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Outcome of Achilles tendon plication and transfer of peroneus longus to Achilles tendon for correction of dynamic calcaneo-valgus deformity of the foot in post-polio residual paralysis

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Abstract
Objective: Tendon transfers are indicated when dynamic muscle imbalance results in a deformity that interferes with ambulation or function of the extremities. Foot and ankle are the most dependent parts of the body and are subjected to greater strain than other parts. Calcaneo-valgus deformity is one of the common deformities seen in Post-Polio Residual Paralysis. A host of operative procedures have been described in the management of this deformity. We report the results of the study conducted in our institute where Achilles tendon plication and transfer of Peroneus Longus tendon to Achilles tendon has been done for dynamic calcaneo-valgus deformity of the foot in patients of post-polio residual paralysis.
Methods: This is a prospective study of 37 patients with Calcaneovalgus deformity having Post-Polio Residual Paralysis presenting to Balaji Institute of Surgery, Research and Rehabilitation for the Disabled Hospital from December 2009 to December 2012. Informed consent was taken from the parents of all the patients. Ethical committee approval was also taken. Patients with age more than 7 years, ability to walk without support and Peroneal tendon having minimum motor power of grade 4 or 5 as per MRC classification are included in our study. Patients with fixed deformity at ankle joint or subtalar joint are excluded from the study. Pre-operative evaluation included detailed motor examination of the involved lower limbs as per MRC (Medical research council) classification, evaluation of deformity in the hip and knee and range of motion at ankle. AOFAS (American Orthopaedic Foot and Ankle Society) clinical rating system was used to assess the patient pre-operatively and post-operatively. The aggregate score of the AOFAS ankle-hind foot clinical rating scale pre and post operatively were analyzed with use of chi-square analysis. The level of significance of < 0.05 was considered to be significant. The surgical procedure was done under spinal anesthesia with the patient in lateral position under pneumatic tourniquet. A longitudinal incision is made starting from the tip of lateral malleolus midway between the posterior border of lateral malleolus & Achilles tendon to about 8-10cm proximally. Skin flaps are mobilized without dissecting the subcutaneous fat. The two peroneal tendons are identified as they pass down the leg and around the back of the lateral malleolus. The peroneus longus tendon is divided as distally as possible and mobilized. Similarly the Achilles tendon is identified. Plication of the Achilles tendon is done in its middle third with nylon sutures and the peroneus longus tendon is transferred through it using Fish-Mouth (Pulvertaft) tendon suturing technique and is secured over itself proximally under tension providing the tenodesis effect. While this is done the ankle is kept in plantar flexion. The deep fascia is closed over the tendon. Pneumatic tourniquet was released, and the incision was closed in layers after hemostasis was achieved. Below knee cast is applied with the foot in plantar flexion. Movements of the toes are encouraged after recovery from anesthesia. Active toe movements were encouraged in the cast. After six weeks sutures are removed and ankle foot orthoses are provided for another six weeks. During this period supervised active exercises for strengthening the Tendoachilles (static cycling exercise) are started. Patient is reassessed after six weeks and the orthoses is discarded at this stage.
Conclusion: Our experience concludes that Achilles tendon plication and transfer of peroneus longus tendon to Achilles tendon is an excellent procedure which improves the dynamic calcaneo-valgus deformity of foot in patients with post-polio residual paralysis. The advantage of the procedure being easy to do with very low complication rate and improves the quality of life in patients with post-polio residual paralysis. 37 patients with the dynamic calcaneo-valgus deformity of foot in patients with post-polio residual paralysis were analyzed with average follow up period of 12.5 months. Dynamic calcaneo-valgus deformity of the foot was corrected in 89.18% of patients. The study fared with 89 percent patients satisfied with the results. The patients showed improvement in their activity limitation, maximum walking distance, gait and stability.

Keywords: Poliomyelitis, Calcaneovalgus Foot, Pulvertaft tendon suturing technique, AOFAS clinical rating system

Introduction

Poliomyelitis is said to have first occurred nearly 6,000 years ago in the time of the Ancient Egyptians. The evidence for this is in the withered and deformed limbs of certain Egyptian mummies [1].

