Single-stage correction for clubfoot associated with myelomeningocele in older children: early results

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ABSTRACT

Background:

Clubfoot deformity associated with myelomeningocele usually is difficult to treat because of rigidity and other associated factors. The treatment becomes even more difficult when the child presents late for the treatment. Limited resources and high recurrence rates with conventional procedures led to evolution of new single-staged, surgical procedures consisting of percutaneous Achilles tenotomy, plantar fasciotomy, and closing dorsolateral wedge osteotomy. The aim of the study was to evaluate the outcome of this single-stage procedure.

Methods:

Fifty-eight children with clubfoot deformity associated with myelomeningocele were operated on using the described procedure in this longitudinal follow-up study. Only those children with minimum 4 years follow-up were included. Thirty-four children (42 feet) were available for preoperative, intraoperative, and postoperative follow-up evaluations. Detailed morphological, functional, and radiographic scoring was done as per International Clubfoot Study Group. Mean age of the children at the time of the described surgical procedure was 8 ± 2.5 (range 4–12) years. The mean follow-up period was 59.3 ± 10.4 (range 48–84) months.

Results:

At final follow-up, out of 42 feet, four feet (9.52%) had excellent, 30 feet (71.42%) had good, five feet (11.90%) had fair, and thee feet (7.14%) had poor results. All 16 feet with preoperative ulcers at the pressure area and eight feet with preoperative osteomyelitis of underlying bones showed good healing in the postoperative period.

Conclusions:

Percutaneous Achilles tenotomy with plantar fasciotomy and closing dorsolateral wedge osteotomy is a good procedure for management of clubfoot associated with myelomeningocele.

Key Words

club foot, myelomeningocele, CTEV, osteotomy, spina bifida

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INTRODUCTION

Clubfoot is commonly seen in patients with myelomeningocele. Because of muscle paralysis and substantial structural abnormalities, in neglected, relapsed, or late presenting cases the deformity is severe, rigid, and differs markedly from idiopathic clubfoot.[1] Most of these clubfeet are difficult to treat because of rigidity (Figure 1), bony deformations, and abnormal bony relationships such as medial subluxation of the navicula, marked posterior displacement of the fibula.[1,2] Treatment becomes more difficult when they present late for the management. The bones in older children are severely deformed and are partly responsible for the high rate of recurrence after surgical correction.[1]

Large numbers of treatment options,[3–19] including serial corrective plaster (Ponseti method), splints, soft-tissue releases, tendon transfers, external fixators, osteotomies, talectomy, and triple arthrodesis have been described in the literature with different rates of success for managing clubfoot deformities associated with myelomeningocele. However, when choosing the treatment option for older children, the main concern is the high recurrence rates with conservative treatment methods[4,14] and the need for repeated surgeries with medial releases.[14] The majority of children in our setup cannot afford surgical procedures such as the Ilizarov method,[7,8] which need expensive implants and frequent visits to the specialized centers. Talectomy gives satisfactory correction of the hindfoot, but the forefoot needs further soft-tissue or bony corrective procedures.[9,10,11,14] Triple arthrodesis is associated with stiffness and ankle arthritis at long-term follow-up.[12,13,18] The most difficult part is the management of nonhealing ulcers on the lateral border of the foot and associated osteomyelitis of the underlying bones that are difficult to manage by existing treatment modalities.

The dilemma in choosing the correct method of treatment for these late presenting (at the age of 4 or more years), rigid and relapsed clubfeet associated with myelomeningocele led to the evolution of a new single-stage, simpler, and effective technique. The technique has already been reported in the management of neglected and recurrent clubfoot deformities.[20] The focus of the surgical procedure was to obtain a mobile, plantigrade, balanced, foot that can fit in a shoe. The aim of this study was to study the outcome of this alternative method.

MATERIALS AND METHODS

This longitudinal follow-up study was conducted from March 2005 to February 2012 at a tertiary level pediatric

FIGURE 1. Six-year-old child with left-sided rigid grade IV equinovarus deformity. He had surgery for myelomeningocele in the neonatal period. These feet are prone to injuries and development of ulcers at pressure areas and are difficult to treat.

orthopaedic hospital. It was approved by the institutional review board and informed consent was obtained from the parents. The study subjects included a retrospective cohort of children having clubfeet associated with myelomeningocele. All feet were associated with myelomeningocele. Idiopathic and other types of clubfeet were not included.

