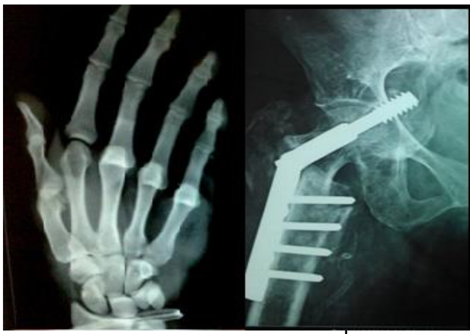

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Transfer of the posterior tibial tendon in common fibular nerve paralysis: A retrospective study of 22 patients at the order of Malta hospital center (Chom) in Dakar, Senegal

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Abstract
Introduction: The transfer of the posterior tibial tendon is the most commonly used surgical procedure to address foot drop caused by paralysis of the foot dorsiflexor muscles. The aim of this study on posterior tibial tendon transfer in common fibular nerve paralysis is to evaluate the anatomical and functional outcomes of the foot and ankle following the transfer of the posterior tibial tendon.
Patients and Methods: This was a retrospective study covering a 72-month period (6 years). The study included 22 patients, comprising 15 men (68.2%) and 7 women (31.8%). The average age of the patients was 22.18 years, with a range of 6 to 58 years at the time of evaluation. Among the 22 patients, there were 11 cases of paralytic equinovarus foot and 11 cases of paralytic foot without deformity. Lower limb nerve conduction studies were performed in 13 patients (59.1%). The aetiologies found in our series included neurological, infectious, traumatic, and iatrogenic causes. All patients underwent tendon-to-bone transfer (Watkins technique).
Results: The average preoperative delay was 228.54 days (32 days to 683 days). The average postoperative follow-up was 37.95 months (3.16 years) with a range of 5 months to 73 months. Functional evaluation was performed using the Kitaoka AOFAS score. The average overall AOFAS score was significantly improved, ranging from 56.27/100 (min=33, max=74) preoperatively to 80.14/100 (min=48, max=97) postoperatively. Patients with traumatic etiology had a better AOFAS score after the transfer. Patient subjective satisfaction was also an evaluation criterion, with 81.8% (18/22) of patients being satisfied or very satisfied with the intervention.

Keywords: Common fibular nerve, paralysis, posterior tibial tendon transfer

Introduction
Tendon transfer of the posterior tibial muscle is the most commonly used surgical procedure to address foot drop caused by paralysis of the foot dorsiflexor muscles. Since Watkins' description in 1954, this technique has seen significant development. It has been extensively studied in patients with peripheral neurological causes of foot drop. However, data on foot drop of central origin are limited, and in such cases, tendon transfer is often contraindicated. Paralysis of the foot dorsiflexor muscles, resulting in equinovarus and supination, is the most common lower limb deficiency, often following neurological and/or neuromuscular conditions. It is most often caused by common fibular nerve (CFN) injury, resulting in loss of dorsiflexion and eversion of the foot. This injury can result from various causal mechanisms such as ischemia, mechanical irritation, traction, crush injuries, or laceration. It is also observed in patients with leprosy. While in most cases, the injury spontaneously recovers, in others, despite advances in nerve repair and grafting, irreversible nerve damage can occur. Compared to other peripheral nerve repairs, CFN repair has poorer outcomes. Despite advances in microsurgery and increased success rates with CFN repair, a significant portion of nerve injuries do not heal, leading to significant loss of function. Therefore, posterior tibial tendon transfer surgery should be an integral part of CFN surgery. Surgeons treating lower limbs must be prepared to apply this technique.

While transfer is a widely accepted solution for foot drop, controversy continues regarding the transfer route (circumtibial or interosseous), the type of transfer (bone insertion or tendon-to-tendon fixation), and the tendons to which the transfer will be made.

The aim of this study on posterior tibial tendon transfer in common fibular nerve paralysis is to evaluate the anatomical and functional outcomes of the foot and ankle following the transfer.

Patients and Methods

This was a retrospective study conducted over a 72-month period, from January 1, 2014, to December 31, 2019, covering 72 months (06 years). Data collection was based on patient medical records, operative protocol registers, and hospitalization records. Patients were invited for evaluation. All patients who underwent posterior tibial tendon transfer for common fibular nerve paralysis during the study period at CHOM were included, totaling 22 patients, including 15 men (68.2%) and 7 women (31.8%). The average age of the patients was 22.18 years, with a range of 6 to 58 years at the time of evaluation (table II). Among the 22 patients, there were 11 cases of paralytic equinovarus foot and 11 cases of paralytic foot without deformity.