In the pre-vaccination era, poliomyelitis was found in all countries of the world. The extensive use of polio vaccines since 1954 has almost eliminated the disease in developed countries [2].

Poliomyelitis is on the verge of eradication from India following concerted and co-ordinated pulse polio immunization program. As per WHO (World Health Organization) in 2010 India reported 44 confirmed polio cases out of which 42 were wild virus confirmed polio cases and 2 were vaccine derived [3].

Poliomyelitis is caused by infection with a Enterovirus known as Poliovirus which infect and cause disease only in humans [4]. Three serotypes have been identified among which serotype 1 is the most commonly encountered form, and the one most closely associated with paralysis [2].

In around 1% of infections this leads to the development of paralytic poliomyelitis which in the chronic stage leads to post-polio residual paralysis. The muscles affected depend on which level of the spinal cord is involved, but the paralysis tends to affect some muscles more than others and the lower limb much more often than the upper limb. As a result of this, contractures are liable to occur, and this is mainly due to gravity, posture and imbalance of muscles. These deformities are seen particularly in the lower limbs where the flexors of the hip, knee and ankle are often less paralysed than the extensors. Flexion contractures of the hip and knee, and equinus deformity of the ankle are therefore common sequelae [5].

Orthopaedic surgery makes its greatest contribution to the rehabilitation of the patient with post-polio residual paralysis in the residual stage of the disease by preventing or correcting deformities, enhancing muscle power, stabilizing flail joints and eliminating the need for such external supports as braces and corsets [6].

Tendon transfers are indicated when dynamic muscle imbalance results in a deformity that interferes with ambulation or function of the extremities. Foot and ankle are the most dependent parts of the body and are subjected to greater strain than other parts, they are susceptible to deformity from paralysis [5]. Various deformities seen around the ankle and foot are equinus, equinovarus, calcaneocavus, calcaneo-valgus, cavus and claw foot, depending up on which various procedures have been described for correction of these deformities.

Calcaneo-valgus deformity is one of the common deformities seen in post-polio paralysis. The deformity commonly increases and is not often prevented by orthopaedic appliances [7]. This deformity is quite disabling to the patient besides giving an ugly look and hence the need of its correction. A host of operative procedures have been described in the management of this deformity.

We report the results of the study conducted in our institute where Achilles tendon plication and transfer of peroneus longus tendon to Achilles tendon has been done for dynamic calcaneo-valgus deformity of the foot in patients of post-polio residual paralysis.

Materials and Methods

This is retrospective as well as prospective study of 37 patients with Calcaneovalgus deformity having post-polio residual paralysis presenting to Balaji institute of surgery, research and rehabilitation for the disabled hospital from year December 2009 to December 2012. Informed consent was taken from the parents of all the patients. Ethical committee approval was also taken.

Inclusion criteria

1. Age above 7 years.
2. Ability to walk without support.
3. Peroneal tendon having minimum motor power of grade 4 or 5 as per MRC classification (Medical Research Council)Annexure II, 17

Exclusion criteria

1. Fixed deformity at the ankle joint or subtalar joint.

Preoperative evaluation

All selected patients were evaluated as per history and clinical examination based on the prepared proforma.

Pre-operative evaluation included detailed motor examination of the involved lower limbs as per MRC (Medical research council) classification, evaluation of deformity in the hip and knee, range of motion of ankle using a standard hand held goniometer.

For assessing the results shape of the foot, correction of dynamic calcaneovalgus deformity, patients subjective opinion regarding outcome of the procedure [10-16] and AOFAS Annexure II, 18 (American Orthopaedic Foot and Ankle Society) clinical rating system ankle-hind foot scale was used to assess the patient pre-operatively and post-operatively in which pain, activity limitation, walking distance, gait abnormality, ankle stability, alignment were assessed.

The aggregate score of the AOFAS ankle-hind foot clinical rating scale pre and post operatively were analyzed with use of chi-square analysis. The level of significance of < 0.05 was considered to be significant.

We could not find any particular scoring system or statistical analysis in the literature for this procedure for the analysis of results.

Results were analyzed on following criteria: Satisfactory-plantigrade normal looking foot, marked overall improvement in the gait, activity limitation, stability, walking distance, alignment and correction of dynamic calcaneovalgus deformity.

