

Impact of Tendon Transfer Surgery on Function and Participation Levels Among People Affected by Leprosy

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Leprosy affects peripheral nerves, sometimes resulting in permanent disabilities. This instigates the self and social stigma, which limits the activity and social participation level of the patients. Tendon transfer surgery is performed to improve or restore limb functions, cosmetic appearance and help prevent further disabilities. This study aimed to assess whether the tendon transfer surgery improves the activity and participation level of the leprosy patients with disabilities. Case records of 80 patients who underwent tendon transfer surgery during 2018 -2021 were retrospectively analysed for activity and participation levels before and after surgery. Eye-Hands-Feet (EHF) score, the Screening of Activity Limitation and Safety Awareness (SALSA), and Participation scores (P Scale) were scales used to measure the outcomes, and these scores were extracted from the patient medical records. There was a significant improvement in the outcome measures after tendon transfer surgery. The mean (SD) difference in the pre and post scores of EHF, SALSA and P Scale were 0.95 (0.69), 7.39 (4.45) and 5.39 (4.05), respectively. The differences were statistically significant. Gender (female) and quantum of disability (EHF score) at the time of tendon transfer were independently associated with the activity level, whereas higher age at the time of tendon transfer was independently associated with the participation level. To conclude, tendon transfer surgery for leprosy patients with disability significantly reduced the levels of activity and participation restriction. Therefore, all the eligible patients should be motivated to undergo correction of deformities through tendon transfer surgery, especially females with correctable deformities.

Keywords : Leprosy, Tendon Transfer Surgery, Activity Limitation, Social Participation, Functioning

Introduction

Leprosy is a chronic bacterial disease that affects skin and peripheral nerves, potentially resulting in permanent disabilities if left untreated (Lockwood 2019). Disability in leprosy is highly stigmatized and has a serious impact on the social and psychological life of affected population (Sermrittrong & van Brakel 2014). Activity limita-

tion and social participation restriction are more common among leprosy patients with disabilities due to leprosy. Disability and disfigurement affect the occupations of the individuals, and in turn the economic status of the affected person and their family. Social participation is directly related to the severity of disability (Abdela et al 2020b, Bhat et al 2022). Stigma due to visible deformities is

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the major determinant of social participation requiring socio-economic rehabilitation (van Brakel et al 2012). Tendon transfer surgeries restore cosmetic appearance and functional abilities of eyes, hands and feet, and reducing disability and stigma. Therefore, measuring the magnitude of activity limitation and participation restriction and providing appropriate rehabilitation measures are crucial (Abdela et al 2020a).

Various tendon transfer procedures are available for the patients to restore limb functions, cosmetic appearance and prevent further worsening of impairments. Tendons of strong muscles with an intact nerve supply are transferred to a new insertion to take on the function of important paralyzed muscles. The common tendon transfer surgeries used to correct leprosy deformities are listed below (Srinivasan et al 1996):

- (i) LASSO: - This is used for complete or partial ulnar and/or median nerve paralysis where the lumbricals and the interossei muscles are weak or paralyzed impairing grasping activities. This procedure restores the intrinsic position, thus making grasp effect and safe.
- (ii) Opponens replacement: - This is procedure used in complete median paralysis called "Ape Thumb" to restore thumb palmar abduction and opposition necessary for pinch function.
- (iii) TMT: - Temporalis Muscle Transfer corrects (restores eyelid closure) lagophthalmos to help cover the cornea to prevent corneal injury, corneal ulcer, and blindness.
- (iv) TPT: - Tibialis Posterior Transfer surgery is done for correction of footdrop where a patient walks with high stepping gait resulting in increased pressure on the forefoot and lateral border of the foot thus making them prone for ulceration.

Tendon transfer surgery improves the

independence and the societal acceptance and in turn the quality of life, social status, and security (Lenka & Mahapatra 2016). A prospective cohort study found that tendon transfer has beneficial effects on functioning (van Veen et al 2011).

Despite the positive effects of tendon transfer, the available services are underutilized due to their limited access to the services as well as misconceptions and stigma. There is a paucity of evidence on the impact of tendon transfer on activity level and social participation. Therefore, this study aimed to assess the change in activity limitation and social participation among patients who underwent tendon transfer for deformity correction among people affected by leprosy.

