International Journal of Multidisciplinary Research and Development
Online ISSN: 2349-4182, Print ISSN: 2349-5979, Impact Factor: RJIF 5.72
www.allsubjectjournal.com
Volume 3; Issue 11; November 2016; Page No. 141-145

Combined triple arthrodesis and soft tissue procedures in management of rigid cavus foot in adults

*** Ahmed E Osman, Wael El-Adly, Yaser E Khalifa, Mohammed G Hassan**

Department of Orthopaedic and Trauma Surgery, Faculty of Medicine, Assiut University Hospitals, Assiut, Egypt.

Abstract

Type of study: prospective study.

Objective: Demonstration the role of combined bony procedures using triple arthrodesis and soft tissue procedures in correction of cavus foot deformity in adults.

Background: Rigid cavus deformity is a complex foot deformity which has different forms and results from different aetiologies. Triple arthrodesis is considered as a golden standard for treatment of such deformities. Combined bony and soft tissue procedures are needed for correction of deformity. Tendon transfer is important to restore the muscle balance around the foot.

Patients and Methods: Between 2013 – 2015 fifteen feet with rigid cavus deformity were corrected surgically with Ryerson's triple arthrodesis (five feet) or Lambrinudi triple arthrodesis (10 feet) combined with tibialis posterior tendon or long toes flexor tendons transfer to the dorsum of the foot. Follow up period ranged from 20 to 47 months (mean 32.17 ± 7.62). All patients were assessed clinically and radiologically for determination of the amount of correction. The outcome was graded according to criteria of Angus and Cowell.

Results: the outcome was good in two feet, fair in eleven feet and poor in two feet. The correction in the hindfoot alignment and in the range of ankle joint motion was significant. The correction in the radiological parameter was statistically insignificant.

Conclusions: Successful treatment of rigid cavus foot deformity requires comprehensive understanding of the nature of the deformity and its pathology. Adding tendon transfer to the corrective bony procedure is mandatory to restore the muscle balance around the foot and to prevent the recurrence.

Keywords: adult cavus foot, triple arthrodesis, cavus foot, lambrinudi

Introduction

Cavus foot deformity is one of the complex foot deformities. It is characterized with increased the height of the longitudinal arch of the foot. The complexity of such deformity is due to the nature of the deformity being affecting both hind and forefoot in the different plains leading to different combinations of deformities. It is not common to see pure cavus. Other patterns of such deformities include cavovarus, equinocavovarus and calcaneocavus [1, 2]. Other source of the complexity of such conditions is the soft tissue affection either due to muscular imbalance around the foot and ankle associated with neurological disorders or soft tissue contractures due to previous surgeries with scaring or trauma with compartment syndrome [3, 5].

Triple arthrodesis has different techniques described in literature. It aims to correct the deformity and to stabilize the hindfoot to prevent the recurrence [6, 9]. Adding soft tissue procedure to restore the muscle balance around the foot is mandatory to prevent recurrence of the deformity which will occur even in presence of perfectly done triple arthrodesis [10].

This work aims to figure out the role of the triple arthrodesis associated with soft tissue procedures to correct such complex deformity.

Patients and Methods

After approval of this study by our institution ethical committee and obtaining an informed consent from every patient, 13 patients (eight males, five females) with 15 rigid cavus feet were treated prospectively in between 2013 - 2015.

All patients were > 18 years old (range 20-55, mean 34.9 ± 12.7 years) had rigid cavus feet deformities of different forms and aetiologies (Table 1, 2). They were treated surgically with one form of triple arthrodesis (Table 3) with soft tissue procedure(s). Those patients who had deformed feet with extensive skin scaring, adherent skin to bone due to previous trauma or burns, previous history of vascular injury or malunited previous corrective arthrodesis in foot which were corrected using gradual correction with Ilizarov technique were not included in this study.

