Minimally Invasive Ankle Stabilisation as a Primary Treatment of Foot Drop

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The Egyptian Orthopedic Journal; 2022 supplement, December, 57: 50-54

Abstract:

Background:
Foot drop, which can be defined as loss of ankle dorsiflexion, results in a “high steppage gait” that leads to difficulty in walking with standard shoes.
Although several treatment options have been described for drop foot, the available evidence concerning treatment options is weak. Many procedures have been described to treat foot drops, which include the repair of damaged nerves, soft tissue procedures such as tendon transfers, and bony procedures such as arthrodesis.
Patients and Methods:
The present work includes patients with foot drop due to flaccid paralysis after peripheral neurologic lesions or muscular lesions. Patients were managed by arthroscopic ankle stabilization and an assessment of the clinical results was conducted using the American orthopedic foot and ankle score (AOFAS).
Results:
The mean total score was significantly improved in the final follow-up as compared to preoperative activity scores.
Conclusion:
In conclusion, the arthroscopic technique is a minimally invasive, safe, and effective procedure to stabilize the ankle in patients with foot drops. The use of arthroscopy is a good/better option for most patients suitable for ankle fusion

Keywords:
Ankle Stabilisation, Foot Drop, Arthroscopic fusion

Introduction:

Foot drop, which can be defined as loss of ankle dorsiflexion, results in “high steppage gait” that leads to difficulty in walking with standard shoes. Foot drops can be caused by either neurological injuries which can be a central or peripheral neurogenic lesion or loss of function of the muscles or tendons of the extensor compartment. Spine-related causes such as herniated discs and iatrogenic nerve root injury after spine surgery are common causes, especially impairment of the L4 nerve root that controls the function of the tibialis anterior tendon**.** Another common cause is an injury to the sciatic or common popliteal nerves [1].

Clinically, patients with foot drop present with difficulties during the swing phase of gait which results in more flexion of the hip and knee. Patients with foot drop show a circumduction gate to be able to move the lower leg forward without the toes touching the ground [2,3].

Clinical assessment for patients with drop foot can be done using the manual muscle test to measure the strength of ankle dorsiflexors. Aono and colleagues took both the power of tibialis anterior and the range of ankle motion into account and further divided MMT grade 3 into two groups. The tibialis anterior having MMT = 3− was also defined as foot drop because of the associated stumbling gait [4]. **(**Table1)

Although several treatment options have been described for drop foot, the available evidence concerning treatment options is weak **[5].** Orthotics can be used to prevent patients from stumbling, but being dependent on orthotic devices means a significant reduction in quality of life [1].

Table 1: A scale using manual muscle test (MMT) of tibialis anterior and ankle motion to define foot drop (adapted from [4])

Grade	Description
0	No contraction of the tibialis anterior
1	Slight contraction of the tibialis anterior is observed, but no joint motion of the ankle
2	Patient can invert and dorsiflex ankle with gravity eliminated through the full range of motion
3−	Patient can dorsiflex and invert ankle against gravity through a partial range of motion
3	Patient can dorsiflex and invert ankle against gravity through the full range of motion
4	Patient can dorsiflex and invert ankle against gravity and moderate resistance
5	Patient can dorsiflex and invert ankle against gravity and full resistance

Many procedures have been described to treat foot drop, which includes the repair of damaged nerves, soft tissue procedures such as tendon transfers, and bony procedures such as arthrodesis. Codivilla in 1899 was the first one to describe tendon transfer. In 1933, Ober described the tibialis posterior transfer to the dorsum of the foot. However, the bony fixation of the tendon to the dorsum of the foot is considered the reason for failure and poor treatment outcomes [6, 7].

Another technique of double tendon transfer via the leg interosseous membrane was described using the tibialis posterior and flexor digitorum longus tendons. However, tendon transfer techniques require bone fixation of the transferred tendons, which can face several complications such as failure of fixation, multiple incisions, and wound dehiscence. Furthermore, terminal bone fixation of the transferred tendon does not permit the surgeon to set the muscle tension [8].

