transfer, tendon transfers should be the procedure of choice for correction of claw hand and restoration of grip strength.

Various tendon transfer procedures have been described for correction of claw hand. These include (i) **Littlers** : The ring or middle finger FDS can also be used to restore adductor pollicis function. The FDS is divided distally in the finger and is retrieved into the palm. It is then passed across the palm to the thumb, passing deep to the flexor tendons, and is inserted on the adductor pollicis insertion, (ii) **Fowlers** : A tendon graft is looped through the extensor retinaculum at the wrist. The two free ends of the tendon graft are passed through the inter metacarpal spaces into the palm, along the course of the lumbricals, and out to the fingers where they are inserted to the lateral bands), and (iii) **Zancolli** : MCPJ capsulodesis, in which a distally based flap of the volar plate was advanced proximally and sutured to the metacarpal neck, effectively limiting MCPJ extension. But these procedures can be advised when the patient presents comparatively early with supple joints, the patient is cooperative and willing for extensive physiotherapy and retraining. Thus these procedures can be rendered useless with reversal of dorsal arch if patient is not motivated and fails to do retraining exercises. Also carpal tunnel syndrome reported after these

procedures due to crowding of carpal tunnel (Malaviya 2002, Brandsma & Brand 1985). Thus modified Bunnell's procedure is more suitable operation in such situations with the advantage of retaining flexor superficialis tendons of the other fingers i.e. index and little fingers in complete claw and index, little and middle finger in ulnar claw, for better power grip. Also, modified Bunnell's procedure removes the powerful flexor of the PIP joints (Calandruccio & Jobe 2008), thus giving better results. Also seen in our study around 93% of patients had excellent to good results with this procedure. We consider modified Bunnell's procedure as preferred method of correction irrespective of joint condition as supported by the results of this procedure in this study.

Alkhooly & Alkhooly (2017) in their study had excellent to good results in all (100%) of their patients with modified Bunnell's procedure. Also Bauer et al (2007) and Jain et al (2014) in their studies reported 80% and 78% excellent to good results respectively with modified Bunnell's procedure, as is seen in our study where 83% of the patients had excellent to good results according to Brand's criteria.

There are various advantages of modified Bunnell's procedure like it is comparatively easy to perform, it has better cosmetic outcomes and also it is easier to retrain the muscles. The results of this procedure assessed at 6 months follow up is superior to other procedures due to the straighter course of tendons giving good leverage with normal angle of approach and causing least possible adhesions. Also the patient satisfaction is very high which is also seen in the current study as the intrinsic function of the hand can also be restored. The only prerequisites for the Bunnell's procedure include availability of FDS along with working FDP.

Conclusion

Modified Bunnel's technique is safe, effective and technically non-demanding procedure for surgical correction of claw hand deformity of leprosy which has very good results and very high patient satisfaction rate.

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