Unsatisfactory-Persistence of deformity. Minimal improvement in the gait, activity limitation, stability, walking distance and alignment.

Surgical Procedure

The surgical procedure was done under spinal anesthesia with the patient in lateral position. A pneumatic tourniquet was applied at the thigh and inflated to 350 mm Hg following exsanguination of the leg.

Incision: A longitudinal incision is made starting from the tip of lateral malleolus midway between the posterior border of lateral malleolus & Achilles tendon to about 8-10cm proximally. Skin flaps are mobilized without dissecting the subcutaneous fat. The short saphenous vein and sural nerves run just behind the lateral malleolus, they should be well anterior to the incision. The two peroneal tendons are

identified as they pass down the leg and around the back of the lateral malleolus. The peroneus brevis is muscular almost down to the ankle, whereas the peroneus longus is tendinous in the distal third of the leg.

The peroneus longus tendon is divided as distally as possible and mobilized. Similarly the Achilles tendon is identified. Plication of the Achilles tendon is done in its middle third with nylon sutures and the peroneus longus tendon is transferred through it using Fish-Mouth (Pulvertaft) tendon suturing technique [5-19] and is secured over itself proximally under tension providing the tenodesis effect. While this is done the ankle is kept in plantar flexion. The deep fascia is closed over the tendon. Pneumatic tourniquet was released, and the incision was closed in layers after hemostasis was achieved.

Below knee cast is applied with the foot in plantar flexion. The leg was elevated for 24 hours after surgery. Movements of the toes are encouraged after recovery from anesthesia.

Post-operative period: Active toe movements were encouraged in the cast. After six weeks sutures are removed and ankle foot orthoses are provided for another six weeks. During this period supervised active exercises for strengthening the Tendoachillis (static cycling exercise) are started. Patient is reassessed after six weeks and the orthoses is discarded at this stage.

Age Distribution

Patients were in the age group of 10-28 years averaging 19 years.

Table 1: Age Distribution

Age group(years)	No. of patients	Percentage (%)
10-14	6	16.21
15-19	16	43.24
20-25	9	24.32
25-28	6	16.21

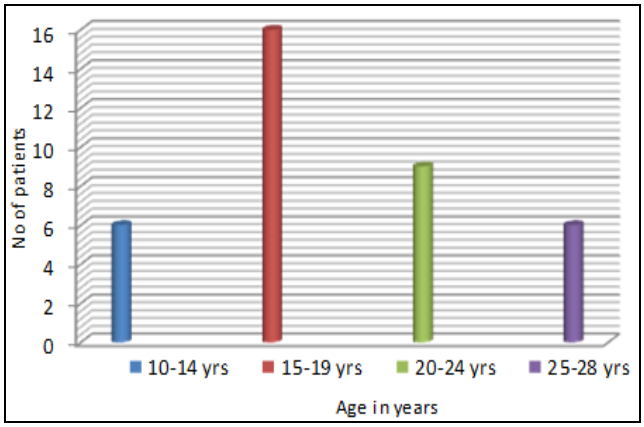


Fig 1: Age Distribution

Sex Distribution

Among the 37 patients operated, 18 were male and 19 were female.

Table 2: Sex Distribution

Sex	No. of patients	Percentage (%)
Male	18	48.64
Female	19	51.35

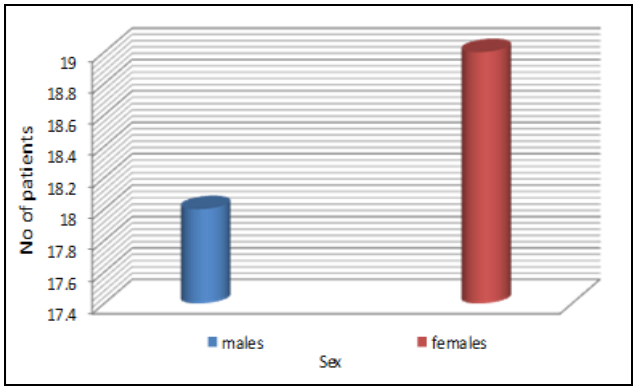


Fig 2: Sex Distribution

Affected Side

Among the 37 patients operated, 14 patients had right lower limb involvement and 23 had left lower limb involvement.