Methodology

This was a retrospective descriptive study with a before and after analytical component. Secondary data collection was done from the electronic case records of 80 patients who had undergone surgery (tendon transfer) for deformity correction for eye, hand, and feet during the period between 2018 and 2021 at The Leprosy Mission Hospital, Chandkhuri, Chhattisgarh, India. This hospital is a part of the Leprosy Mission Trust India network of hospitals and is recognized as a tertiary care centre of leprosy management in the state of Chhattisgarh.

The hospital's medical records system has been computerized since 2008. The case records of each patient are stored under unique identification number. The assessment forms for those undergoing tendon transfer are standardized and conducted according to the hospital protocol at start of physiotherapy, the day before a surgery, upon completion of physiotherapy protocol for tendon transfer, and at 3 and 12 months of follow-up assessments from the date of surgery. Trained physiotherapists / physiotherapy technicians did all assessments. SALSA and P-scale assessments were done once in 6 months as per hospital protocol.

In this study we collected the demographic and clinical data, SALSA scores, EHF scores and Participation scale scores of patients who underwent tendon transfer surgery in the hospital.

Data collection and analysis plan

Demographic and clinical information, muscle strength, angle measurements of joints of hands, feet and functional assessments were extracted using researcher developed structured data collection forms. The occupation of the participant was classified into heavy and light work based on the nature of job. The main outcome measures were Eye-Hands-Feet (EHF) score, the Screening of Activity Limitation and Safety Awareness (SALSA) score, and Participation scores (P-Scale). The data were double entered in Excel and analysed using Epi Info 7.2.5. Socio-demographic and clinical variables were summarised using mean (Standard Deviation, SD), median (Inter Quartile Range IQR), frequencies and proportions. Multiple linear regression analysis was used to assess the impact of tendon transfer on activity limitation and participation restriction.

SALSA Score

The SALSA Scale (2007) is a validated tool used to measure the activity limitation and safety awareness in people affected by leprosy and diabetes. SALSA is a cross-cultural tool and is administered using interview method. It provides a means to evaluate the outcome of interventions aims to improve function and/or self-care. It consists of 20 items of daily activities covering three domains mobility, selfcare and work. For each item, a 'yes' or 'no' answer is recorded according to whether the interviewee can perform the activity or not. 'Answer 'Yes' is accompanied by a rating of ease with which the individuals can perform the activity, and 'no' answers require a reason for the inability to be recorded. The SALSA score has a hypothetical range from 0 to 80, but one would expect a score of 20 if the respondents had no activity limitation,

higher scores are associated with increasing levels of activity limitation. A score of 25 or more points is indicative of activity limitation.

Eye Hand Foot Score

The Eye-hand-foot (HF) impairment score in leprosy (Brandsma & van Brakel 2003) patients is the sum of the WHO (World Health Organization) disability grades for eyes, hands, and feet. This score shows the severity of impairments and helps to measure the progression of impairments.

Participation Scale

The participation Scale is an 18-item questionnaire used to assess client perceived social participation in people affected by leprosy or other disabling conditions (van Brakel et al 2006) 2006.

In most items the respondent is asked to compare his or her level of participation with that of an actual or hypothetical peer (a person or group of persons of the same age with the same social position and same abilities but without the disease or disability). If the respondent indicates that they perceive their participation as restricted compared with peers, he or she is then asked to rate how much of a problem this restriction is to him or her. A score of 13 or more points indicates restrictions in participation.

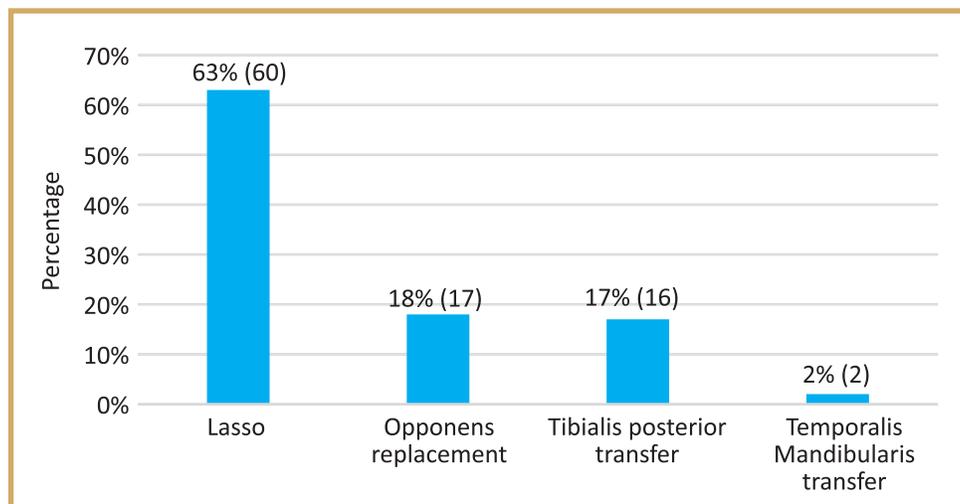
Ethical approval was obtained and the study was conducted in accordance with the principles outlined in the Declaration of Helsinki.