All feet were graded using the classification by Dimeglio et al.[21] Only grade III (resistant but partly reducible, with a score of 10-15) or grade IV (very severe and stiff feet with a score of 15-20) deformities were considered for this one-stage corrective osteotomy; while grade I (postural feet with a score of 1-5) and grade II (reducible but partly resistant with a score of 5-10) deformities were excluded. The study subjects were divided into two groups, neglected and relapsed variety.

The neglected feet were those which were not treated previously anywhere, and presented to the study setting for the first time for correction. These children mainly belonged to underprivileged communities from remote tribal areas. The relapsed feet were those that had undergone one or more surgical procedures in the past elsewhere and presented to the study setting for the first time with recurrent deformity. These children mainly belonged to urban areas.

A total of 58 children (aged 4 years or older) underwent a single-stage surgical procedure consisting of percutaneous tendoAchilles tenotomy, plantar fasciotomy and a closing dorsolateral wedge osteotomy during the last 7 years. Only those children (n = 34) having at least 4 years postoperative follow-up were included. Nonambulatory and wheelchair bound children were excluded. Other types of neuorogenic foot deformities including equinus, valgus, and calcaneovalgus were excluded from the study.

The mean age of the children at the time of described surgical procedure was 8 ± 2.5 (range 4–12) years. The mean age of the children at the time of follow-up was 12.8 ± 2.6 (range 9–17) years. The mean follow-up period was 59.3 ± 10.4 (range 48–84) months. There were 24 (70.6%) males and 10 (29.4%) females.

Twenty-nine had neglected clubfeet and presented to us for treatment for the first time. Thirteen feet had relapsed deformity and had undergone some other form of surgery in the past elsewhere. Eight feet had undergone one surgery in the past; one foot was operated twice and four feet were operated three times in the past. Seven feet were treated with posteromedial release. One foot was treated with the Ilizarov method, while the other foot had undergone posteromedial release and tendon transfer previously. Four feet had undergone posteromedial release, tendon transfer, and calcaneocuboid osteotomy before reporting to us.

Finally 34 children (42 feet) were analyzed. Eight children had bilateral involvement, nine had left side involvement and seventeen children had right side involvement. Thirty-three feet were classified as grade IV and nine were grade III deformity (as per Dimeglio et al.[21]). Sixteen feet (38.1%) had ulcers at pressure areas on the dorsolateral aspect of the feet, while eight feet (19.05%) had ulcers along with osteomyelitis in the underlying bones.

Of 34 children, 18 (52.9%) had neurological involvement at a high lumbar level; eight (23.5%) had lower thoracic, five (14.7%) had lower lumbar, and three (8.8%) had sacral-level involvement.

All feet were evaluated postoperatively and at each follow-up by a registered occupational therapist (who was not part of the study), using the scoring system described by the International Clubfoot Study Group (ICFSG) and Bensahel et al.[22] This system is based on morphological, functional, and radiographic evaluation of treated clubfeet. Morphological evaluation is further subdivided into hindfoot varus or valgus, equinus or calcaneus, midfoot supination or

pronation, adduction or abduction and global alignment of the foot including medial or lateral rotation. Functional evaluation is further subdivided into passive motion at ankle, subtalar, and midtarsal joints. Functional evaluation also consists of muscle function, dynamic function including gait, ability to run, ability to jump, heel walking, toe walking and evaluation of pain. Radiographic evaluation is based on various angles drawn on standing anteroposterior as well as lateral views for foot and ankle. On standing anteroposterior view talocalcaneal, cuboid-calcaneal, cuboid-fifth metatarsal, talo-first metatarsal, talonavicular angles were measured. On standing lateral view, talocalcaneal, tibiocalcaneal, talonavicular, talofirst metatarsal, calcaneo-fifth metatarsal angles and flat-top talus were measured. Each evaluation is scored as 0, 1, or 2. The lower the score, the better the evaluation. This scoring system has not been validated for neurogenic clubfeet.

Associated clinical or radiographic evidence of arthritis, if present during follow-up, was noted. In unilateral cases, the foot length was measured and compared with the other foot. Any associated findings were noted.