Table 3: Affected Side

Side involved	No. of patients	Percentage (%)
Right	14	37.83
Left	23	62.16

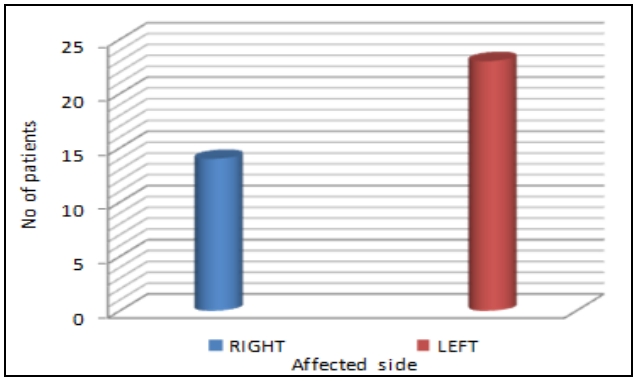


Fig 3: Affected Side

Additional Surgeries

Among the 37 patients included in the study 14 patients were already operated for additional surgery. Of which 8 patients underwent Posterior soft tissue release operation for correction of flexion deformity at the knee, remaining 6 patients underwent Posterior angulation osteotomy of distal femur for patients with complaint of hand to knee gait.

Table 4: Additional Surgeries

Additional surgeries	No. of patients
Posterior soft tissue release	8
Posterior angulation osteotomy	6

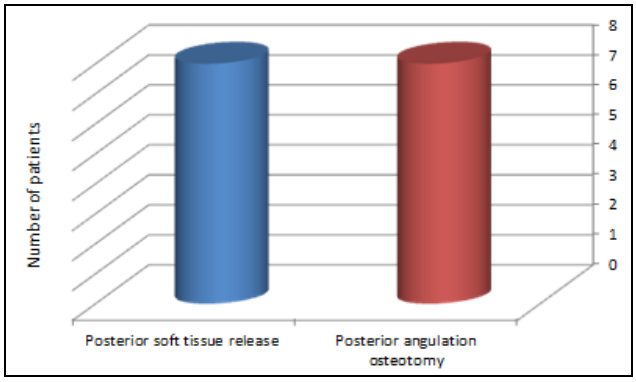


Fig 4: Additional Surgeries

Motor Power of Peroneus Longus

Motor power of the peroneus longus was assessed according to MRC classification. 26 patients had peroneus longus of motor power grade 5 and remaining 11 patients had motor power of grade 4.

Table 5: Motor Power of Peroneus Longus

Motor power of peroneus longus (Grade)	No. of patients
Grade 4	11
Grade 5	26

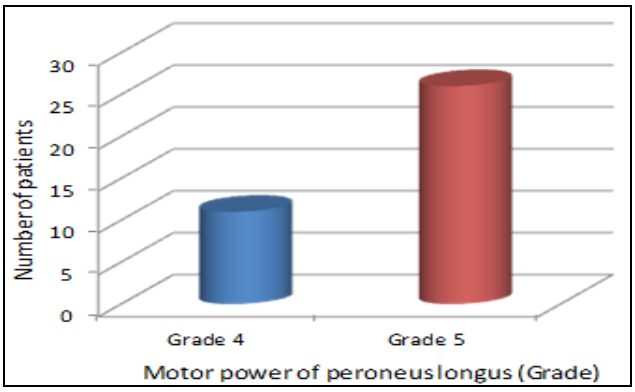


Fig 5: Motor Power of Peroneus Longus

Instruments

Photographs

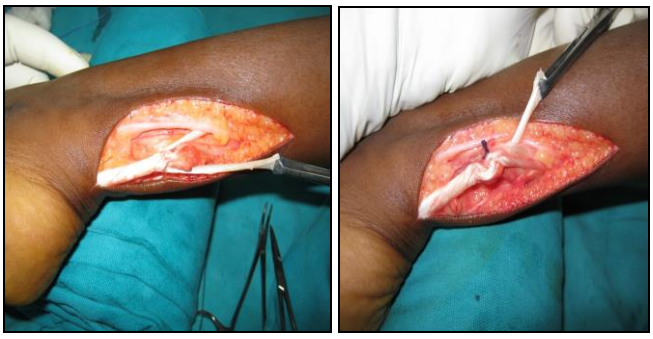
Surgical steps

Position and incision

Exposure of Achilles tendon

Exposure and detachment of Peroneus longus

Plication of Achilles tendon



Transfer of Peroneus longus to Achilles tendon (Pulvertaft Technique)