All patients were assessed preoperatively clinically to identify the aetiology by detailed history including family history. Clinical Examination to detect the components of the deformity at the level of hind- and forefoot, the pattern of callosity on the plantar surface of the foot reflects the excessive pressure areas on the foot was done. Neurological examination to identify the muscle power around the foot was important to plan for tendon transfer to restore soft tissue balance around the foot and ankle. Radiological examination of the loaded feet in standing position was adopted. In lateral view Meary's (talo- 1st metatarsal), calcaneal pitch, lateral talocalcaneal, tibial-calcaneal and Hibb's (calcaneo-first metatarsal) angles were measured. Also in dorsoplantar view talocalcaneal, Forefoot adductus, and talo- first metatarsal angles were measured [11, 13].

Table 1: Types of Foot Deformities

Equinocavovarus	6
Calcaneocavovarus	4
Clubfoot	5

Table 2: Aetiology of foot deformities

Neurogenic	8
Poliomyelitis	4
Charcot-Marie-Tooth Syndrome	3
Cerebral palsy	1
Traumatic	3
Recurrent Clubfoot	3
Idiopathic	1

Surgical technique

All patients were operated in supine position. Tourniquet was applied for all patients except one with previous history if ischemia and arterial bypass surgery. Medial and lateral incisions of the foot were used in all cases. Through the medial incision, along the tendon of tibialis posterior tendon, the planned tendon to be transferred (either tibialis posterior tendon or long toes flexor tendons) was released and pulled out another proximal medial wound in the distal part of the leg. The tibialis posterior tendon was split and each half was sutured in whipstitch pattern. If the long flexors (flexor hallucis longus and flexor digitorum longus) were to be transferred (Hiroshima transfer) [14], each tendon was sutured in whipstitch pattern. The tendons were transferred between the tibia and fibula through the interosseous membrane into the extensor compartment of the leg. Then the transferred tendons or tendon halves were pulled through the sheath of tibialis anterior tendon and peroneus tertius tendons underneath the extensor retinaculum to the dorsum of the foot. The transferred tendons were sutured to the tibialis posterior and peroneus brevis tendons using Pulvertuft's technique [15]. In our series, total split tibialis posterior tendon transfer was adopted in 13 feet, while Hiroshima tendon transfer was used in two foot. Ryerson triple arthrodesis [16] was done (in five feet) by denuding the subtalar and calcaneocuboid joint and part of the talar head through the lateral incision. The talonavicular joint was denuded through the medial incision.

In presence of fixed equinus deformity Lambrinudi triple arthrodesis [17, 18] was done (in ten feet) to correct the equinus deformity by removing ventrally based bone wedge at the level of the subtalar joint. In severe varus deformity, wedge removal from the bone at the level of calcaneocuboid and subtalar joints was done (Fig. 1).

The arthrodesis was fixed with wires and/or cannulated screws.

Table 3: The type of operation used relative to the type of the deformity

	Equinocavovarus	Calcaneocavovarus	Clubfoot	Total
Ryerson triple arthrodesis	2	3	0	5
Lambrinudi triple arthrodesis	4	1	5	10

Fig 1: Plain X-rays of the left foot a female patient 23 years old with recurrent clubfoot deformity: A, B- Preoperative x-rays showing amount of the fore-and hindfoot deformity. C, D- 30 months follow up X-rays showing the correction of the foot with Lambrinudi triple arthrodesis

Dorsal wedge removal osteotomy from the base of the 1st metatarsal was done to correct excessive plantar flexion of the 1st metatarsal (five feet). Modified Jones procedure was done in case of clawing of the big toe (four feet). Z- Plasty of Achilles tendon was done to aid the correction of equinus deformity (four feet). Steindler plantar aponeurosis release was done to help the correction of cavus element of the deformity (six feet). Percutaneous alternating hemitransections of the Achilles tendon (Hoke procedure) was done in two feet. Distal tenotomy of long toes flexor tendon at the level of proximal interphalangeal joint was done to correct clawing of the toes (nine feet).

In postoperative program, below knee plaster cast was applied for 12 weeks. Non- weight bearing in the first 6 weeks and then protected partial weight bearing was allowed for the next 6 week. Radiological assessment was done 6, 12 and 18 weeks

for assessment of union. Wires were removed 6 weeks post operatively to avoid pin-tract infection. Nonunion was considered if the arthrodesis was not united for more than 6 months. Clinical examination for residual deformity, callosity development, ankle joint arthritis and instability was done (Fig. 2).