Operative Technique

The surgical steps have been described in a previously published research article on management of neglected and recurrent clubfoot deformity.[20] For the benefit of the readers a few salient points are mentioned here:

For correction of the cavus deformity, a percutaneous plantar fasciotomy is done. To correct the equinus, percutaneous tendoAchilles tenotomy is done. Achilles tenotomy unlocks the heel, correcting equinus as well as heel varus. No separate procedure is required for correction of heel varus. To get the final correction, a closing dorsolateral wedge osteotomy is done through an elliptical skin incision taken on the dorsal aspect of the apex of the deformed foot (Figure 2). The osteotomy is performed through the cuboid and all three cuneiforms. Occasionally, the navicular or distal calcaneus or base of the metatarsals may require osteotomy, depending on severity of the deformity. The wedge should be wider dorsally and taper towards the sole. The amount of bony wedge required depends on the severity of the deformity. Usually 1-1.5 cm of a wedge is sufficient to correct the deformity. Any associated wound or ulcer at the apex of the foot is excised. In case of osteomyelitis of the underlying bones, the necrotic bone is included in the wedge to be removed. Occasionally, impingement of the navicula occurs against the head of the talus, not allowing full correction of the deformity. In those cases, naviculectomy is required to get the correction. An above knee cast is applied. A window is made in the cast and the limb is kept elevated on pillows.

