CRITICAL EVALUATION OF PARALYTIC CLAW HAND CORRECTED WITH ZANCOLLI'S LASSO PROCEDURE FOR IMPROVEMENT OF DEFORMITY, POWER GRIP, PINCH STRENGTH AND MOTION & FUNCTION OF HAND

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INTRODUCTION

The basis of all knowledge, construction and realities, in short, of all civilization is the hand. It can be described as second only to the eye in the emotional and economical development of man. Basic unit of productivity is hand. The loss of such a valued asset to anyone can't be reasonably appreciated and estimated. The normal hand is pentadactylate mechanism of basic design. Its finer movement and sensibility developed over the ages, from the primitive amphibian pattern is largely responsible for the great handicrafts of man. It is an organ of grasp as well as sensation and expression and thus acts as an expansion of intellect. The importance of hand in our day-to-day life can't be over emphasized.

Many diseases including trauma-involving bone, muscle tendon units, peripheral nerves spinal cord, and brain can affect function of hand. In the present study we have taken into consideration the clawing of fingers which is a common deformity following ulnar/median/both nerve involvement either due to leprosy (most common cause in developing countries like ours), trauma, polio or any other neurological disorder.

Leprosy is still a disease commonly seen in developing countries like INDIA. Nearly 4 million leprosy patients are found in India comprising of one third of total leprosy patients found in the world. Leprosy is recognized by its deformities and disabilities and is a cause for its social stigma as it affects mainly the skin and nerves. Newly 20% of leprosy patients have got deformities. The most common nerves involved are coetaneous nerves and peripheral nerves like ulnar, median and radial in upper limbs and lateral popliteal, posterior tibial nerve in lower limbs. Neuritis leads to inflammation, edema and thickening of nerves resulting in compression of nerve passing through osseofacial tunnels like cubital tunnel for ulnar nerves and carpal tunnel for median nerve. Most common nerve involved in upper limb is the ULNAR NERVE (at the elbow). Once there is complete paralysis of this nerve, unless it is recognized very early and treated properly, recovery from paralysis often does not occur.

Clawing is defined as hyperextension at metacarpophalangeal joint and flexion of interphalangeal joint. Clawing of fingers not only weakens the hand but also leads to instability, non-coordination, imbalance and asynergism. So normal functioning of hand is badly affected. Most important function that are affected are the total grasp of the hand and the thumb prehension or pinch. The normal opening and closing pattern of fingers are lost. In normal hand the metacarpophalangeal joint flexion initiated total finger flexion and all joints closes nearly simultaneously. In intrinsic paralysis the terminal joint flexion initiates more proximal joint flexion and hence basically the finger closes upon them rather than on an object within the hand.

In the past few decades' extensive work has been carried out in the field of correction of clawing of fingers. In most of the hands, the fingers can be extended if metacarpophalangeal hyperextension is prevented (Bouvier phenomenon[64]). The ideal surgical procedure is a dynamic procedure, which mimics the action of intrinsic muscles but most hands needs prevention of hyperextension of metacarpophalangeal joint and initiate flexion of interphalangeal joint. The aims of the surgical procedures are to prevent hyperextension at metacarpophalangeal joint and to initiate flexion of proximal phalanx as in normal hands and also to reinforce the extensor power to extend the interphalangeal joints as in dynamic procedures.

Many procedures are currently followed for correction of clawing of fingers, but most of them need good and extensive postoperative re-education and training and also they require operative skill and more time. The other disadvantage with current procedures like Extensor Carpi Radialis Longus many tail graft, Palmaris Longus four finger many tail or Extensor bypass operation etc.; is operating at another site (for tendon graft) and adhesions of graft.

The above-mentioned procedures are quite satisfactory in improving deformity, power and motion and function of hand; but they need meticulous surgical technique especially while adjusting the tension of extensor expansion. The complications like FDS minus fingers, checkrein deformity, stiffness of fingers, (Brandsma[5] 1992) are seen. They need meticulous postoperative re-education of the transferred tendon and intelligent patient to get good results. The satisfactory results are obtained in 70-80% cases. Palmaris Longus is not a powerful muscle, is useful in

mild clawing and chances of stretching of tendon quite high. Therefore, the patients need institutional treatment in a Hand reconstructive unit that may not be available at all centers especially peripheral centers where facilities are minimal.

So there is need to evolve a surgery which can obviate above mentioned disadvantages. In this thesis; Zancolli's lasso procedure for correction of claw hand has been used because it is simple to perform with minimal complications, re-education of transferred tendon is easy and gives better results. Zancolli has described two types of lasso procedure to correct clawing of fingers in his book 'Structural and Dynamic Basis of hand Surgery[64] (1979)'. In direct lasso all FDS tendons of the fingers or one flexor digitorum superficialis tendon, split into four slips are used. In indirect lasso a different motor like Palmaris Longus, Extensor Carpi Radialis Longus or Brachioradialis is used by extending it using a free graft.