Given that equinus ankle deformity, which impact negatively shoe wear and gait could be treated via ankle arthrodesis when other corrective joint-sparing surgical managements are not possible, this concept can be extended to cases of foot drop. The authors have been applying this principle to cases of foot drop over the past decade through arthroscopic ankle arthrodesis [9].

The study aims to evaluate the short-term results of arthroscopic ankle arthrodesis for ankle stabilization in patients with foot drop deformity.

Patients and Methods

All patients with foot drop were recruited from the outpatient clinic of an academic institution in the period from December 2018 to April 2020. Inclusion criteria included patients with flaccid paralysis after peripheral neurologic lesions or muscular lesions. Exclusion criteria include patients with spastic paralysis or patients with motor power of posterior tibial tendon > M3 for whom tendon transfer could be performed. Nerve conduction velocity and EMG were done for all patients to confirm nerve injury and muscle grading for muscles around the ankle.

Operative technique:

Patients received either spinal or general anesthesia. Surgery was performed in the supine position with the knee flexed 30° and a thigh tourniquet was used in all cases. No traction device was used.

After skin preparation and draping, the degree of passive correction was assessed. If the equinus deformity couldn't be corrected to the neutral position, percutaneous lengthening of the Achilles tendon was performed. Thereafter, identification of the joint line was by the anteromedial portal in the standard fashion followed by standard diagnostic ankle arthroscopy [10].

An anterolateral portal was done under direct vision to avoid injury of the superficial peroneal nerve. The joint surface preparation consisted of the debridement of soft tissue and removal of the articular cartilage using both a shaver and bony burr.

After the complete removal of the articular cartilage of both the talus and tibia, the ankle joint was positioned under fluoroscopy in neutral flexion, 0-5 degrees' valgus, and slight external rotation. In patients with polio, plantar flexion of 5 degrees was considered to compensate for the flexion deformity of the knee. Insertion of the guide wires was done under fluoroscopy control. Fixation was done using cannulated 6.5 mm screws. The final position of the ankle and screws was confirmed radiologically, followed by wound closure.

Partial weight bearing in protecting below knee cast or orthosis was allowed on day two post-operative then full weight bearing from 6th week to 12 weeks in a removable boot. After 12 weeks, full weight bearing without protection was allowed. Follow-up x-ray was done at 6 weeks, 12 weeks and 6 months, and 1 year. The postoperative assessment was done using the American orthopedic foot and ankle score (AOFAS) (Table 2) after one year as a final postoperative assessment of the patients.

Table 2. American orthopedic foot and ankle score (AOFAS).

CATEGORY	VARIABLE	SCORE	SUBTOTAL
***Pain* (40 points)**	None	40	
	Mild, occasional	30	
	Moderate, daily	20	
	Severe, almost always present	0	
***Function* (50 points)**			
Activity limitations, support requirements	No limitations, no support	10	
	No limitation on daily activities, limitation of recreational activities, no support	7	
	Limited daily & recreational activities, care	4	
	Severe limitation daily & recreational activities, walker, crutches, wheelchair, brace	0	
Maximum walking distance, blocks	> 6	5	
	4-6	4	
	1-3	2	
	<1	0	
Walking surfaces	No difficulty on any surface	5	
	Some difficulty on uneven terrain, stairs, inclines, ladders	3	
	Severe difficulty on uneven terrain, stairs, inclines, ladders	0	
Gait abnormality	None, slight	8	
	Obvious	4	
	Marked	0	
Sagittal motion (flexion+extension)	Normal/mild restriction (≥30°)	8	
	Moderate restriction (15-29°)	4	
	Severe restriction (<15%)	0	
Hindfoot motion (inversion+eversion)	Normal/mild restriction (75-100% normal)	6	
	Moderate restriction (25-74% normal)	3	
	Marked restriction (<25% normal)	0	
Stability(anterior-posterior,varus-valgus)	Stable	8	
	Definitely unstable	0	
***Alignment* (10 points)**	Good, plantigrade foot, ankle-hindfoot well aligned	10	
	Fair, plantigrade foot, some degree of ankle-hindfoot malalignment observed, no symptoms	5	
	Poor, nonplantigrade foot, severe malalignment, symptoms	0	
TOTAL		100	