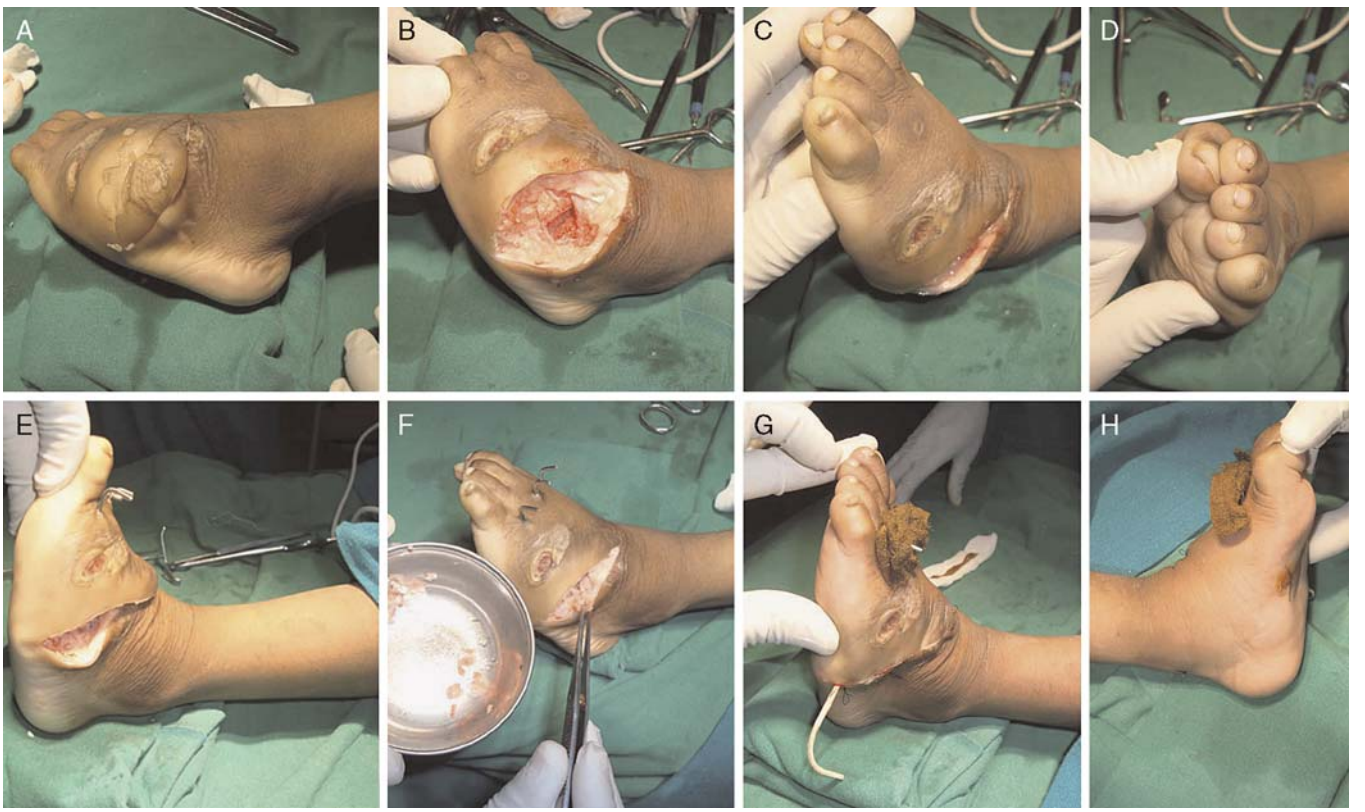

FIGURE 2. Operative procedure steps in the same child as in Figure 1. (A) An elliptical skin incision placed dorsally at apex of the deformity. (B) Skin and bursa are excised. Osteotomized bony dorsal wedge (including cuboid and all cuneiforms) was removed. The wedge is wider dorsally (1–2 cm) and tapers towards the sole. (C) The deformity is corrected by closing the space manually by everting and dorsiflexing the foot. (D) Bony surfaces are approximated, and the deformity is completely corrected. (E) The forefoot is stabilized to the hindfoot with three Kirschner wires. (F) Cancellous bone (noninfected) from resected wedge is grafted at the site of bony approximation area. (G) Drain kept at osteotomy-site. H, View from medial side after complete correction of equinus as well as heel varus. No separate procedure is required for heel varus correction.

Postoperative management

The cast is kept in place for 6 weeks and patients did not bear weight before cast removal. Postoperatively, once the Kirschner wires and plaster are removed a plastic molded ankle foot orthosis is applied and is encouraged to be worn for the future. Squatting was encouraged at home. Postoperatively, the children were followed up to 6 mo and thereafter at yearly intervals. Full correction was possible on the table in all the feet. Poor results were not associated with the amount of correction but with scarring and higher functional scores.

Statistical methods

Data was entered in MS excel and analysed with STATA software (Version 9.0, StataCorp LP, College Station, TX). Differences between means were analyzed with a Student t-test and differences between proportions by the Pearson's chi-square test. For small frequencies in categorical data, the Fisher exact test was applied. A *P*-value of <0.05 was considered statistically significant.

RESULTS

No intraoperative or immediate postoperative complications occurred.

Postoperative evaluation

No child had any neurovascular compromise or infection at the osteotomy site. One foot (2.4%) had a pin track infection at the Kirschner-wire site and was treated with intravenous antibiotics. None of the patients had nonunion or pseudarthrosis at the osteotomy site clinically or radiographically.

Follow-up evaluation

The scores were totalled, and the results were graded as excellent, good, fair, or poor under these criteria. At final follow-up, of 42 feet, four (9.52%) had excellent results, 30 (71.42%) had good results, five (11.90%) had fair results, and three (7.14%) had poor results (Table 1).

Comparative results of relapsed and neglected feet are presented in Table 2. Of 42 feet, excellent and good results were observed in 34 (80.9%) feet. Eight (19.1%) feet had fair or poor results. Among 13 relapsed feet, seven (53.9%) had excellent or good results. Similarly, among 29 neglected feet, 27 (93.1%) had excellent or good results. The trend that was noted in relapsed feet was that the greater number of previous operations a patient had the poorer were the results.

The relationship between the age at which surgery was performed and results is shown in Table 3. The relative frequency of good results was significantly ($P = 0.027$) higher in younger (< 10 years) than older (10+ years) children.

All sixteen (38.1%) feet with ulcers at pressure area and eight feet with osteomyelitis of underlying bones showed good healing in the postoperative period (Figure 3).

One foot developed a nonhealing ulcer on the plantar aspect of the great toe during the follow-up period. This foot had ulcers over the dorsolateral aspect preoperatively, which healed in the immediate postoperative period. The foot had loss of sensation at the great toe and developed an ulcer 2 years after surgery.

TABLE 1. Classification of results according to Bensahel *et al.* and the International Clubfoot Study Group[22]

Results	Score	No. of feet	%
Excellent	0-5	4	9.52
Good	6-15	30	71.42
Fair	16-30	5	11.90
Poor	> 30	3	7.14
Total		42	100.00

In 42 feet, various radiographic angles that were found abnormal on standing anteroposterior view were as follows: talocalcaneal 26 (62%), cuboid-calcaneal eight (19%), cuboid-fifth metatarsal 20 (48%), talo-first metatarsal 23 (55%), and talonavicular 22 (52%). Similarly, on standing lateral view, in 42 feet, various radiographic angles were abnormal as follows: talocalcaneal four (10%), tibiocalcaneal six (14%), talonavicular 12 (29%), talo-first metatarsal 17 (41%), calcaneo-fifth metatarsal 22 (52%), and flat-top talus 34 (81%). The abnormality of radiographic angles was found similar for left and right feet. Results of the surgical procedure were found independent of radiographic findings.