Zancolli's lasso procedure[64] (1979) was tried as a new surgical procedure to correct the claw fingers. In this procedure the transferred tendon is inserted to the proximal pulley (A_1) looping around it. The principle of this procedure is that the transferred tendon prevents hyperextension of metacarpophalangeal joint and initiates flexion of proximal phalanx. This procedure is so simple and with minimum re-education needed that it can be done at peripheral health centrs/ camps where no extensive physiotherapy backup is available. This operation also tends to correct the reversal of transverse metacarpal arch.

MATERIAL AND METHODS

During the period of March 2009 – March 2010, 25 patients with claw hand were selected from the outpatient department of Umkal Hospital & Metro Heart institute, Gurgaon, Haryana. Out of 25, five patients were lost to follow up, so results and analysis of 20 patients are given in this thesis.

The **Criteria for Selection** of cases was:

1. Simple claw had due to any pathology with mobile fingers i.e. no fixed deformities or skin contractures should be present.

2. Positive Bouvier phenomenon i.e. by preventing metacarpophalangeal joint extension, the interphalangeal joint can be extended.

3. In case of post leprosy ulnar/median/both nerve paralysis, disease should be controlled by antileprotic chemotherapy (minimum of 6 months of MDT)[18]. Age, sex, bacterial positivity for M. Leprae is not considered as contraindication. Cases with repeated reaction and uncontrolled reaction are excluded.

4. No infective focus anywhere in the body.

5. Good synergistic motor should be available for transfer, like Flexor Digitorum Superficialis, Palmaris Longus, Extensor Carpi Radialis Longus or Brachioradialis.

Patients were admitted after detailed clinical work up as described in assessment methods and after admission they undergo routine investigations for preanaesthetic work up. A set proforma was followed for assessment of patients.

SURGICAL TECHNIQUE

Surgery can be done under Brachial Block/General Anaesthesia/ Local Anaesthesia with or without tourniquet. But in this thesis we preferably used Brachial Block/IVRA (intravenous regional anaesthesia) /General Anaesthesia with tourniquet. A transverse incision was made at the level of the distal palmar crease, in its length it includes the fingers to be corrected. Skin, fascia was cut along the incision taking care of neuro-vascular bundles. The flexor tendon sheaths were exposed from the middle of the metacarpal to the middle of the proximal phalanx. The proximal (A_1) pulley was identified by its thick, glistening fibrous strands**.** The flexor tendon sheath was opened proximally to the proximal pulley by making 'T' shaped incision. Distally the digital fibrous tunnel was opened in an 'L' shaped incision at the level of the so-called proximal arciform ligament. The flexor tendons were indentified through the distal opening**.** Flexor digitorum superficialis tendon of the selected finger was hooked up and cut as distally as possible taking care not to injure profundus tendon, which lies beneath it. The distal cut end is allowed to retract. Through a small curved incision at the base of the palm along the thenar crease, the tendon was withdrawn**.** But in cases where opponensplasty had been done the proximal incision was given approximately 5-6 cms from the wrist flexion crease. The tendon was split into four slips, one slip for each finger. The slips were passed deep to palmar aponeurosis preferably through the flexor sheath with the help of tendon tunneller**.** The slips were then passed under the proximal pulley (A_1) of the corresponding finger and through the opening distal to the pulley, the tendon was taken out and brought palmar to the pulley and proximally. The slip was sutured to the same slip (thus forming a loop) under proper tension with metacarpophalangeal joint in 30-90 degree flexion (flexion increases from index to little finger to make resting position of hand) and wrist in 30-degree flexion. Any excess of the tendon slip is cut off. In cases where opponensplasty was done, the FDS of ring finger divided into two slips was taken as motor, one slip is sutured to abductor pollicis brevis and other to extensor pollicis longus **under** proper tension. Now tourniquet released and skin sutured after obtaining hemostasis. Wound was dressed and a posterior below elbow Plaster of Paris slab given with metacarpophalangeal joints in 60-70 degree flexion and wrist in 20-degree flexion, interphalangeal joints are left free.

POSTOPMANAGEMENT

Active flexion of interphalangeal joints was started after 24 hours as the pain and swelling subsided. Sutures were removes on 14th day and a Plaster of Paris metacarpophalangeal block was given for 4 weeks. Later active flexion and extension exercise were started with the help of cylindrical splint. Spiral splint(knuckle bender) was given to prevent metacarpophalangeal joint extension for 3 months in adults and for 6 months in children.

ASSESSMENT METHODS

The deformity was assessed by Dynamograph. The angles of metacarpophalangeal and interphalangeal joints were measured with the fingers fully extended and in the lumbrical position (intrinsic plus position), using protractor. The transverse metacarpal arch angle was measured with the help of protractor. The power grip was measured by Jamar dynamometer. Pinch strength was measured by Pinchometer for key pinch and pulp-to-pinch. Motion and function of the hand was assessed by counting of 20 beads using thumb and other fingers**.** The patients were asked to pickup and keep the beads in bowl one after the other (Time taken to count 20 beads was recorded and compared to normal hand), the ability to hold a ball with a diameter of 7.5 cm in a normal fashion and with patient evaluation questionnaire which was asked postoperatively and scoring was done accordingly.