Closure and below knee cast in equinus position

1) Pre-op Post-op

2) Pre-op

2) Pre-op

Post-op

Results and Discussion

Deformity correction and subscales of the AOFAS (American Orthopaedic Foot and Ankle Society) ankle-hind foot score were analyzed for improvement pre and post operatively.

Activity limitation

Among the 37 patients 36 patients had limitation in their functional activity. 10 patients scored 4 points, 3 patients scored 5 points, 17 patients scored 6 points and 6 patients scored 7 points pre-operatively.

Post-operatively 11 patients scored 7 points, 23 patients scored 8 points and 2 patients scored 9 points post-operatively. Maximum score was 10 points.

Table 6: Activity limitation (pre-operative score)

Number of patients	Pre-operative score
10	4
3	5
17	6
6	7

Table 7: Activity limitation (post-operative score)

Number of patients	Post-operative score
11	7
23	8
2	9

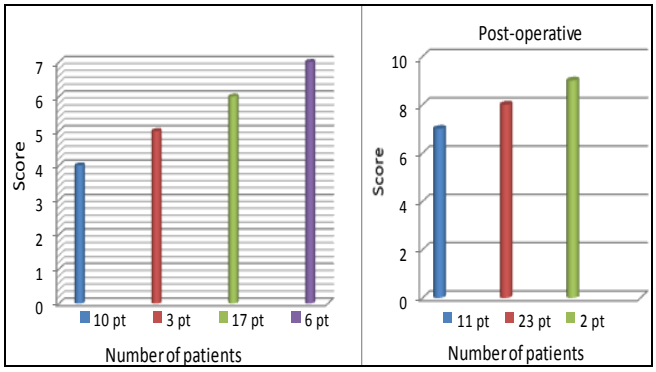


Fig 6: Activity limitation

Maximum Walking distance

Among the 37 patients 4 patients scored 1 point, 29 patients scored 2 points and 4 patients scored 4 points preoperatively.

Post-operatively 4 patients scored 2 points, 8 patients scored 3 points, 21 patients scored 4 points and 4 patients scored 5 points. Maximum score was 5 points.

Table 8: Maximum Walking distance (pre-operative score)

Number of patients	Pre-operative score
4	1
29	2
4	4

Table 9: Maximum Walking distance (post-operative score)

Number of patients	Post-operative score
4	2
8	3
21	4
4	5

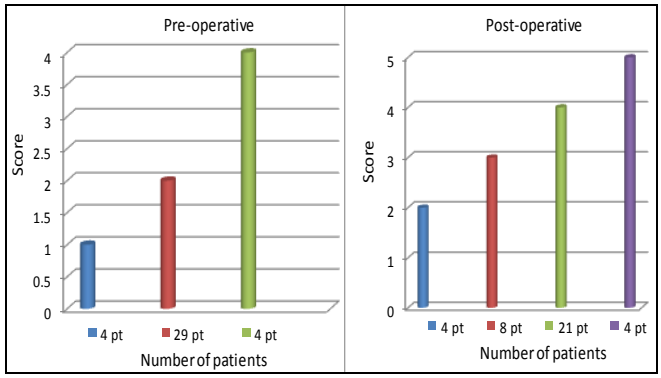


Fig 7: Maximum Walking distance

Walking surface

Among the 37 patients 4 patients scored 2 points, 31 patients scored 3 points and 5 patients scored 2 points pre-operatively.

Post-operatively 12 patients scored 4 points and 25 patients scored 5 points. Maximum score was 5 points. Maximum score was 5 points.