The results were graded according to criteria of Angus and Cowell [19] into good, fair and poor results (Table 4), depending on clinical radiological findings in the last follow up. The follow up period ranged from 20 to 47 months (mean 32.17 ± 7.62).

Table 4: Grading of the outcome after surgical correction of foot deformity using Angus and Cowell Criteria.

Grade	Symptoms and signs
Good	No pain, or minimal pain on heavy use No or minimal residual deformity No callosities No pseudoarthrosis No neighbour joints degeneration
Fair	Pain on light use Moderate residual deformity Single callosity Single pseudoarthrosis Moderate joints degeneration
Poor	Pain on standing or at rest Sever residual deformity Multiple callosity Multiple pseudoarthrosis Sever joints degeneration

IBM SPSS version 21 program was used for statistical analysis of clinical and radiological results using paired sample T-test.

Results

There was significant correction of the hindfoot varus malalignment as well as the range of motion of the ankle joint (Table 5).

Table 5: Pre- and operative hindfoot alignment and total range of ankle motion in degrees.

	Preoperative (mean)	Postoperative (mean)	P-value
Hindfoot alignment	-14.27	0.53	<0.001*
total range of ankle motion	14	29.67	<0.001*

* Significant results

$ Negative values means varus malalignment of the hindfoot

Despite achievement of clinical correction of hindfoot malalignment, the radiological correction of fore- and hindfoot measured parameters into the normal values was not statistically significant (Table 6).

The outcome was considered good in two feet. Fair outcome was found in 11 feet. In two feet the outcome was poor. The main cause of the poor results was the progression of ankle arthritic changes.

Wound dehiscence was encountered in three feet, which was treated conservatively. Non-union of the calcaneo-cuboid joint occurred in one foot. Painful exostosis was developed at the base of the 5th metatarsal tarsal which was removed surgically after 10 months after the index surgery. Arthritic changes of the ankle joint were seen in three feet. Two of them were associated with chronic lateral instability of the ankle. Ankle joint arthrodesis was done in one foot due to failure of tenodesis effect of transferred tibialis posterior in a poliomyelitis patient with equinocavovarus. Residual varus hindfoot alignment was found in 3 feet. One of them was due to under correction and the other two were due to lateral instability of the ankle joint.