Deformity, power, motion and function of the hands were assessed before and after operation. The assessments were repeated after 6 weeks, 3 months, 6 months and one year. Clinical photographs were taken before, during and after operation. The results are graded in to three groups good, fair and poor depending on the improvement in the deformity, power grip, motion and function of the hand.

Deformity In Open Hand Position[41,61]

Good	- MCP angle + 30 to 0 degree
	- IP angle 0 to +20 degree
	- Distal metacarpal arch ≥ 15 degrees
Fair	- MCP angle 0 to -20degree
	- IP angle +20 to +40 degree
	- Distal metacarpal arch 10 to 14 degrees
Poor	- MCP angle more than -20 degree
	- IP angle more than +40 degree
	- Distal metacarpal arch ≤ 10 degrees

Power grip and pinch strength[61]

Increased	- increase in power
Static	- power remains the same
Decreased	- decrease in power

Motion and function*[41.61]

Good	- Able to hold the fingers in lumbrical position (PIP Jt. < 30 Degree)
	- Able to hold a ball of 7.5 cm in diameter in normal fashion.
	- Strong pulp-to-pulp precision grip with thumb.
	- Time taken to pick up and count 20 beads is normal or near normal.
	- Patient evaluation questionnaire score ≥ 21.
Fair	- In lumbrical position, PIP Jt. 30 to 60 degrees
	- Able to hold a ball of 7.5 cm diameter in normal fashion.
	- Able to have pulp-to-pulp pinch wit thumb but weak.
	- Time taken to pick up and count 20 beads improves.
	- Patient evaluation questionnaire score 11 to 20.
Poor	- In lumbrical position, PIP Jt. > 60 degrees
	- Not able to hold a ball of 7.5 cm in normal fashion.
	- Pulp to pulp precision pinch not possible.
	- Time taken to pick up and count 20 beads does not improve.
	- Patient evaluation questionnaire score ≤ 10.

*_ IF ≥3 criteria present out of 5 than the result is labeled as good, fair, and poor.

Good and fair results are considered as satisfactory.

OBSERVATIONS & ANALYSIS

This series consists of 25 patients on whom Zancolli's Lasso procedure were carried out for the correction of paralytic simple claw hand. Of these 25 patients, only 20 patients came for subsequent follow up (five patients were lost to follow up) and observation made in these 20 patients are presented in the following text, supplemented with the tables and figures where necessary, correction was effected at the first decimal point.

Patient Profile

Of these 20 cases, majority of cases were due to leprosy. The causes of claw hand in this study are listed below in Table-1.

Table-1: Cause of Clawhand

S.No.	Cause of Clawhand	No. of Pts.	%
1.	Leprosy	17	85%
2.	Posttraumatic Ulnar Nerve Palsy	2	10%
3.	Tardy Ulnar Nerve palsy	1	5%
Total		20	100%

The youngest patient in the study was of 7 yr. old and oldest of 48yr. with an average of 28 yrs and most of them are males. The age and sex distribution of the patients is shown in Table-2.

Table-2 Age and Sex distribution

S. No.	Age Group	Males	Females	Total	%
1.	0-10 yrs.	0	1	1	5%
2.	11-20 yrs.	4	0	4	20%
3.	21-30 yrs.	8	1	9	45%
4.	31-40 yrs.	4	0	4	20%
5.	41-50 yrs.	2	0	2	10%

Total		18	2	20	100%

Most of the patients are unskilled workers like working as Vegetable Seller, manual laborer involved in construction work, security guard etc. some are semiskilled like auto rickshaw driver, tailor, small shop owner, and some are students. Most of the patients were from lower socioeconomic strata. The occupation distribution in our series is shown in Table 3.

Table 3. Occupation distribution

S.No.	Occupation	No. of Pts.	%
1.	Unskilled Worker	9	45%
2.	Semiskilled Worker	6	30%
3.	Students	54	25%
Total		20	100%

Most of the patient i.e. 15 (75%) had involvement of dominant hand, so they had difficulty in carrying out day-to-day activities. The distribution of patient according to involvement of hand is given in Table 4.

Table – 4 : Hand Involved

S.No.	Side Involvement	No. of Pts.	%	Dominant Hand	%
1.	Right side	13	90%	18	90%
2.	Left Side	7	10%	2	10%
Total		20	100%	20	100%

The duration of paralysis varied from 5 months to 108 months with an average of 33.3 months. [Table-5]

Table:-5: Duration of Paralysis

S.No.	Duration of paralysis	No.	%
1.	≤ 1 yr	7	35%
2.	> 1 yrs to ≤ 4 yrs	10	50%

3.	> 4 yrs	3	15%
Total		20	100%

Among the patients of Leprosy the duration of illness varies from 1 yr – 9 yrs with average of 2 yr 8 months. They all had minimum of 6 months of MDT, but most of them finished their full course of treatment. The majority of the patients had high ulnar nerve palsy except in 2 cases of posttraumatic palsy, which was of low ulnar type. Only 2 cases had low median nerve palsy, which was associated with high ulnar nerve palsy (all are cases of leprosy).