Results

Eighty patients' records (95 tendon transfer procedures) were reviewed. Table 1 shows the demographic and clinical details of study participants. Of all, 21 (26%) of them were females. The age group of the patients ranging from 12 to 53 years, the mean (SD) age of the participants was 25.8 (9.3) and 45 (56%) participants were married. Majority of patients 51 (64%) were below 25 years. The number of the heavy workers were 43 (54%) and 21(26%)

Table 1 : Demographic and clinical details of study participants (Number=80).

Gender		n (%)
	Male	59 (74%)
	Female	21 (26%)
Age in years		
	Below 18 males	10 (13%)
	Below 18 females	5 (6%)
	Above 18 males	49 (61%)
	Above 18 females	16 (20%)
Marital status		
	Married	45 (56%)
	No	35 (44%)
Occupation		
	Heavy worker	43 (54%)
	Light worker	37 (46%)
Number of deformities		
	Single	53 (66%)
	Two	24 (30%)
	More than 2	3 (4%)
	Mean duration of deformity in years \pm SD	2.8 \pm 2.4
	Mean duration of follow-up in years \pm SD	1.4 \pm 1.7

**Fig. 1 : Types of Tendon Transfer surgery performed in percentage and number in parenthesis (n=95)**

were students. The median (IQR) duration of the deformity was 2 Years (1.5 – 3 Years). Of the 80 participants, 53(66%) had one deformity, 24(30%) had two deformities and 3(4%) had more than two deformities.

Of these, deformities were completely corrected for 67 (84%) patients and for the remaining 13 (16%) patients some of the deformities were yet to be corrected. The types of surgeries performed and number of patients who underwent a particular type of procedure is shown in Fig. 1. Out of the 95 procedures performed, 60 (63%) Lasso procedures were done for correction of claw fingers, followed by 16 TPT (17%), 17 Opponens replacement (18%) and 2 TMT (Temporalis Muscle Transfer) (2%).

Sixty-six (83%) patients underwent single surgery, 13 (16%) had two surgeries and 1 (1%) had three surgeries. Single surgeries. The types of different surgeries performed are given in the Fig. 1.

The main outcome measures EHF, SALSA and P-Scale scores are given in Table 2. The mean (SD) difference in the pre and final follow-up scores of EHF, SALSA and P Scale were 0.95, 7.39 and 5.39 respectively and the difference were statistically significant.

Table 3 shows the EHF, SALSA and P-scale scores disaggregated by gender at pre and final follow up assessments. The scores for the women were consistently higher in all three outcomes and at both stages of the assessment. However, the difference was statistically significant for SALSA score at pre and at follow-up assessment.

There was significant reduction (improvement) in EHF, SALSA, and P-scale scores post tendon transfer surgery at final follow-up assessment as compared to pre-operative stage. Within group comparisons were performed with Wilcoxon signed rank test (Figs. 2a, 2b & 2c) and the difference was statistically significant $p < 0.001$.

Table 2 : Distribution of Pre and final follow-up scores of outcome measures (N=80).

	Pre-Op			Final follow-up		
	Mean \pm SD	Median	Interquartile Range (IQR)	Mean \pm SD	Median	Interquartile Range (IQR)
EHF	3.1 \pm 1.9	2	(2-4)	2.1 \pm 2	1	(1-4)
SALSA	34 \pm 10	30	(27-38)	26 \pm 9	23	(20-32)
P Scale	11 \pm 10	6	(4-14)	5 \pm 9	0	(0-6)

Table 3 : Gender wise distribution of mean (SD) scores of pre and final follow-up assessment of outcome measures (N=80).