On comparison of results in neurological level, six of eight feet with thoracic level involvement had fair to poor results while all 26 feet with upper lumbar involvement had good to excellent results. This suggests a significant association ($P < 0.001$) between results and neurological level. Also, there was a significant association ($P < 0.001$) between sensory loss and location of ulcer.

None of the patients had pain in any activities at final follow-up. None of the patients had clinical or radiographica evidence of arthritis of the ankle, subtalar, or any other joint.

In unilateral cases (n = 26), the foot was 1.23 ± 0.38 cm (range, 0.5-2 cm) shorter than the other foot at final follow-up.

One patient had persistent severe tibial internal torsion and needed external rotation osteotomy of tibia in subsequent follow-up. Eleven feet had associated shortening of the tibia (mean 1.32 ± 0.34, range, 0.5-2.5 cm) that was managed with shoe raise in a splint.

DISCUSSION

Clubfoot is the most common deformity associated with myelomeningocele and usually requires surgical corrections.[3] Hayes, Gross, and Dow,[23] in their series reported usefulness of splinting, manipulations, and serial casting. However, for older children, which the study population dealt with, Sharrard and Grosfield,[14] in their study stated that splinting, manipulation and serial casting can result in disaster. In these feet, soft-tissue surgeries in the form of releases and tendon transfers do not work adequately and bony correction is required.

TABLE 2. Comparison of results in relapsed and neglected feet

	Type of foot					
	Relapsed		Neglected		Total	
Results	No. of feet	%	No. of feet	%	No. of feet	%
Excellent and good	7	53.9	27	93.1	34	80.9
Fair and poor	6	46.1	2	6.9	8	19.1
Total	13	100.0	29	100.0	42	100.0

Chi-square = 8.97, degree of freedom (df) = 1, $P = 0.003^{**}$.

The goal in managing these foot deformities is to achieve a plantigrade foot with stable skin. Whenever there is a problem with sensation, concentrated pressure in one area of a deformed foot will lead to skin breakdown[24–27] and subsequent formation of ulcer. And hence surgical procedures are not only aimed at correction but also on achieving a foot that will distribute the pressure all over sole.

The higher frequency of good results in younger (< 10 years) children in the present study could be explained on the basis that older children had greater bony incongruency[1,14,25] and less ability to remodel. Foot bones in older children are so much more deformed[14,28] that they cannot achieve a normal radiographic relationship. Results of the surgical procedure were found independent of radiographic findings. On standing anteroposterior view, the least abnormal angle was cuboid-calcaneal alignment; while the talocalcaneal angle was abnormal in the highest number of feet. Interestingly, on standing lateral view, the abnormality was lowest in talocalcaneal angle while it was highest for flat-top talus.

The outcome evaluation system developed by ICSG[22] is a comprehensive system that involves skilful activities such as the ability to walk on heels, walk on toes, and run and jump. Eight (19.1%) feet with fair and poor results had associated weakness in different muscle groups along with stiffness at various joints because of scarring from previous surgeries. Scarring had led to decreased movements, poor performance in skilful activities and higher scores. It is evident from Table 2 that although the technique was found effective in both types of feet, the proportion of excellent and good results was significantly higher in neglected as compared with relapsed clubfeet ($P = 0.003$). The poor results were not associated with the amount of correction but were associated with scarring and higher functional scores.

None of the feet (including those with poor results) had clinical or radiographic evidence of arthritis of the ankle or any other joint at 4-7 years of follow-up. A possible reason could be that the surgical procedure preserves the subtalar joint of feet. This is an advantage over triple arthrodesis;[12,13,18,29] however, longer follow-up studies will be required to look for development of arthritis and recurrences in future. The follow-up period of the present study might possibly be too short to note development of osteoarthritis.