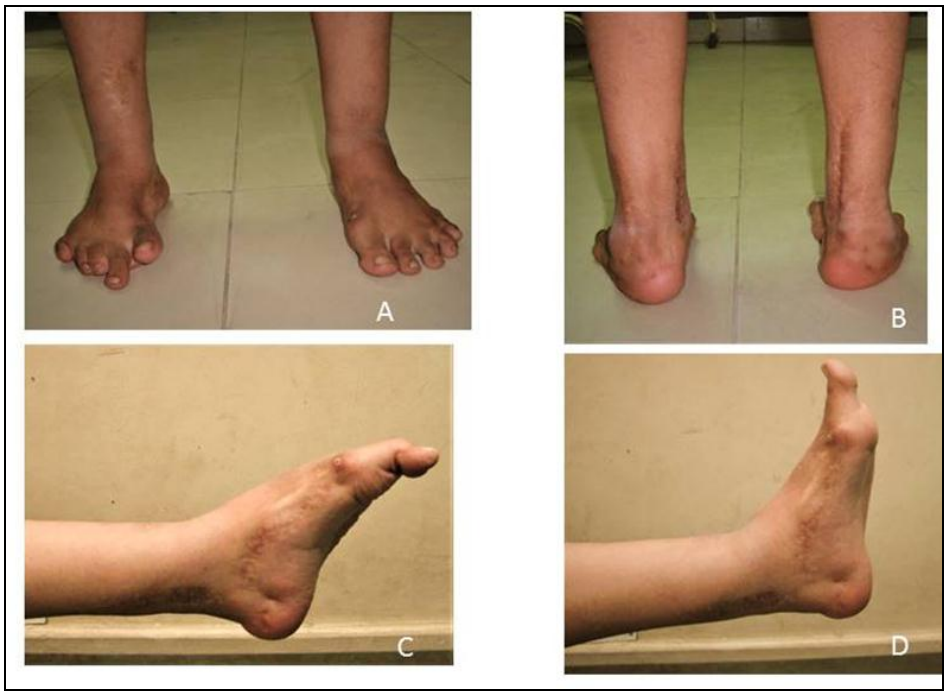

Fig 2: Clinical photos of the same previous patient after 30 months follow-up. A, B- showing the amount of correction in hindfoot alignment and forefoot supination and adduction of the left foot. C, D- showing the active plantar- and dorsiflexion of the left ankle Joint, which means the effective split total tibialis posterior transfer to the tibialis anterior and peroneus brevis tendons.

Subjective patient satisfaction was found in 93.3% of patients. The same surgical procedure would be accepted to be repeated to correct the same deformity in 86.7% of cases.

Table 7: Pre- and postoperative mean values of the radiological measurements compared with paired sample t-test.

	Equinocavovarus			Clubfoot			Calcaneocavovarus			Normal
	Preoperative	Postoperative	P-Value	Preoperative	Postoperative	P-Value	Preoperative	Postoperative	P-Value	
Lateral Talo-1st metatarsal	28.10	-4.17	0.63	-13.75	-3.75	0.224	24.25	-2.97	0.036*	0 - 5
Calcaneal pitch	13.40	12.67	0.916	17	11.8	0.338	31	16.47	0.008*	20 - 30
Tibial-calcaneal	103.43	78.50	0.032*	77.6	67.6	0.488	63.67	65.73	0.902	60-80
Lateral talo-calcaneal	41.2	39.50	0.829	53	33.25	0.033*	53.67	38.23	0.226	35 - 50
Calcaneo-1st metatarsal	57.03	35.33	0.081	37.4	33	0.635	82	36	0.008*	<45
Anteroposterior talo-1st metatarsal	42	14.2	0.166	47.8	7	0.026*	40	4.68	0.003*	0 - 20
Forefoot adductus angle	49.33	28.6	0.008*	48.4	15.6	0.004*	46.5	22.58	00078	4 - 12
Anteroposterior Talo-Calcaneal	18	18.8	0.986	3.2	15.4	0.178	11	21.42	0.243	17- 21

* Significant result ($p<0.05$)

Discussion

Correction of cavus deformity is one of the most challenging problems in orthopaedic surgery. The difficulty rises from the heterogeneity in the form, aetiology, and flexibility of the deformity. Triple arthrodesis was adopted as a method of correction of the deformity and stabilizing the foot by many authors [7, 16, 18, 20, 24]. The recent literature shows the tendency to shift to joint preserving surgery in form of single or combined osteotomies at different levels of the foot [3, 25, 32]. Such joint preserving surgeries are specialy needed in patients with flixible deformities without artheritic changes in foot joints to avoid the development of degenerative changes [33].

The remaining challenge for joint preserving surgery is the high rate of recurrence of the deformity which may be related to the progressive nature of the aetiology such as Charcot-Marie-Tooth Syndrome [5]. Zide *et al.* emphasised on the superiority of obtaining a plantigrade foot through a perfectly done triple arthrodesis over doing a joint preserving surgery with undercorrection of the deformity and preserving useless joint motion [34].

The role of tendon transfer in restoring the soft tissue balance around the foot to prevent the recurrence of the deformity was cleared by many authors [2, 35, 39]. In our series the tendon transfer used to restore the muscle balance around ankle and to restore the lateral stability of the ankle joint even through tenodesis effect of non-functioning transferred muscle. It seems to be that, tendon to tendon suturing is not sufficient to restore the lateral stability of the ankle joint if the muscle power of the transferred muscle was 0/5. This may explain the residual varus due to lateral instability of the ankle in two cases of poliomyelitis in spite of transferring of one half of the tibialis posterior tendon to the peroneus brevis tendon.

In one systematic review of 13 studies include the results of 515 operations in 481 patients. It included different deformities with different aetiology. Subjective outcome was good in 75%, fair in 18% and poor in 7.9%. The reported complications: infection (11.6%), non-union (6.5%), wound complications (6.5%), neuropathic pain (2.8%), mal-union (1.2%), deep vein thrombosis in two patients and pulmonary embolism in one patient (40). In our series the results were good in 13.3%, fair in 73.3%, poor in 13.4% of cases. The complications in our study included wound complications (20%), non-union (6.6%) and ankle arthritis progression (20%). No cases of infection, neuropathic pain or deep venous thrombosis.