The average preoperative delay was 228.54 days (ranging from 32 days to 683 days). The average postoperative follow-up period was 37.95 months (approximately 3.16 years) with a range from 5 months to 73 months. All patients underwent standard ankle and foot X-rays (anteroposterior and lateral views) both before and after the surgery. Nerve conduction studies of the lower limbs were performed on 13 patients (59.1%). Knee MRI (in the paralyzed limb) was conducted on 3 patients (13.6%) who had associated ligamentous injuries. The etiologies of common peroneal nerve paralysis identified in our series were neurological, infectious, traumatic, and iatrogenic (Table 2).

Table 1: Characteristics on studied population

Patients	Age (Year)	Gender	Profession	Affected Sidé	Etiologies
1	18	M	Professional Footballer	R	Knee injury with ACL (Anterior Cruciate Ligament) tear and severe peroneal nerve compression
2	19	M	Professional Footballer	R	Knee injury with ACL and PCL (Posterior Cruciate Ligament) tears and severe peroneal nerve compression
3	58	M	Sonatel Agent	R	Tibial plateau fracture and peroneal nerve section.
4	29	M	Student	L	Iatrogenic (post-injection intramuscular)
5	13	M	Student	L	Open leg injury with peroneal nerve section
6	22	F	Elève	R	Iatrogenic (post-injection intramuscular
7	19	M	Tailor	R	Poliomyelitis
8	42	F	Midwife	L	Iatrogenic (post-Total Hip Replacement).
9	26	F	Unemployed	R	Iatrogenic (post-tibial osteotomy)
10	18	M	Student	R	Leprosy
11	14	F	Student	L	Leprosy
12	18	M	Student	R	Iatrogenic (post-injection intramuscular).
13	19	M	Islamic School Student	R	Iatrogenic (post-injection intramuscular).
14	20	M	Worker	Bilateral (operated on. the left)	Charcot-Marie-Tooth Disease
15	6	M	Student	L	Cerebral Palsy
16	12	M	Student	Bilateral (operated on the left)	Charcot-Marie-Tooth Disease
17	29	M	Berger	L	Stab wound to the knee with peroneal nerve section.
18	9	M	Student	Bilateral (operated on the right)	Cerebral Palsy
19	45	F	Nurse	R	Fibular head fracture, ACL and PCL tears, and peroneal nerve section
20	12	M	Student	Bilateral (operated on both sides)	Cerebral Palsy
21	24	F	Student	L	Iatrogenic (post-injection intramuscular).
22	16	F	Unemployed	R	Knee injury with peroneal nerve involvement.

Table 2: Distribution of patients according to etiologies

Etiologies	Number	Percentage
Neurological	5	22,8%
Infectious	3	13,6%
Traumatic	7	31,8%
Iatrogenic	7	31,8%
Total	22	100%

Eleven patients received spinal anesthesia, 6 had a sciatic and femoral nerve block, 3 had general anesthesia with a mask, and 2 had general anesthesia with endotracheal intubation. All patients were positioned in a supine dorsal position on a regular table with a tourniquet at the root of the thigh. All patients underwent a tendon-to-bone transfer.

Four incisions were made: the first incision, measuring 3 cm, was made at the medial edge of the foot in line with the navicular bone, with dissection and identification of the distal end of the posterior tibial tendon that had been detached from the navicular bone. A second incision, measuring 5 cm, was made on the postero-medial aspect in line with the middle third and distal third of the leg. At this level, the posterior tibial tendon was retrieved. A third incision was made on the anterior aspect of the leg, allowing for the retrieval of the posterior tibial tendon after passing it through the tibiofibular interosseous membrane. A fourth incision, measuring 2 cm, was made on the dorsal aspect of the midfoot in line with the chosen attachment site, i.e., in line with the cuneiforms or cuboid or the 4th metatarsal. We proceeded with passing the posterior tibial tendon under the extensor retinaculum and securing it to the skeletal structure with osteosutures, reinforced with Blount staples.

Surgical procedures were combined with tendon transfer in 10 patients presenting with a varus equinus foot (Table 3).