Outcome measures	Gender	Pre-Op Mean \pm SD	Final follow-up Mean \pm SD
EHF	Male (59)	3.1 \pm 1.9	2.1 \pm 2.1
	Female (21)	3.1 \pm 1.8	2.4 \pm 1.8
SALSA	Male (59)	32.2 \pm 8.4	25.3 \pm 8
	Female (21)	38.7 \pm 12.7	30.7 \pm 11.5
P Scale	Male (59)	10.5 \pm 9.2	4.5 \pm 7.8
	Female (21)	10.6 \pm 12.5	7.4 \pm 12

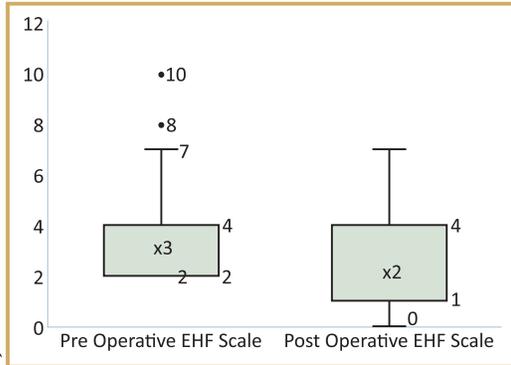


Fig. 2a : Comparison of EHF scores before and after tendon transfer surgery of patients with disability in leprosy.

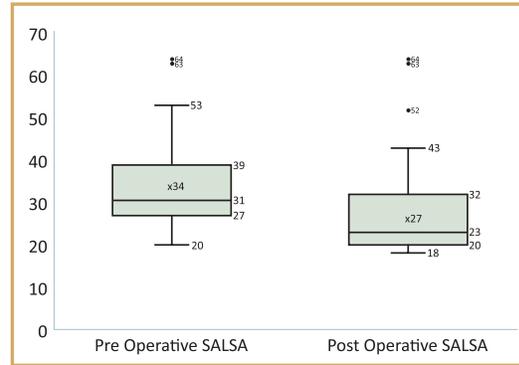


Fig. 2b : Comparison of SALSA scores before and after tendon transfer surgery of patients with disability in leprosy.

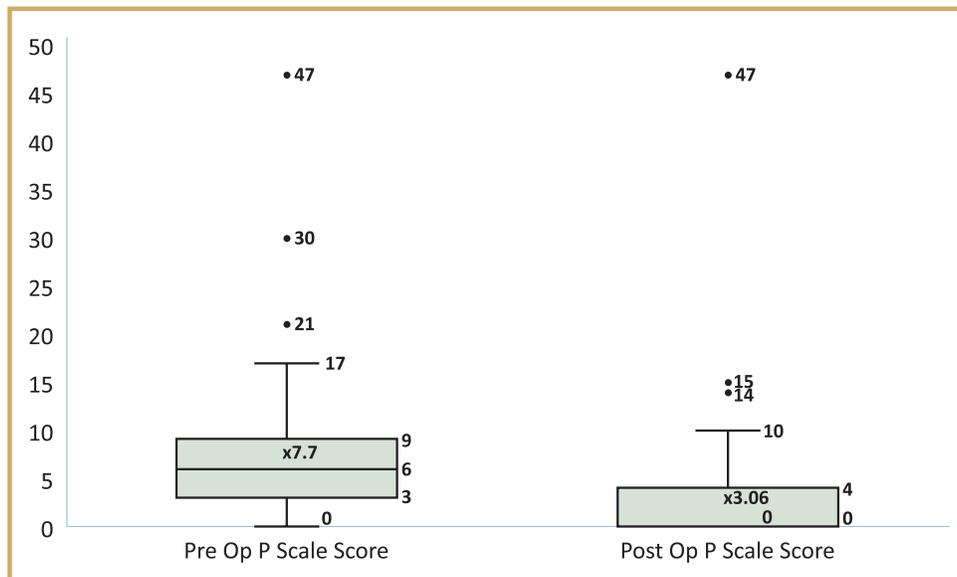


Fig. 2c : Comparison of P scale scores before and after tendon transfer surgery of patients with disability in leprosy.

Multiple Linear regression analysis was done to determine the impact of tendon transfer on activity level (SALSA scale) and on participation level (P scale). The results showed significant reduction by 9 and 7 points in activity limitation and participation restriction level, respectively

when patient underwent complete correction of deformities through tendon transfer. Gender (female) and quantum of disability (EHF score) at the time of surgery were independently associated with the activity level whereas higher age at the time of tendon transfer was

Table 4 : Linear regression analysis to determine the impact of tendon transfer on activity level (SALSA Scale) and participation level (P Scale).