Table 10: Walking surface (pre-operative score)

Number of patients	Pre-operative score
4	2
31	3
2	5

Table 11: Walking surface (post-operative score)

Number of patients	Post-operative score
12	4
25	5

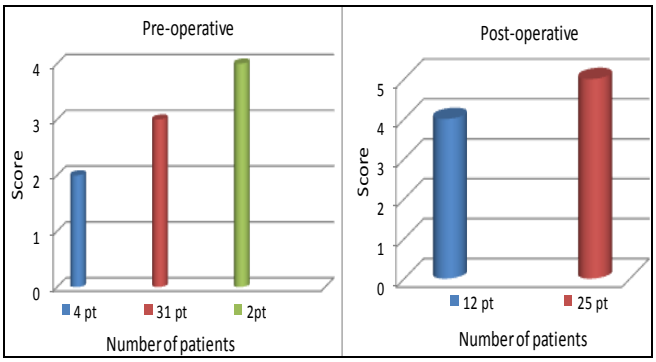


Fig 8: Walking surface

Gait abnormality

Among the 37 patients 9 patients scored 3 points, 21 patients scored 4 points, 4 patients scored 5 points and 3 patients 6 points pre-operatively.

Post-operatively 2 patients scored 5 points, 4 patients scored 6 points, 26 patients scored 7 points and 5 patients scored 8 points. Maximum score was 8 points.

Table 11: Gait abnormality (pre-operative score)

Number of patients	Pre-operative score
9	3
21	4
4	5
3	6

Table 12: Gait abnormality (post-operative score)

Number of patients	Post-operative score
2	5
4	6
26	7
5	8

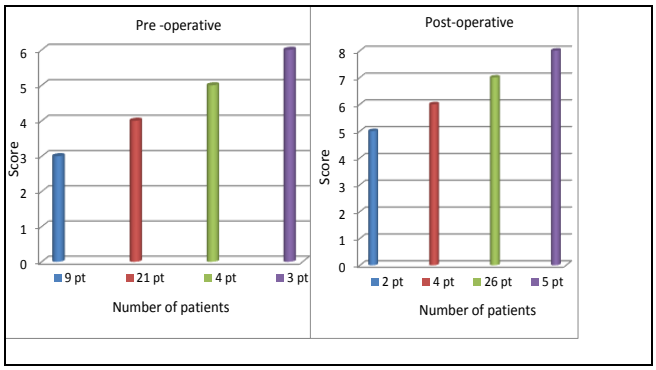


Fig 9: Gait abnormality

Stability

Among the 37 patients 2 patients scored 3 points, 27 patients scored 4 points, 6 patients scored 5 points and 2 patients scored 6 points pre-operatively.

Post-operatively 9 patients scored 6 points, 20 patients scored 7 points and 8 patients scored 8 points. Maximum score was 8 points.

Table 13: Stability (pre-operative score)

Number of patients	Pre-operative score
2	3
27	4
6	5
2	6

Table 14: Stability (post-operative score)

Number of patients	Post-operative score
9	6
20	7
8	8

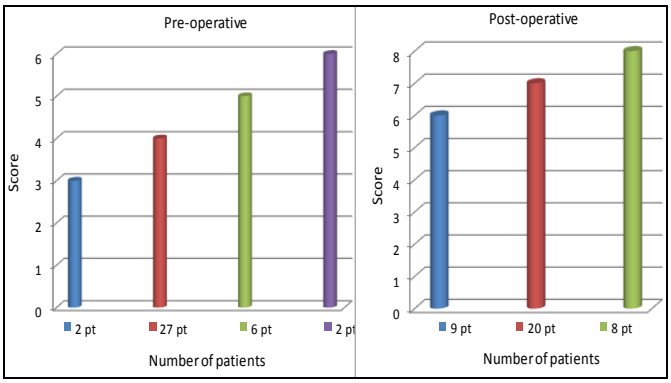


Fig 10: Stability

Alignment

Among the 37 patients 2 patients scored 3 points, 4 patients scored 4 points, 27 patients scored 5 points and 4 patients scored 6 points pre-operatively.

Post-operatively 4 patients scored 6 points, 4 patients scored 7 points, 13 patients scored 8 points and 16 patients scored 9 points. Maximum score was 10 points.