Table 3: Location of Bone Fixation for Tendon Transfer and Associated Surgical Procedures Intraoperatively

Patients	Site of Fixation	Associated Surgical Procedures with Tendon Transfer
1	Lateral cuneiform	-
2	Lateral cuneiform	-
3	Lateral cuneiform	-
4	Cuboid	Subtalar arthrodesis
5	4th metatarsal	-
6	Lateral cuneiform	Midtarsal osteotomy + subtalar arthrodesis
7	Lateral cuneiform	Midtarsal osteotomy
8	Cuboid	-
9	Cuboid	-
10	Lateral cuneiform	-
11	Lateral cuneiform	-
12	Lateral cuneiform	Subtalar arthrodesis
13	Cuboid	Calcaneal tendon tenotomy + midtarsal osteotomy + subtalar and calcaneocuboid arthrodesis
14	Lateral cuneiform	Subtalar arthrodesis
15	4th metatarsal	Calcaneal tendon tenotomy
16	Cuboid	Calcaneal tendon tenotomy + Cahuzac osteotomy
17	Medial cuneiform	-
18	Lateral cuneiform	-
19	Lateral cuneiform	-
20	Cuboid	Calcaneal tendon tenotomy + Cahuzac osteotomy
21	Medial cuneiform	Subtalar arthrodesis
22	Cuboid	-

After the surgical procedure, all patients were fitted with a plaster cast. Analgesic treatment and a short course of antibiotics were prescribed. However, anticoagulant treatment was prescribed only for adult patients without contraindications.

A standard foot X-ray was performed immediately postoperatively and on the 45th day for all patients.

Rehabilitation was initiated at an average of 6 weeks for all patients after the plaster cast was removed. This rehabilitation included a gradual passive and then active ankle mobilization, as well as muscular strengthening of the posterior tibial tendon. Progressive weight-bearing was allowed upon plaster cast removal.

Results

Clinical evaluation was performed using the AOFAS score. The average pain score improved from 32.27/40 (min=20 and max=40) preoperatively to 39.09/40 (min=30, max=40) postoperatively (Figure 1). Ninety-nine percent (20/22) of our patients did not complain of pain after the surgery (Table 4).

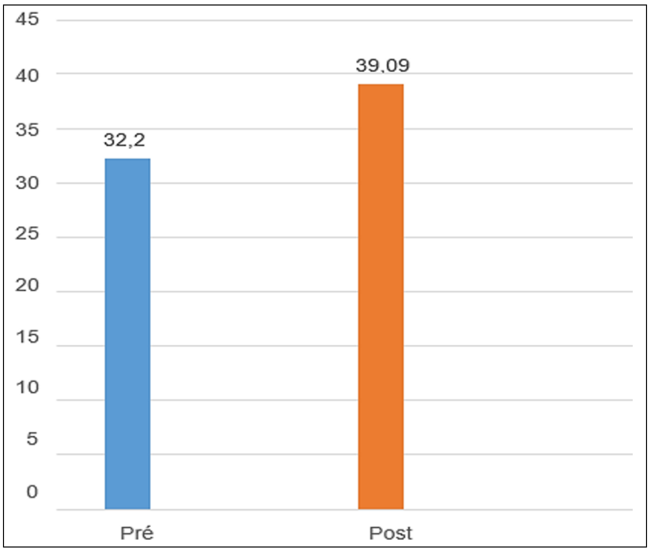

Fig 1: Average Pain Score Pre and Post Surgery

Table 4: Comparative Clinical Data for Pre and Postoperative Pain

Pain	Preoperative n = 22 (100%)	Postoperative n = 22 (100%)
Absent	10 (45, 5%)	20 (90, 9%)
Mild, Moderate, or Severe	12 (54, 5%)	2 (9, 1%)

The average functional score improved from 19/50 (min=8, max=26) preoperatively to 33.09/50 (min=8, max=47) postoperatively (Figure 2). Before the surgery, all patients had a steppage gait associated with a deficit in dorsal and plantar flexion of the foot. After the surgery, 50% of the patients no longer had a steppage gait, and ankle mobility improved in 86.4% (19/22) of patients, with a range of active mobility (dorsal and plantar flexion) greater than 15 °C.

All patients had difficulties on uneven surfaces before the surgery. After the surgery, 40.9% of patients no longer had difficulties on any type of terrain (Table 5).