Activity Level (SALSA Scale) Variable (comparator)	Co- efficient	(95% Confidence Interval)	p-value
Constant	16.1		-
Age	0.15	(-0.05 – 0.34)	0.11
Female (Male)	6.20	(1.94 – 10.47)	0.005*
Duration of deformity	0.2	(-0.43 – 0.83)	0.53
EHF score at tendon transfer	1.62	(0.64 – 2.60)	0.001*
Occupation-heavy worker (Mild worker)	0.445	(-3.60 – 4.49)	0.82
Complete correction of deformity (Incomplete correction)	-9.128	(-4.39 – -3.87)	0.000*

R² = 0.55

Participation level (P Scale) Variable (comparator)	Co- efficient	(95% Confidence Interval)	p-value
Constant	2.74		
Age	0.27	(0.05 – 0.50)	0.021*
Female (Male)	2.01	(-3.15 – 7.16)	0.448
Duration of deformity	0.11	(-0.65 – 0.88)	0.773
EHF score at tendon transfer	0.74	(-0.45 – 1.92)	0.227
Occupation-heavy worker (Mild worker)	-2.38	(2.50 – -7.27)	0.342
Complete correction of deformity (Incomplete correction)	-7.24	(-1.55 – -2.98)	0.0155*

R² = 0.31

*P Value <0.05 is significant value

independently associated with the participation level (Table 4). The duration of deformity and type of occupation was not associated with the activity limitation and participation restriction scores post tendon transfer at final follow-up assessment.

Discussion

The study examined the impact of tendon transfer surgery on patients with deformities, focussing on disability severity, activity limitation and participation levels. A total of 80 patients (95 procedures) were included with diverse demographic and clinical characteristics.

There were fewer number of females in the study than males. Several studies in leprosy (Noordeen

1993, van Brakel et al 2012) have consistently shown a higher number of male beneficiaries compared to females. Noordeen's review attributes the higher incidence of infection among men to lifestyle choices that result in increased exposure to infection. Consequently, the number of affected and impaired males surpass that of females. A study conducted in Odisha, India revealed that females lacked permission from their family or spouse to undergo tendon transfer. Dependence on family to access healthcare services has been a significant barrier leading to lower female enrolment (Rath et al 2010a). The process of preparing for tendon transfer surgery involves various stages such

as releasing contractures, healing calluses and cracks softening the skin and improving joint flexibility. Total duration of rehabilitation protocol per surgery takes approximately two and half months for a patient to completely return to their normal activities. This extended duration poses a challenge particularly for females who have family responsibilities. This may explain why fewer females opt for tendon transfer surgeries as the lengthy recovery may prevent them from fulfilling their familial obligations. This highlights the need for gender specific considerations in understanding the acceptability and outcomes of the surgery. Early mobilization strategy post tendon transfer surgery can be adopted for those with suitable deformities in hands and feet and has shown good outcomes (Rath 2008, Rath et al 2010b).

The mean age of the participants was 25.8 years indicating a young sample. The younger age group emphasizes the importance of timely correction of correctable deformities and rehabilitation to fully participate in their occupation including student role. Despite the younger population, increasing age found to be independently impacting the outcome of social participation. This highlights the fact that delay in diagnosis and presenting with irreversible secondary impairments such as fixed or contracted joints and absorption may not be effectively corrected through tendon transfer and even after correction may not be fully useful in the context of social participation. The delay in diagnosis and timely access to surgical and other related care are still major public health concerns in India. Nerve function impairment can occur any time during and /or after treatment. This demands a constant vigilance to detect and treat impairments, so that no one is left with irreversible deformity that demands correction. This consistent monitoring is lacking in the public health system whereby timely management of such cases does not happen.

Majority of the patients were married, comprising 56% of the participants implies that the impact of the surgery extends beyond the individual patient, potentially affecting their family and social dynamics. The reduction in activity limitation and participation restriction reduces the impact of disabilities on family. There is scant evidence on the impact of disability on family and necessities further investigation to suggest support methods.

The occupation of the participants was classified into heavy and light work, with 54% being heavy workers and 26% being students. This categorization provides insight into the varied lifestyles and activity levels of the individuals involved. The high proportion of heavy workers among the participants suggest that occupational factors might play a role in the development and progression of deformities and consequently outcome of the tendon transfer surgery. However, the difference was not statistically significant, although overall there was improvement. Perhaps, their rehabilitated limbs could not meet the required skills in their heavy work profile. The significant representation of students in the study population highlights the urgent need for correction of their deformities/ disabilities to minimize dropouts due to stigma and discrimination (Ahmad 2023).