Operative Details

The duration of surgery varies from 50 min. to 107 min. with an average of 74.1 min. In cases where only lasso procedure is done, then average duration was 58.4 min. The tendon used in majority of cases was FDS of middle finger divided in four slips. Tendon used for transfers is given in Table 6.

Table 6 – Tendons used for transfer

S.No.	Tendon used	No.	%
1.	FDS of middle finger (Divided in 4 slips)	18	90%
2.	FDS of middle finger (Divided in 2 slips)	1	5%
3.	FDS of ring Finger (Divide in 2 Slips	1	5%
Total		20	100%

In 2 cases where opponensplasty was done, ring finger FDS (divided in 2 slips) are also taken with FDS of middle finger. The majority of cases 85% were operated under brachial (supraclavicular) block. The type of anaesthesia used is given in Table 7.

Table 7 – Type of Anaesthesia

S.No.	Anaesthesia	No. of Pts.	%
1.	Brachial Block	17	85%

2.	IVRA (Intravenous regional anaesthesia)	2	10%
3.	General Anaesthesia	1	50%
Total		20	100%

Out of these 20 cases, in 6 cases we had done additional procedures. Opponensplasty was done in 2 cases of low median nerve palsy, anterior transposition of ulnar nerve done in 2 cases (1 for tardy ulnar nerve palsy and one in high ulnar nerve palsy due to leprosy), and ulnar nerve repair done in 2 cases in ulnar nerve trauma cases.

Pre Operative Vs Post Operative Profile.

The follow up period varied from 5 months to 1 yr with an average of 7.7 months.

a. DEFORMITY CORRECTION

The correction of deformity was good in 15 (75%) cases, fair in 3(15%) cases and poor in 2(10%) cases. The average angle improvement was maximum in little finger followed by ring, index & middle finger in that order. Minus (-) sign shows extension * Plus (+) sign shows flexion. The preoperative and postoperative angles of MCP and PIP joints are given in Table 8.

Table 8: Dynamograph (Open Hand Position)

		Preoperative angels (In Degrees)			**Postoperative angles** (In Degrees)			**Avg. Angle Improvement**
		Min.	Max.	Avg.	Min.	Max.	Avg.	
INDEX FINGER	MCP Jt.	-65	0	-19.9	-45	0. 2	0.2	20.1
	PIP Jt.	0	110	25.5	0	55	11.3	14.2
MIDDLE	MCP	-60	5	-	-35	25	1.3	18.9

FINGER	Jt.			20.2				
	PIP Jt.	4	90	28.3	0	50	10.3	17.8
RING FINGER	MCP Jt.	-70	0	-32.7	-35	15	-0.3	32.4
	PIP Jt.	5	95	41.8	0	35	11.2	30.6
LITTLE FINGER	MCP Jt.	-75	-20	-41.5	-30	10	-1.0	40.5
	PIP Jt.	28	80	54.8	-10	40	13.4	41.4

The transverse metacarpal arch was reversed in 7(35%) cases but most of them had decreased angles as compared to the normal hand. The normal angle in open hand position was 20^0 -30^0. The distal transverse metacarpal arch was graded as good >15^0, fair 10^0 -14^0, and poor < 10^0. The avg. increase in arch angle was maximum in cases that initially had reversal of arch. The preoperative and postoperative observations are shown in Table 9.

Tab. 9 – Grading of Restoration of the Transverse MC Arch After Procedure

	Arch Angle reversed	**0^0-9^0**	**> 10^0**
Pre Op.	7 poor	10 poor	2 fair, 1 good
Avg. angle (Range)	-14.1^0 (-9^0 to -20^0)	6.0^0 (3^0 to 8^0)	13.3^0 (11^0 to 18^0)
Post Op.	3 Good, 2 Fair, 2 Poor	9 Good, Fair	3 Good
Avg. angle (Range)	12.6^0 (6^0 to 18^0)	20.9 (11^0 to 25^0)	22.7^0 (20^{0}to 26^0)
Avg. inc. in angle	26.7^0	14.9^0	9.4^0

b. POWER AND PINCH STRENGTH

Improvement of power and pinch strength was increased in 13 (65%), static in 6 (30%) and decreased in 1(5%) cases. Satisfactory results that includes good and fair was found in (95%) cases. The power grip varied from 2 kg to 16 kg with an average of 9.7 kg (normal-16.5 kg). During the immediate postoperative period (i.e. at 6 wks), power grip decreased in all the cases with the average of 6.6 kg. But by about 3 months grip strength increased to an average of 9.39 kg and by 6 months the average was 13.3 kg, 0.3-2.6 kg with an average of 1.5 kg (normal 4.6 kg) preoperatively. Post operatively the pinch strength decreased in all the hands during the immediate postoperative period i.e. at 6 wks. But by 3 months it increased to and\ average of 1.8 kg and by 6 months it was 2.9 kg with very little progress further. [Table-11]