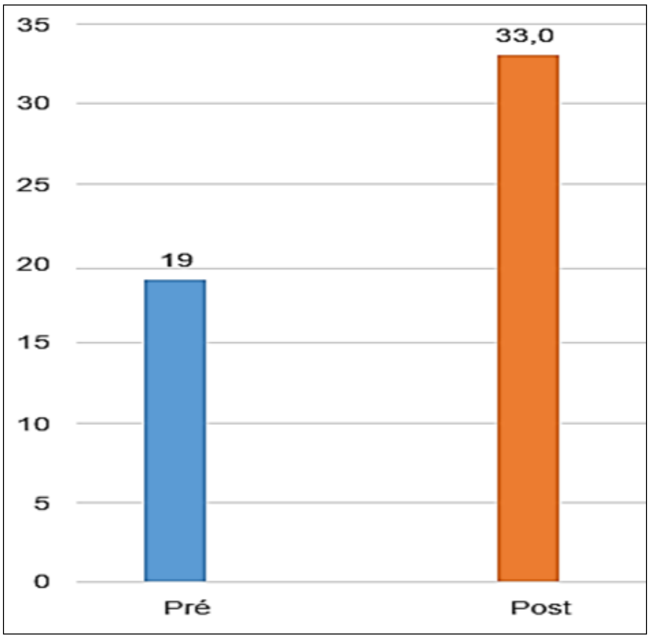

Fig 2: Average Function Score Pre and Post Surgery

Table 4: Comparative Clinical Data for Pre and Postoperative Function

Function		Preoperative n = 22 (100%)	Postoperative n = 22 (100%)
Activity Level	Unlimited	15 (68, 2%)	19 (86, 4%)
	Limited	7 (31, 8%)	3 (13, 6%)
Walking Distance	> 500	21 (95, 5%)	21 (95, 5%)
	< 500	1 (4, 5%)	1 (4, 5%)
Limping	None	0	11 (50%)
	Present or Severe	22 (100%)	11 (50%)
	No Difficulty	0	9 (40, 9%)
Terrain Type (Regular and Irregular)	Difficulty on Irregular Surface	22 (100%)	13 (59, 1%)
Sagittal Ankle Mobility: Dorsiflexion and Plantarflexion	> 15°	0	19 (86, 4%)
	< 15°	22 (100%)	3 (13, 6%)
Inversion and Eversion Mobility of the Hindfoot	> 25°	0	2 (9, 1%)
	< 25°	22 (100%)	20 (90, 9%)
Ankle and Hindfoot Stability	Stable	11 (50%)	21 (95, 5%)
	Unstable	11 (50%)	1 (4, 5%)

The average alignment score improved from 5/10 (min=0, max=10) preoperatively to 7.95/10 (min=0, max=10) postoperatively (Figure 3).
Before the surgery, 50% (11/22) had a plantigrade support with a normal-axial ankle. After the surgery, 95.5% (21/22) of patients had normal plantar support with minimal ankle varus deformity in 45.5% (10/22) of patients (Table 6)

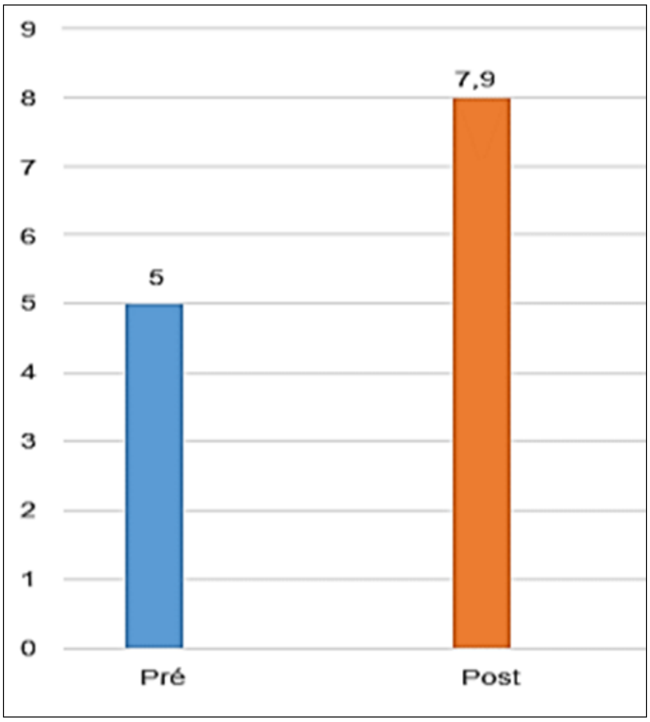

Fig 3: Average Alignment Score Pre and Post Surgery

Table 5: Comparative Clinical Data for Pre and Postoperative Alignment

Alignment: Plantar Support, Ankle Axis	Preoperative n = 22 (100%)	Postoperative n = 22 (100%)
Plantigrade, Normal Ankle Axis	11 (50%)	11 (50%)
Plantigrade, Minor Misalignment	0	10 (45, 5%)
Abnormal Plantar Support, Major Misalignment	11 (50%)	1 (4, 5%)

The average overall score improved from 56.27/100 (min=33, max=74) preoperatively to 80.14/100 (min=48, max=97) postoperatively (Figure 4). In the postoperative period, more than half of our patients had a good to very good AOFAS score (Table 7).