Results

This prospective study was carried out on 25 patients with foot drop requiring ankle arthrodesis. The causes of foot drop in patients included in this study were as follows: herniated disc prolapse in 10 patients, post-spinal surgery in 5 patients, post-traumatic sciatic nerve injury in 5 patients, peroneal nerve injuries in 3 patients and 2 residual polio in two patients.

All the patients had MMT of posterior tibial tendon < 3 which excludes the possibility of tendon transfer surgery. Surgery was advised for all patients 1 to 2 years after the injury for possible recovery.

Twenty-five patients were operated on for arthroscopic ankle fusion in the period from May 2018 to December 2020 in Mansoura University Hospital. The age of the patients ranges from 20 to 55 years old with a mean age of 52.3 years. There were 20 male patients and 5 females.

Percutaneous Achilles tenotomy was done for 2 cases who had fixed equinus of 15˚.

Clinical assessment of union was considered to be the absence of pain and no motion at the ankle on stressing it in all planes. All patients showed clinical signs of union with an average time of clinical union was 10 weeks and ranging from 8 to 12 weeks. Radiological signs of the union were noted in all patients at the final follow-up after 1 year with an average time for union of 11 weeks and ranged from 9 to 14 weeks.(Fig.1A,B)

The preoperative AOFAS score was (40.5 ± 1.9 ranging from 20 to 65), which has been improved to a better postoperative score (80.6 ± 5.4), (P value < 0.0001, Fig.1C).