Table 11- Pinch Strength and Power Grip

		Preoperative					**Postoperative**			**Avg Inc**
		Min.		Max.		Avg.	Min.	Max.	Avg	
POWERGRIP(in kg)		2		16		9.7	2	18	12.3	2.6
PINCH STRENGTH (IN KG)										
Pulp to Pulp Pinch	0.3		2.6		1.5		0.3	4.5	2.9	1.4
Key Pinch	0.5		3.8		2.2		0.5	5.5	3.7	1.7

c. MOTION AND FUNCTION OF HAND

The ability to hold 7.5 cm ball was abnormal in all preoperative patients as they were not able to hold the ball in normal fashion i.e. with their palmar aspect of fingers in contact with the ball. Postoperatively majority of patients i.e. 15

(75%) were able to hold ball in normal fashion. These were those patients who had good improvement in their deformity. None of the patients are able to hold fingers in the lumbrical position preoperative. But majority of the patients i.e. 16 (80%) are able to hold their hand in lumbrical position. The average angle improvement was maximum in little finger followed by ring, index & middle finger in that order. Minus (-) sign shows extension & Plus (+) sign shows flexion. The pre and postoperative Dynamograph in lumbrical position are given in table-10.

The time taken to count 20 beads using thumb and other finger was increased in all the patients preoperatively ranging from 28s to 88s with an average of 52.5 sec. In some patients it was not possible to hold a bead because of paralysis of thumb. There was marked improvement after the operation in counting of the beads. Most of the patients 18 (90%) were able to hold and count bead with pulp to pulp to pinch. Time to count 20 beads (postoperatively) varied from 18s to 70s, with an average of 30.2 sec.

Table 8: Dynamograph (Intrinsic Plus Position)

		Preoperative angels (In Degrees)			**Postoperative angles** (In Degrees)			**Avg. Angle Improvement**
		Min.	Max.	Avg.	Min.	Max.	Avg.	
INDEX FINGER	MCP Jt.	40	80	66.8	60	82	73.2	6.4
	PIP Jt.	5	110	34.7	0	90	18.1	16.6
MIDDLE FINGER	MCP Jt.	48	85	71.3	60	85	71.3	0.0
	PIP Jt.	2	110	34.9	0	65	18.5	16.4
RING FINGER	MCP Jt.	0	95	45.9	55	85	67.4	21.5

	PIP Jt.	5	120	77.7	5	75	27.5	50.2
LITTLE FINGER	MCP Jt.	-15	100	30.7	55	90	67.4	36.7
	PIP Jt.	65	120	88.5	-10	65	24.4	64.1

A patient evaluation questionnaire was asked postoperatively and scoring was done accordingly most of the patients 14 (70%) had good score i.e. ≥21. The score varied from 8 to 27 with an average of 21.3. One patient can't be evaluated, as she was only 7 yr old, so she can't understand the nature of questions.

Results

Table-12 Results

	Good	Fair	Poor
Deformity Correction	15 (75%)	3 (15%)	2 (10%)
Improvement in Power	13 (65%)	6 (30%)	1 (5%)
Improvement in motion & function of hand	12 (60%)	6 (30%)	2 (10%)
Average	13.3(66.6%)	5 (25%)	1.7 (8.4%)

Complications

No major complications like stiffness of fingers, intrinsic plus deformity, sublimis minus finger, checkrein deformity etc are not seen. Only cases had complications, one had swan neck deformity in the little finger (not in the donor finger) one patient had paraesthesia over the lateral aspect of index finger might be due to injury to digital nerve during surgery and one had superficial infections. [Table - 13]

Table-13: Complications

Complication	No.	%
Swan neck deformity	1	5

Paraesthesia over lateral aspect of index finger	1	5
Superficial infection	1	5

Overall results Satisfactory – **90.0%,** Poor – 10%

DISCUSSION

In the absence of any procedure on the nerves, which can bring about regeneration of nerve & reactivation of paralysed muscle supplied by effected nerves, the tendon transfer procedures remain the main stay of treatment by reconstructive surgery. This study comprises a total of twenty patients on which Zancolli's lasso operations have been performed for the correction of claw hand. Of

these, 17 patients were cases of Hansen's disease; two patients had posttraumatic ulnar nerve paralysis, one patient of tardy ulnar nerve palsy.

PATIENT PROFILE

The commonest cause of paralysis of the hand in this study was found be leprosy. Seventeen (85%) patients out of twenty had Leprosy. Leprosy is probably the most frequent cause of crippling of the hand in the world. This is especially true for a tropical country like ours with a high prevalence rate of leprosy. Only two (10%) patient of all were female. This does not really indicate the sex incidence of hand paralysis. It reflects more, our experience that more men than women were willing to undergo surgery for correction of their deformity. All patients in this study hail from the lower socio-economic class where traditionally, it is the man who goes out to work. The disabled man, upon whom the family's livelihood depended, appeared to be more easily motivated to seek the option of surgical correction.