Table 15: Alignment (pre-operative score)

Number of patients	Pre-operative score
2	3
4	4
27	5
4	6

Table 16: Alignment (post-operative score)

Number of patients	Post-operative score
4	6
4	7
13	8
16	9

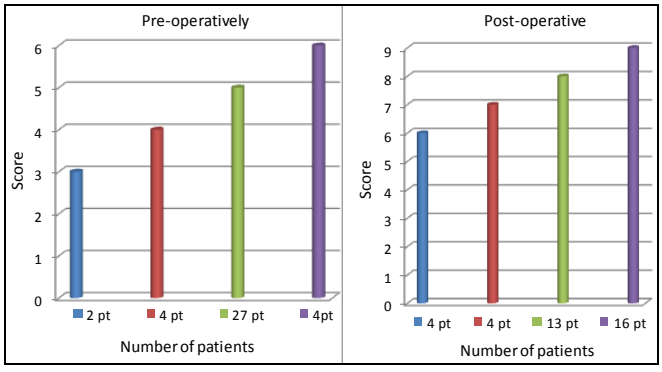


Fig 11: Alignment

Deformity correction

Among all the 37 patients operated the dynamic calcaneo-valgus deformity was corrected completely with normal plantigrade looking foot in 33 patients, residual valgus deformity was present in 4 patients.

Table 17: Deformity correction

Deformity correction	Number of patients	Percentage (%)
Yes	33	89.2
No	4	10.8

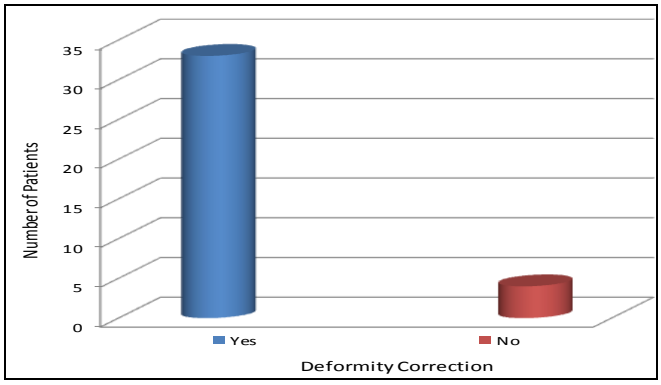


Fig 12

Complications

Among 37 patients, 2 patients had mild break down of wound and infection which was treated with oral antibiotics and dressing. There were no other complications associated with this procedure in any of the patients.

Discussion

Acute poliomyelitis is at the verge of extension especially in the western countries. Newly diagnosed polio cases are still being reported in the Asian and African continent, consequence of which cases of post-polio residual paralysis are still seen in these parts of the world.

Calcaneo-valgus deformity is one of the common deformities seen in post-polio residual paralysis. The deformity commonly increases and is not often prevented by orthopaedic appliances. Several procedures have been described in literature for the correction of this deformity. The purpose of this study was to evaluate the clinical and functional outcome of patients with post-polio residual paralysis having dynamic calcaneo-valgus deformity where Achilles tendon plication and transfer of peroneus longus tendon to Achilles tendon has been done.

This is a prospective study of 37 patients with dynamic calcaneo-valgus deformity of the foot in patients of post-polio residual paralysis presenting to Balaji institute of surgery, research and rehabilitation for the disabled hospital from year December 2009 to December 2012.

Our study included total of 37 patients from age group 10 years to 28 years averaging about 19 years.

Among them 18 were males and remaining 19 were females. Right side was involved in 14 patients and left side in 23 patients.

In our study average follow up was 12.5 months ranging from 3 to 22 months. Average age at the time of surgery was 19 years with range from 10 years to 28 years.

The median AOFAS score was 79 points (range 74 to 84) pre-operatively. Follow up at 3 months post-operatively median AOFAS score was 91.5 points (range 87 to 96) with P value < 0.05 which is considered to be significant.

Among all the 37 patients none of the patients had pain pre-operatively and post-operatively. Ankle and hind foot motion were normal in all 37 patients pre-operatively and post-operatively.