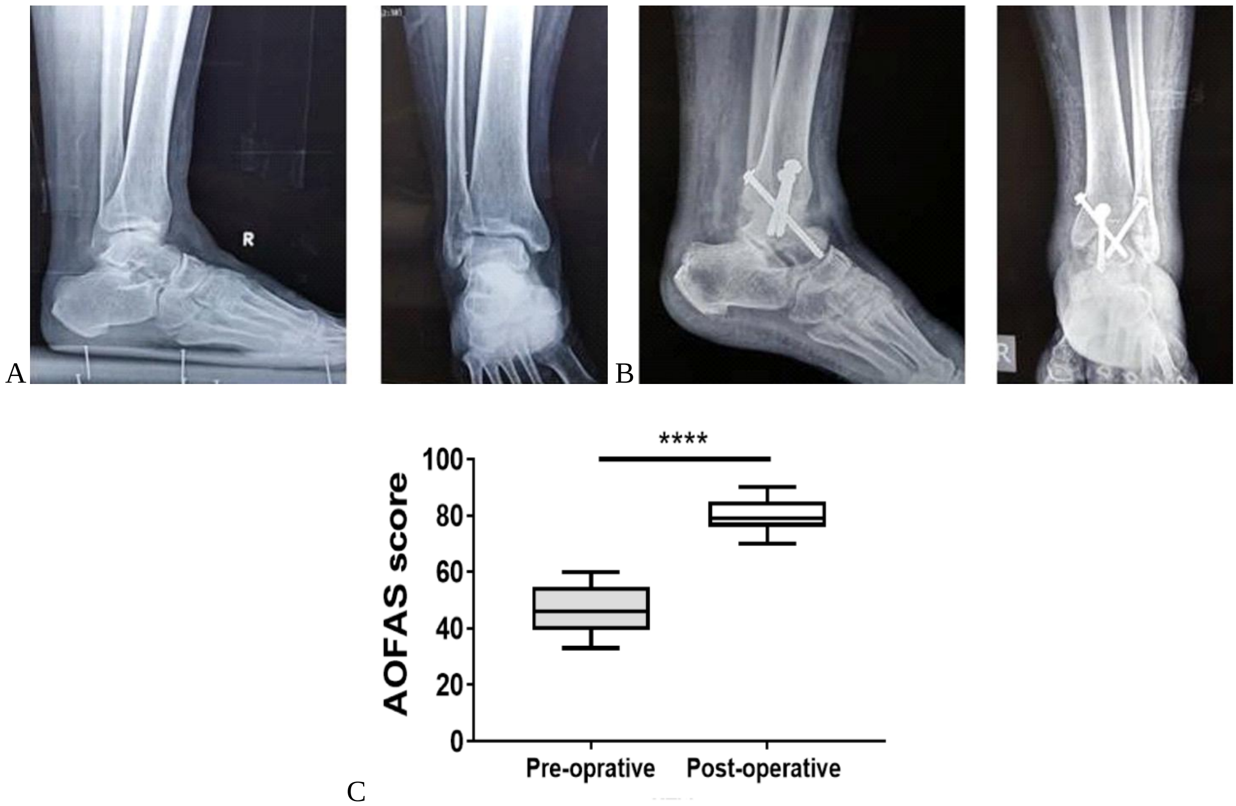

Fig. 1: A) Pre-operative standing ankle x-ray. B) Post-operative ankle x-ray at 1-year follow-up. C) Pre-operative and post-operative AOFAS score. Data are shown as mean ± SEM: ****: $P < 0.0001$

Superficial wound infection at the site of screw insertion occurs in 2 patients. Infection was discovered in the first week after surgery. The injection antibiotic was extended for one week then the oral antibiotic for 3 weeks after the infection was controlled and debridement was not indicated for any of these patients.

Hardware complications were noted in 3 patients. In one patient, the drill bit was broken intraoperatively. It was not removed as it was completely inside the tibia and did not cause problems. Hard ware associated pain was noted in 2 patients that persisted for 6 months after surgery and the screws were removed in these patients with improvement of pain after removal.

One patient had subtalar arthritis one year after surgery and persistent pain which required the removal of hardware and subtalar fusion.

Discussion

Ankle fusion is categorized into two groups: arthrodesis in situ as well as realignment arthrodesis. Different surgical techniques in addition to methods of fixation can be used according to soft tissue condition, the severity of the deformity, the bone quality, and the experience of the surgeon [1].

Arthroscopic ankle fusion is one of the recent techniques used for arthrodesis. Arthroscopic ankle fusion was first described by Schneider who demonstrated a faster rate of union, earlier mobilization, and less patient morbidity compared to open techniques. Following this initial study, several reports were in line with this finding. Recently, other reports described several advantages of the arthroscopic technique [11].

Various studies reported that arthroscopic ankle arthrodesis is a procedure with higher benefits in patients displaying minimal deformity, leading to faster union and lower postoperative morbidity, for instance, pain or wound healing compared with open arthrodesis [11, 12].

In our study, we had complete fusion at the final follow-up (100%). early weight bearing was allowed for all patients 2nd the day postoperative in a walking cast. Therefore, based on our findings, we feel justified in our practice of early weight-bearing in uncomplicated cases following arthroscopic ankle arthrodesis. The duration of the bony union is predictable with high patient satisfaction.

One of the potential advantages of arthroscopic ankle fusion compared to open surgical methods is its cost-effectiveness in agreement with the conclusion of Nielsen and colleagues who showed that arthroscopic ankle arthrodesis is considered an inexpensive and safe technique [13].

Conclusion

In summary, arthroscopic ankle fusion is considered an effective and safe procedure for the treatment of foot drop patients. Arthroscopic ankle fusion is a good/better approach for the majority of patients eligible for ankle fusion. Arthroscopic fusion of the ankle results in similar fusion rates, shorter union time, decreased pain, reduced hospital stay, earlier mobilization, and reliable clinical outcomes as well as less complications.

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