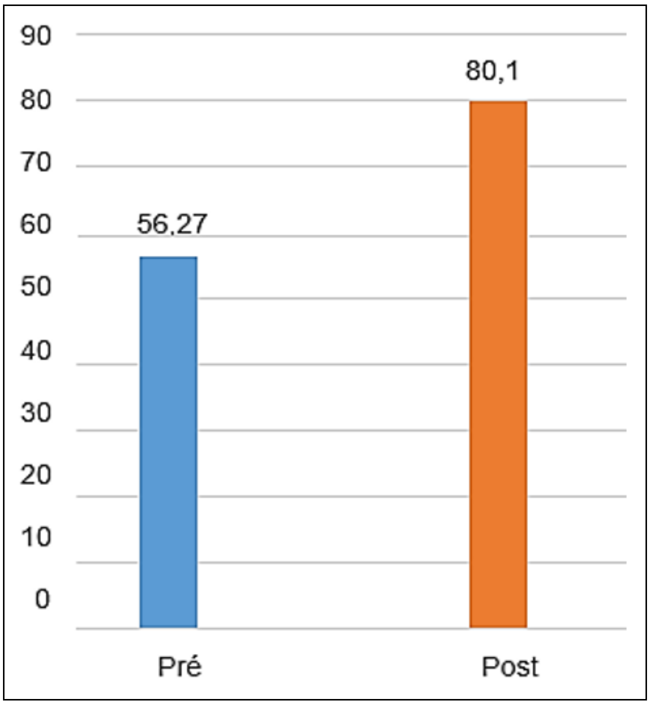

Fig 4: Average Overall Score Pre and Post Surgery

Table 6: Postoperative AOFAS Score by Number of Patients

AOFAS Score	Excellent (90-100)	Good (80-89)	Fair (70-79)	Poor (<69)
Number of Patients = 22 (100%)	4 (18.2%)	10 (45.5%)	4 (18.2%)	4 (18.2%)

Patients with a traumatic etiology had a better AOFAS score after the intervention. A poor AOFAS score was found only among those with iatrogenic and neurological etiologies (Table 8)

Table 7: Postoperative AOFAS Score by Etiology

AOFAS Score / Etiologies	Excellent	Good	Fair	Poor
Traumatic (n=7)	3	4	0	0
Iatrogenic (n=7)	0	2	3	2
Infectious (n=3)	1	1	1	0
Neurological (n=5)	0	3	0	2

In the postoperative period, the majority of our patients were satisfied with the intervention (Table 9).

Table 8: Distribution of Patients by Subjective Satisfaction

Subjective Satisfaction	Very Satisfied	Satisfied	Moderately Satisfied	Not Satisfied
Number of Patients = 22 (100%)	2 (9,1%)	16 (72,7%)	4 (18,2%)	0 (0)

Discussion

The American Orthopaedic Foot & Ankle Society (AOFAS) score is a clinical evaluation system developed by Kitaoka *et al*. This score combines subjective assessments of pain and function provided by the patient with objective evaluations based on the physical examination of the patient by the surgeon. It is considered the reference score for assessing anatomical and functional outcomes after foot or ankle surgery [6, 3].

In our study, we observed that 90.9% (20/22) of patients did not complain of pain after the intervention. Only two patients (patient 4 and 6) experienced mild mechanical-type pain, primarily occurring during prolonged walking. For patient 4, the pain was localized to the hindfoot, while for patient 6 (who had hammer toes), the pain was in the toes. The transfer of the posterior tibial tendon plays a crucial role in relieving paralytic drop foot. It allowed patients to have normal and pain-free plantar support, especially in patients with foot deformities. Walking with the outer edge of the foot, which caused chronic pain and skin lesions, was significantly improved after surgery. These skin lesions can also be a source of pain during shoe conflicts.