The ages of the patients in the study ranged from the youngest, a seven-year-old girl to the oldest, a 48-year-old man. The largest number of patients (45%) fell between the ages twenty one to thirty years. This probably is again due to the reason that the burden of a disability or functional loss is fell most in this age group.

Of the 17 patients of leprosy, 15 (75%) had a pure high ulnar nerve paralysis and the other 2 (10%) had a combined high ulnar never and low median nerve palsy, i.e. total clawhand. No radial nerve involvement was observed in these cases. This conforms to the known predilection of Hansen's disease to affect the ulnar, medina and Radial nerves in that order of frequency. All patients in the study were either unskilled or semi-skilled workers whose primary requirement was a proper grasp. All the patients when explained the options available, opted for the correction of the clawing deformity.

OPERATIVE DETAILS

Even with normally functioning intrinsic of the thumb, flexion of metacarpophalangeal and interphalangeal joints is necessary for proper opposition. Palande[42] (1975) in his article on opponensplasty advised that is should preferably

follow intrinsic replacement surgery. Though although theoretically, an opponensplasty could be done simultaneously along with the intrinsic replacement as we did in two patients in our series. Though, Antia[1] (1969) has suggested combining opponensplasty with Palmaris longus four finger many tail, it has been found to be time consuming and has the disadvantage of operating at another site for the graft. Opponensplasty with correction of claw finger in one sitting was also supported by Shah[49] (Oct, 1984). This not only conserves the scarce resources but also improves the ability of the patient to resume his occupation in 6 8 weeks and re-education is easy.

The other additional procedures done were secondary repair of ulnar nerve in two cases (case No. 4 and 15) and anterior transposition of ulnar nerve in two cases [one for tardy ulnar nerve palsy (case no. 5) and other for high ulnar nerve palsy in Hansen's disease (case no. 16), in which decompression with medial epicondylectomy was done. There was no sensory and motor recovery in cases secondary repair in cases secondary repair of ulnar nerve till their last follow up. The reason of poor results was timing of surgery (5 to 6 months following injury) and lesser duration of follow up.

The average duration of surgery in our series was 74.1 min (for only lasso procedure it was 58.4 min), suggesting a lower surgical time and simplicity of the procedure. In most cases FDS of middle finger was taken leaving other flexor tendons intact for better power grip and avoiding swan neck deformity. So no further sacrifice of function in a hand that is already imbalanced by the loss of function of the intrinsic. In this procedure no new tendon is routed through the carpal tunnel, so chances of median nerve compression I not there.

The tendency for occurrence of clawing is greater in the small than in ring finger; tension was set slightly greater on the small finger. Although the index and long fingers generally do not exhibit the clawing posture, both objective testing and comments from the patients strongly suggest that dysfunction of these digits is also present. So, transfer is make to all four fingers regardless of clawing limited to the ring and little finger; except in two cases (case no 4 and 5) where only ring and little finger were corrected.

These are cases of posttraumatic paralysis and tardy ulnar nerve pasy with duration of paralysis 6 months and 1 yrs respectively good results were obtained in both of the cases. The duration of follow up in both the cases was 11 Months and 9 months respectively.

Most of the cases are done under brachial black and patient discharged after the effect of drug wears down. So patient need not be admitted for long time and can go to home on the day of surgery (Day care surgery). This also reflects the simplicity of procedure of this procedure & low burden on hospitals carrying out reconstructive surgery. The other advantage of this procedure is that the fingers are mobilized 24 hrs. after the operation to prevent adhesions around the flexor sheath.

RESULTS

The correction of deformity (as assessed by dynamograph in open hand position) was 90% satisfactory (Good 75%, Fair 15%). The 2 cases which faired badly are case no 7 and 12, both of them had longer duration paralysis which badly affects the biomechanics casts and physiotherapy. The 3 cases, which head fair results, are cases no. 11, 13 and 19. The cases no. 11 and 19 had paralysis of more than 4 yrs. The case no. 141 is a 7yrs old child with hyper mobile hand, but the duration of paralysis was only 12 months. In a younger patient there is a potential of growth causes tendon lengthening and thus making transfer to be ineffective. Children also had hypermobile/lax hand, so possibility laxity of transferred tendon is always there if adequate tensioning was not done. In this age group re-education in terms of avoiding hyperextension of MCP joint are also poor. This was also observed by Ozkan[38, 39] et al (2003). So, age and duration can be taken as a prognostic factor in the outcome of this procedure.

When an operation for correction of an intrinsic minus hand does not restore the transverse metacarpal arch to optimum status, and additional procedure may be advisable like Bunnell's Tendon-T operation, or Ranney's transfer of digiti quinti minimi to restore transverse metacarpal arch, as in our series i.e. 15 (75%) cases

had good results, only two cases had poor results, with average increase in arch angle by 23.2^0 . Patients were very happy, as now they could have four fingers pinch needed for eating rice.