In terms of the deformities, the study found that the median duration of the deformity was 2 years, with a range of 1.5 to 3 years implying that the patients have been living with deformities for a significant period before undergoing the surgery. However, the delay had no significant impact on the outcome in terms of activity level and social participation. Delay in diagnosis is a major risk of disability (G2D/G1D) among adult leprosy patients. A patient delay of more than 3 months from the notice of the first symptom is a significant indicator for the disabilities among adult leprosy patients (Srinivas et al

2019). To prevent disability, prompt treatment is necessary and there is a lot of evidence on type and duration of delay. It is in fact suggested that not only early correct treatment of leprosy with Multi Drug Therapy, but also timely and correct treatment of reactions and neuritis can prevent disability (Mahato 2006). Strengthening the efforts of the public health system to minimize delay in detecting nerve damage will help reduce the burden of disability in the country.

Moreover, the number of deformities varied, with most patients 53 (66%) were having one deformity. Multiple deformities have different dynamics of navigating household activities and that of daily living. Tendon transfer or corrective surgeries also take a long time for correction implying longer hospital admissions, loss of wages and the social problems associated with an absent family member.

The study observed that approximately 64% of participants were below the age of 25 while the remaining participants were up to 53 years old. However, increasing age did not have a significant association with the levels of activity but was associated with participation restriction (Table 4). The largest study conducted in Brazil, found that a higher percentage of older patients aged 50 years experienced activity limitations (Monteiro et al 2014).

Regarding the number of deformities observed, 53 individuals (66%) had one deformity, 24 (30%) had 2 deformities and only 3 (4%) had more than 2 deformities. The median (IQR) duration of deformity of 2 (1.5 – 3) years indicated that most participants had been experiencing their disabilities for a considerable period which could have implications for the severity of the condition and the effectiveness of treatment interventions. Even though majority of participants had one deformity, understanding the causes and consequences of specific deformities and multiple deformities should be investigated.

In terms of EHF scores, both male and female participants had similar pre-operative scores. However, females exhibited slightly higher post-operative scores at final follow-up assessment, suggesting slightly less favourable outcome for women in terms of hand function. On the other hand, SALSA scores showed that females had higher pre-operative scores, indicating greater activity limitations, but experienced greater improvements post-operatively at final follow-up assessment compared to males. However, their final follow-up assessment of activity limitation score was higher than males. Participants with (extreme) high scores at baseline tend to improve more than those with lower scores at baseline (van Veen et al 2011).

Multiple linear regression analysis was performed to identify factors influencing activity limitation (SALSA Scale) and participation restriction (P Scale). The results indicated that complete correction of deformities through tendon transfer led to a significant reduction in activity limitation by 9 points and participation restriction by 7 points. Moreover, gender (female) and the severity of disability (EHF score) were independently associated with activity level, while older age at the time of tendon transfer was independently associated with participation level. These findings are consistent with the other studies (Menaldi et al 2022). These findings emphasize the importance of considering individual characteristics when evaluating the impact of tendon transfer surgery.

It was found that the surgery improved the visible appearance of affected eyes, hands, and feet. The researchers of this study qualitatively observed the patients after their correction of deformities and reported that, the social and self-stigma are being reduced, which, in turn, increases their self-confidence allowing them to participate in social activities as before. Therefore, it can be presumed that the quality of life of the

patients improved after tendon transfer (Lenka & Mahapatra 2016).

It is crucial that all the eligible patients should be motivated to undergo tendon transfer. The benefits of tendon transfer should be made aware and counselled among the patients with disability for the better utilisation of services. Qualitative studies are recommended to explore the nature of improvement in activities and social participation and how tendon transfer improved the quality of life of the patients to design the motivation and counselling strategies for leprosy patients and in removing taboos on tendon transfer in the community. The impact of multiple deformities needs to be studied and the potential restoration of function and visible appearance needs to be documented.

Limitations

There is a considerable number of patients who underwent tendon transfer did not turn up for the follow up: this, in turn reduced the sample size and limited the analysis for studying the possible associations and interactions. Therefore, counselling support is needed not only for enrolling them in tendon transfer, but also for attending regular post operative follow-ups. Further, the strengths and weaknesses of health systems relevant for providing such care should be studied for reaching out to needy persons suffering from these disabilities.

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