Paralysis of the foot dorsiflexors causing drop foot was found in all patients, leading to a steppage gait with difficulties in walking on any type of surface. However, a deficit in dorsal flexion of the foot was also identified. Tendon transfer allows for the restoration of ankle dorsiflexion, improvement in walking, and foot function in daily activities [4]. According to OMER [5], complete active dorsiflexion strength is rarely restored by the transfer alone, as a transferred muscle generally loses some degree of strength. This was the case in our patients, where the transfer improved foot function. It was marked by a plantigrade stance while walking in 95.5% (21/22) of patients, with an active ankle mobility sector (dorsiflexion and plantar flexion) greater than 15° in 86.4% (19/22). Walking on irregular surfaces was improved in all patients, with or without a limp.

Before the intervention, we observed that 50% (11/22) of patients had an abnormal plantar stance. These patients had a paralytic foot with deformities such as equinovarus, forcing them to walk on the outer edge of the foot. These deformities were corrected through the transfer of the posterior tibial tendon, combined with other surgical procedures. These surgical procedures involved Achilles tendon tenotomy in cases of irreducible fixed equinus, as well as midtarsal osteotomy involving the cuboid and calcaneus in the form of subtraction (see Table 3). Talonavicular arthrodesis was also performed in six patients. All of this allowed for the correction of hindfoot varus and the restoration of a plantigrade stance with minimal misalignment in our patients.

After the intervention, 95.5% (21/22) of patients had a plantigrade stance. Only one patient (patient 20) still had persistent abnormal plantar stance postoperatively. In this patient, a transfer of the posterior tibial tendon, combined with Achilles tendon tenotomy and Cahuzac osteotomy (2nd, 3rd, and 4th metatarsal osteotomy + Cuneo metatarsal opening), had been performed on both feet, and despite this, the drop foot and deformities persisted.

In our study, we achieved a good AOFAS score, with an average overall score increasing from 56.27/100 preoperatively to 80.14/100 postoperatively. Our results were similar to those of CHO *et al*. [1] and GARNAOUI *et al*. [2]. Molund *et al*. had reported an even better AOFAS score [4].

Table 9: Median comparative AOFAS Score

Authors	Number	Follow-up (Month)	AOFAS preoperative	AOFAS postoperative
M. Molund [4]	12	56	-	91
B. Cho [1]	17	36	65,1	86,2
H. Garnaoui [2]	12	46	62,41	80,41
Our series	22	37,95	56,27	80,14

Compared to our series, which includes 22 patients with various causes of common peroneal nerve palsy, these authors report cases of tendon transfer for traumatic origin paralysis. In their studies, patients did not exhibit any osseous abnormalities clinically or radiographically before surgery. They had undergone conservative treatment preoperatively, including a foot-ankle orthosis of the foot drop type (equinus deformity correction device) and muscle strengthening rehabilitation. This was not the case for our patients.

All these criteria would likely have allowed us to achieve a better AOFAS score after tendon transfer.

In our study, we observe that patients with a traumatic etiology had a better AOFAS score after the intervention. Several studies [1, 2, 4] involving patients with traumatic common peroneal nerve palsy have reported similar results after posterior tibial tendon transfer, with a good or very good AOFAS score.

This can be explained by the fact that patients with traumatic foot dorsiflexor paralysis do not exhibit any osseous foot abnormalities clinically or radiographically before the intervention. They already had a pain-free plantigrade stance with mobile and stable joints from the outset. Consequently, no foot correction was performed intraoperatively. This significantly improved foot motor function after the transfer and, consequently, the AOFAS score.

In our series, we note that 81.8% (18/22) of patients were satisfied or very satisfied with the intervention. Our results are similar to those of GARNAOUI *et al*. [2], who reported that 80% of their patients were satisfied after the intervention. In our study, all patients saw an improvement in their walking quality due to the disappearance of steppage, replaced by a pain-free plantigrade stance with a minimally or non-deformed foot, except for one patient (patient 20). This patient exhibited static and dynamic imbalance due to severe thoracolumbar scoliosis. Over time, chronic pain and skin lesions on the back of the foot, commonly found in cases of equinovarus foot, had significantly decreased. However, aesthetic issues and footwear conflicts were also improved. This may explain the satisfaction among our patients.

Conclusion

The tendon transfer of the posterior tibial muscle is one of the palliative treatments used to correct paralytic drop foot. This study, focusing on the transfer of the posterior tibial tendon in common peroneal nerve (CPN) paralysis, demonstrates that surgical treatment of foot dorsiflexor paralysis through the transfer of the posterior tibial tendon, combined with other surgical procedures, yields satisfactory results in both deformity correction and the reanimation of foot dorsiflexors.

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Not available

Author's Contribution
Not available

Conflict of Interest
Not available

Financial Support
Not available

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