Many author like Shah[48] (1984); Hasting and Davidson[20] (1988); Hasting and McCollam[21] (1991), Claim that power improvement is not seen with the lasso procedure. But in our study, we had seen a definite increase in pinch and grip strength. We had 95% satisfactory results i.e. power increased in 65% cases and remains static in 30% of cases, with average increase in power grip of 2.6 kg and in pinch strength of 1.4 kgs. Power decreases initially but regained to preoperative value at 3 months, after which it increases up to 6 months. This type of results was also given by Ozkan T, et al [39, 40] (2003). While other procedures like Bunnell's, Brand's, Antia's results in decrease of power and pinch strength. Flexor superficialis is the prime flexor of the PIP Jt. and is essential for power grasp. In above-mentioned procedures flexor tendon rerouted to extensor expansion thus causing deficiency in power grasp. However in lasso procedure, flexor tendon is not rerouted to extensor expansion thus no flexor power deficiency is there. As the deformity improves, the hand can be put into more mechanically advantageous position to use remaining muscle tendon units, thus increasing power grasp. This well evident by our results. The patients (90% of cases) who had satisfactory deformity improvement had improvement in power grip (60% of cases) and power remains static in 35% of cases.

The motion and factions of the hand improves postoperatively (results – 60% Good, 30% Fair, 10% Poor). The ability of holding 7.5 cm diameter ball, bead counting time, pulp-to-pulp pinch and ability to hold hand in lumbrical position; improved satisfactorily in 90% patients. Majority of the patients are satisfied with the procedure as evident by the patient evaluation questionnaire with an average score of 21.3 out 30 (max. score).

Overall our results are very good except some complications, which occurred, in only 3 cases. Case no. 10 developed superficial infection in early postoperative period, which was adequately treated with oral antibiotics and wound toilet. Case no. 6 developed Paraesthesia Sensation over the lateral aspect of index finger, which

might be due to injury to the digital nerve during surgery, treated conservatively, recovered after 6 months.

One case had swan neck deformity in his little finger (case no. 8), which was not the donor finger. The development of swan neck deformity can be explained on the basis of following explanation. In hypermobile hands particularly in India hands, most of the procedures including those of Bunnell's[12] (1942), Riordan[47](1953), Brand's[3] (1958) and Antia's[1] (1969) had the disadvantage of producing swan neck deformity. Three factors were suggested to contribute to the development of this deformity: 1) removal of the prime flexor of the PIP joint (for donor fingers), 2) insertion of the transfer into the lateral slip (for recipient fingers), and 3) laxity of the volar plate of the PIP joint (for both donor and recipient fingers). It can be due to preoperative weakness of FDS, which was unmasked in the postoperative period by correction of clawing, as clawing, as clawing masking the deformity. The other possible reason may be that the patient also has nonhealing ulcer over the PIP Jt. Which may cause scarring of the dorsal expansion over PIP Jt. Patient had no complaints regarding the deformity except cosmetics. So, patients treated conservatively.

In this series only one case of swan neck deformity has been seen that also not in the donor finger, the reasons behind it are: a) this technique does not reinforce the extensor expansion, b) the distal stump which was allowed to slide up, finds its surgery is inadequate than there is danger of checkrein deformity, which however was not observed in any of the patients.

Another commonly reported deformity in the donor fingers is flexion contracture of the PIP joint. This is thought to be related to the harvesting of the FDS tendon, either due to a long stump causing adhesion to the surrounding tissue, or surgical trauma and bleeding. To minimize these adhesions, some authors recommended the removal of the FDS tendon near its insertion on the middle phalanx, whereas other suggested the removal to be performed between the A1 and A2 pulleys. Flexion contracture of PIP Jt. is not seen in our series because of early mobilization of fingers (within 24 hrs.).

There is always scope of new innovations and new techniques in the field of surgery. Even through many surgical procedures like static and dynamic procedures are available for correction of claw fingers. There was always a search for new technique. The common tendon transfers done are Bunnell's FDS many tail, Brand's EF 4 tail, Antia's Palmaris longus with long free graft. The results of these procedures varied from author to author. Brand[3] (1958) reported a series of 150-claw hand operated upon by the modified Bunnell's FDS transfer. The reported excellent and good results of 73% in the open hand assessment and 93% in the closing mechanism assessment. He also reported of late intrinsic plus deformity in these patients. Brand[4] (1961) reported series of 861 clawed fingers operated by Brand I procedure, results- 24% excellent, 47% good, fair 27% and poor in 2%. He admits reeducation is difficult. Also, there are high incidences of median nerve compression which can develop even after years of surgery. (GN Malaviya, Sept. 2002).