The limitations in our study are the limited sample size and relatively short follow up period.

Conclusions

Successful correction of rigid cavus deformity is challenging and requires understanding the underlying pathology for successful planning for the corrective procedure. Adding tendon transfer is mandatory to restore the muscle balance around the foot and ankle to prevent the recurrence of the deformity.

References

1. Döderlein L. Einleitung. In: Döderlein L, Wenz W, Schneider U, editors. Der Hohlfuß. Berlin, Heidelberg: Springer-Verlag. 2001, 1-7.
2. Dreher T, Wenz W. Surgical Treatment of Cavus Foot Deformity. In: Bentley G, editor. European Surgical Orthopaedics and Traumatology, the EFORT Textbook: Springer Berlin Heidelberg. 2014, 3595-619.
3. Younger AS, Hansen ST. Jr. Adult cavovarus foot. The Journal of the American Academy of Orthopaedic Surgeons. 2005; 13(5):302-15.
4. Nagai MK, GC, JT G, SJ K, MS, WG M. Prevalence of Charcot-Marie-Tooth Disease in patients who have bilateral cavus foot. J Pediatr Orthop. 2006, 26(4).
5. Ward CM, Dolan LA, Bennett DL, Morcuende JA, Cooper RR. Long-term results of reconstruction for treatment of a flexible cavovarus foot in Charcot-Marie-Tooth disease. The Journal of bone and joint surgery American. 2008; 90(12):2631-42.
6. Arabmotlagh M, Richolt J, Scale D, Rauschmann M. Historical development of arthrodesis of pes cavus. Der Orthopade. 2006; 35(4):372, 4-6, 8-9.
7. Dunn N. Stabilizing Operation in the Treatment of Paralytic Deformities of the Foot. Proceedings of the Royal Society of Medicine. 1922; 15:15-22.
8. Ryerson EW. Arthrodesing operations on the feet : Edwin W. Ryerson MD (1872-1961). The 1st president of the