Among all the 37 patients, dynamic calcaneo-valgus deformity was corrected in 33 patients (89.18%) with normal plantigrade looking foot and 4 patients (11%) had residual dynamic valgus deformity due to the action of extensor digitorum longus and peroneus brevis acting as the deforming force.

33 (89.18%) of patients showed improvement in their activity limitation, maximum walking distance, gait, alignment and stability.

Among all the 37 patients 33 (89.18%) of patients rated the result of the operation as satisfactory and 4 (11 %) of patients rated the results as unsatisfactory at the time of follow up three months post-operatively.

P. M. de Moraes Barros Fucs *et al*. (2006) in their study of treatment of paralytic calcaneo-valgus feet by westin technique in 17 patients of which 6 were post-polio residual paralyses. All 6 patients were satisfied with the outcome however the results were not correlated statistically due to small group of patients [10].

AK Das (2004) *et al*. in their study of 75 patients for calcaneus feet tibialis anterior or posterior & or peroneus longus to heel reported restored push off power of foot with plantigrade appearance in 52 patients (63.33%) [20].

T. K. Mitra *et al*. (1999) in their study of correction of paralytic calcaneo-cavus deformity by plantar release and calcaneal osteotomy alone or either translocation of peroneus longus or transfer of tibialis anterior or posterior and peroneus longus or transfer of peroneus longus and brevis to heel in 23 patients reported excellent results in 5 (21.75%), good in 13 (56.50%), fair in 4 (17.40%) and poor in 1 (4.35%) of patients [16].

L. V. Raghav Rao *et al*. (1976) in their study for 11 patients Peroneus Longus Translocation in the treatment Of paralytic calcaneo-valgus foot with grice extra articular arthrodesis in some case of excessive valgus deformity reported excellent results in 4, good in 3, fair in 3 and poor in 1 patients [7].

G. W. Westin in (1965) in their study Tendon Transfers about the Foot, Ankle, and Hip in the Paralyzed Lower extremity 32 patients with calcaneo-valgus deformity underwent posterior stabilization in form of triple or subtalar arthrodesis with posterior transfer of peroneus longus, brevis and flexor hallucis muscle to calcaneum. He reported satisfactory results when the tendon transfers were associated with stabilization procedure. Exact numbers have not been mentioned [15].

J. Mortens *et al*. (1956) in their study of 27 feet with calcaneo-cavo-valgus deformity where peronei alone or with other muscles were transferred to the calf reported results as improved in 12 patients, unaltered in 6 patients and worse in 9 patients [21].

John A. Reidy *et al*. (1952) in their review of tendon transplantation about the ankle and foot, 34 cases where tendons were transferred posteriorly to the os calcis or Tendo Achilles for calcaneus deformity with or without triple arthrodesis reported good results in 9 (26.5%), fair in 10 (29.4%), and poor in 15 (44.1%) patients [22].

T. Campbell Thompson (1939) in their study of 41 patients of calcaneus or calcaneo-valgus deformity in paralytic foot treated by astragalectomy reported results as good in 27, fair in 7 and poor in 10 patients [23].

Charles W. Peabody (1938) reported 45 cases of calcaneus imbalance peronei transfer to os calcis reported adequate function in 28 cases, improved in 16 cases and failure in 1 case [24].

Conclusion

Our experience concludes that Achilles tendon plication and transfer of peroneus longus tendon to Achilles tendon is an excellent procedure which improves the dynamic calcaneo-valgus deformity of foot in patients with post-polio residual paralysis.

The advantage of the procedure being easy to do with very low complication rate and improves the quality of life in patients with post-polio residual paralysis.

- 37 patients with the dynamic calcaneo-valgus deformity of foot in patients with post-polio residual paralysis were analyzed with average follow up period of 12.5 months.
- Dynamic calcaneo-valgus deformity of the foot was corrected in 89.18% of patients.
- Extensor digitorum longus can also act as a deforming force in producing dynamic valgus deformity of foot.
- The study fared with 89 percent patients satisfied with the results.
- The patients showed improvement in their activity limitation, maximum walking distance, gait and stability.

Large scale study with long term follow up is required to corroborate findings of the study and to find out long term functional results.

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