Sundaraj, et. al.[60] (1983) reported 95% good results with EF4 tail procedure. Lakhanpal et. al[23] (1979) reported 90% good results with Paul Brand technique. Brandsma[6] (1992) gives 78-83% good to excellent results with FDS many tail procedure, but also point out the complication like swan neck deformity (15%) DIP flexion (29%), checkrein deformity (26%) and insufficient finger flexion in (18%).

In all three procedures the transferred tendon is suture to extensor expansion. These procedures take longer surgical time, meticulous surgical technique and very good postoperative reeducation (lakhanpal[23] 1979) is required. Complications like median nerve compression (G.N. Malaviya), stiffness of fingers, FDS minus deformity, checkrein deformity, under correction are quite high.

Zancolli[64] (1979) in his book Structural and Dynamic Bases of hand Surgery, second edition, illustrated a technique call Lasso procedure. Many authors like Shah, A [48, 49, 50] (1984, 1986); Oberlin[37] (1985); Hasting and McCallum[21] (1994); Patond[44], et.al (1997); and Ozkan[39, 40], et.al (2003) reported very good results and minimal complication with this procedure. In their series, most of have only deformity correction as their criteria but in our study we have also taken power and motion and function of hand into consideration, around 20 cases of claw hand were operated

with average follow up of 7.7 months. The FDS lasso procedure is technically simple and is effective and predictable in correcting clawhand deformity, restoring the synchronous pattern of finger flexion and is also tends to restore reversal of transverse metacarpal arch. It also improves power strength of the patient's hand, which was originally described by Zancolli but not reproduced by many authors. Satisfactory result was found in 90% of cases. Correction of clawing was most difficult in the little finger. The complications were minimal. The surgical procedure was simple, easy to perform, need less surgical time (average 58.4 minute), no reeducation required. This can be done at Peripheral Health Centers and in surgical camps. However, the results achieved in a small series with short follow-up of 7.7 months are encouraging.

"In general, nothing is more unpredictable and nothing varies more with the time than tendon transfers. Nevertheless, the end effect is generally more desirable than the disability for which the operation was done." The purpose of tendon transfers is not so much to gain strength as to gain the ability to place the hand in position to make the use of the remaining functional muscle tendon units. With this last note I am end my discussion.

SUMMARY AND CONCLUSION

A study of a total of twenty patients on which Zancolli Lasso procedure has been performed for the correction of claw hand and evaluation of the patients for the improvement in deformity, power grip, pinch strength and motion & function of hand. The conclusions arrived are as follows:-

1. Hansen's disease was found to be the commonest cause of hand clawing, comprising of 85% of the patients.

2. 90% of the patients who subjected themselves for surgery were males.The largest group of patients fell in the in the age group 21-30 yrs constituting 45% of the patients. The other two larger groups constituting 20% each, were in the age group 11-20 yrs and 31-40 yrs respectively.

3. Majority of the patients (45%) were unskilled workers.Most of the patients i.e. 15 (75%) had involvement of dominant hand, suggesting high morbidity and socio-economic loss.

4. All the cases of leprosy had high ulnar nerve palsy. In only two (10%) cases were associated with low median nerve involvement.The average duration of paralysis was 33.3 months.

5. The duration of surgery on an average took 74.1 Min and for lasso alone, it took 58.4 Min. suggestive of lesser operative time. The FDS of middle finger was most commonly used as motor, which was divided into 4 slips. Transfer be made to all four digits regardless of clawing limited to ring & little finger.

6. Most of the patients were operated under brachial (supraclavicular) block, suggesting low morbidity, which was associated with general anaesthesia.

7. The average follow up was 7.7 months (5 month to 12 months).

8. In two cases where opponensplasty was also done using FDS of ring finger as motor divided into 2 slips. The functional results in these two cases were 50% Good and 50% Poor, as the second case faired badly.

9. The maximum deformity improvement was noticed in cases of lesser duration of paralysis than those who had longer duration of paralysis. Also deformity correction was fair in children. Above two finding suggested that age and duration of paralysis could be taken as prognostic factor in the outcome of reconstructive surgery of the hand.

10. There was definite improvement in pinch and power strength, 60% of cases had improvement in power and pinch strength.With this procedure restoration of reversal of transverse metacarpal arch was seen, with an average improvement in transverse metacarpal arch angle in open hand position was 23.2^0.The motion and function of hand improved in 90% of cases.

11. Only in 3 cases, complication had been observed; with one patient developing swan neck deformity in little finger.

12. This procedure take less surgical time, simple to perform, no re-education is required, had minimal complication and gives excellent results. This can be done at peripheral health centers and in surgical camps. Countries like India who was has loads of patients waiting for their surgery can be benefited with this procedure.

13. The analysis of poor result demonstrates the importance of obtaining correct tension during suture of transferred slips and of adequate protection and training of the hand during the postoperative period.

14. Overall satisfactory results (Good and Fair) were seen in 90% of the cases. The recurrence of deformity was maximum in the little finger. However the results achieved in a small series of 20 patients with short follow up of 7.7 months (average) age encouraging.

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