AAOS 1932. Clinical orthopaedics and related research. 2008; 466(1):5-14.
9. Soren A, Waugh TR. The historical evolution of arthrodesis of the foot. International orthopaedics. 1980; 4(1):3-11.
10. Jahss MH. Evaluation of the cavus foot for orthopedic treatment. Clinical orthopaedics and related research. 1983; 181(181):52-63.
11. Abulsaad M, Abdelgaber N. Correlation between clinical outcome of surgically treated clubfeet and different radiological parameters. Acta orthopaedica Belgica. 2008; 74(4):489-95.
12. Arangio GA, Wasser T, Rogman A. The use of standing lateral tibial-calcaneal angle as a quantitative measurement of Achilles tendon contracture in adult acquired flatfoot. Foot & ankle international. 2006; 27(9):685-8.
13. Gentili A, Masih S, Yao L, Seeger LL. Pictorial review: foot axes and angles. The British journal of radiology. 1996; 69(826):968-74.
14. Hiroshima K, Hamada S, Shimizu N, Ohshita S, Ono K. Anterior transfer of the long toe flexors for the treatment of spastic equinovarus and equinus foot in cerebral palsy. Journal of pediatric orthopedics. 1988; 8(2):164-8.
15. Pulvertaft RG. Suture Materials and Tendon Junctures. American journal of surgery. 1965; 109:346-52.
16. Ryerson EW. The classic. Arthrodesing operations on the feet: Edwin W. Ryerson MD. Clinical orthopaedics and related research. 1977; (122):4-9.
17. Bényi P. A modified lambrinudi operation for drop foot. 1960.
18. Lambrinudi C. New operation on drop-foot. British Journal of Surgery. 1927; 15(58):193-200.
19. Angus P, Cowell H. Triple arthrodesis. A critical long-term review. Bone & Joint Journal. 1986; 68(2):260-5.
20. Hoke M. An operation for stabilizing paralytic feet. J Orthop Surg. 1921; 3:494.
21. Haritidis JH, Kirkos JM, Provellegios SM, Zachos AD. Long-term results of triple arthrodesis: 42 cases followed for 25 years. Foot & ankle international. 1994; 15(10):548-51.
22. Daglar B, Deveci A, Delialioglu OM, Kanatli U, Tasbas BA, Bayrakci K, *et al.* Results of triple arthrodesis: effect of primary etiology. Journal of Orthopaedic Science. 2008; 13(4):341-7.
23. Bernau A. Long-term results following Lambrinudi arthrodesis. The Journal of bone and joint surgery American. 1977; 59(4):473-9.
24. Elsner A, Barg A, Stufkens S, Knupp M, Hintermann B. [Modified Lambrinudi arthrodesis with additional posterior tibial tendon transfer in adult drop foot]. Operative Orthopadie und Traumatologie. 2011; 23(2):121-30.
25. Zhou Y, Zhou B, Liu J, Tan X, Tao X, Chen W, *et al.* A prospective study of midfoot osteotomy combined with adjacent joint sparing internal fixation in treatment of rigid pes cavus deformity. Journal of orthopaedic surgery and research. 2014, 9:44.
26. Watanabe RS. Metatarsal osteotomy for the cavus foot. Clinical orthopaedics and related research. 1990; (252):217-30.
27. Dwyer FC. The present status of the problem of pes cavus. Clinical orthopaedics and related research. 1975; (106):254-75.
28. Krackow KA, Hales D, Jones L. Preoperative planning and surgical technique for performing a Dwyer calcaneal osteotomy. Journal of pediatric orthopedics. 1985; 5(2):214-8.
29. Cole WH. The classic. The treatment of claw-foot. By Wallace H. Cole. 1940. Clinical orthopaedics and related research. 1983; (181):3-6.
30. Japas LM. Surgical treatment of pes cavus by tarsal V-osteotomy. Preliminary report. The Journal of bone and joint surgery American. 1968; 50(5):927-44.
31. Mitchell GP. Posterior displacement osteotomy of the calcaneus. The Journal of bone and joint surgery British. 1977; 59(2):233-5.
32. Sammarco GJ, Taylor R. Cavovarus foot treated with combined calcaneus and metatarsal osteotomies. Foot & ankle international. 2001; 22(1):19-30.
33. Azmaipairashvili Z, Riddle EC, Scavina M, Kumar SJ. Correction of cavovarus foot deformity in Charcot-Marie-Tooth disease. Journal of pediatric orthopedics. 2005; 25(3):360-5.
34. Zide JR, Myerson MS. Arthrodesis for the cavus foot: when, where, and how? Foot and ankle clinics. 2013; 18(4):755-67.
35. Wenz W, Dreher T. Charcot-Marie-Tooth disease and the cavovarus foot. In: Pinzur MS, editor. Orthopaedic knowledge update – foot and ankle. Rosemont: AAOS. 2008, 291-306.
36. Dreher T, Wenz W. Tendon Transfers for the Balancing of Hind and Mid-foot Deformities in Adults and Children. Techniques in Foot & Ankle Surgery. 2009; 8(4):178-89.
37. Dreher T, Wolf SI, Heitzmann D, Fremd C, Klotz MC, Wenz W. Tibialis posterior tendon transfer corrects the foot drop component of cavovarus foot deformity in Charcot-Marie-Tooth disease. The Journal of bone and joint surgery American. 2014; 96(6):456-62.
38. Fahmy WM. Retrofibular transfer of tibialis posterior to control residual adduction deformity of clubfoot. International orthopaedics. 1983; 7(3):191-3.
39. Grzegorzewski A, Borowski A, Pruszczynski B, Wranicz A, Domzalski M, Synder M. [Split tibialis posterior tendon transfer on peroneus brevis for equinovarus foot in CP children]. Chirurgia narzadow ruchu i ortopedia polska. 2007; 72(2):117-20.
40. Walker R, Francis R, Singh S, Ajuied A. Death of the triple arthrodesis. Orthopaedics and Trauma. 2015; 29(5):324-33.