The biggest advantage of the surgical procedure is its effectiveness in feet having nonhealing chronic ulcers in weightbearing areas, as well as, feet having osteomyelitis and necrotic bones.

We performed a percutaneous plantar fasciotomy to correct the cavus, which may carry a risk of injury to the plantar nerves if the knife goes in deeper planes. If surgeons take precautions of being superficial while cutting the plantar fascia, damage is avoided. However, an open technique is safer if inevitable damage is anticipated in a particular case.

The only disadvantage of the surgical procedure is possible shortening of the foot in unilateral cases. The shortening observed by us is comparable to other series[30] of bony procedures and even those feet treated[31,32] conservatively. Although long-term follow-up until maturity will be required to determine the final shortening of foot, early results are encouraging.

This study used a scoring system that was designed for evaluation of results in classic clubfoot and not for neurogenic clubfoot. In our opinion, the ICSG[22] evaluation system is one of the most comprehensive scoring system that takes in to account all aspects of the foot including morphology and function. Hence, evaluation with this system gives us a fair idea of the surgical results for any clubfoot deformity.

On the basis of study findings, we conclude that a procedure including percutaneous Achilles tenotomy with plantar fasciotomy and closing dorsolateral wedge osteotomy is a good method for management of neglected, relapsed, late presenting clubfoot deformities associated with myelomeningocele. It is very useful in feet having

TABLE 3. Relationship between age at which surgery was performed and results

	Age at surgery					
	Younger than 10 years		10 years or older		Total	
Results	No. of feet	%	No. of feet	%	No. of feet	%
Excellent and good	23	92.0	11	64.7	34	80.9
Fair and poor	2	8.0	6	35.3	8	19.1
Total	25	100.0	17	100.0	42	100.0

Chi-square = 4.9, degree of freedom (df) = 1, $P = 0.027^{*}$.

FIGURE 3. Seven-year follow-up of the same child as shown in Figures 1 and 2. Good maintenance of the hindfoot, forefoot, and midfoot correction. Child was able to perform all day-to-day activities without any pain.

chronic nonhealing ulcers and osteomyelitis of underlying bones. It suits the needs of developing countries, particularly in settings such as ours where patients are mostly from remote villages, with low socioeconomic background and are unable to comply with follow-up protocols.

REFERENCES

1. Westcott MA, Dynes MC, Remer EM, *et al*. Congenital and acquired orthopedic abnormalities in patients with myelomeningocele. *RadioGraphics*. 1992; 12:1155–1173.
2. Broughton NS, Graham G, Menelaus MB. The high incidence of foot deformity in patients with high-level spina bifida. *J Bone and Joint Surg*. 1994; 76-B:548–550.
3. Specht EE, Goodner EK, Tanagho EA, *et al*. Myelomeningocele. A symposium on orthopedic, ophthalmologic, urologic, psychological and social, neurosurgical and general considerations. *West J Med*. 1974; 121:281–291.
4. Gerlach DJ, Gurnett CA, Limpaphayom N, *et al*. Early results of the Ponseti method for the treatment of clubfoot associated with myelomeningocele. *J Bone Joint Surg*. 2009; 91-A: 1350–1359.
5. Gourineni P, Dias L, Blanco R, *et al*. Orthopaedic deformities associated with lumbosacral spinal lipomas. *J Pediatr Orthop*. 2009; 29:932–936.
6. Williams PF. Restoration of muscle balance of the foot by transfer of the tibialis posterior. *J Bone Joint Surg*. 1976; 58-B: 217–219.
7. Segev E, Ezra E, Yaniv M, *et al*. V osteotomy and Ilizarov technique for residual idiopathic or neurogenic clubfeet. *J Orthop Surg*. 2008; 16:215–219.
8. Kelley SP, Bache CE, Graham HK, *et al*. Limb reconstruction using circular frames in children and adolescents with spina bifida. *J Bone Joint Surg*. 2010; 9(B):1017–1022.
9. Jozwiak M, Idzior M, Kowalski I. Talectomy for the clubfeet treatment in children with myelomeningocoele. *Chir Narzadow Ruchu Ortop Pol*. 2007; 72:43–49.
10. Yalcin S, Kocaoglu B, Berker N, *et al*. Talectomy for the treatment of neglected pes equinovarus deformity in patients with neuromuscular involvement. *Acta Orthop Traumatol Turc*. 2005; 39:316–321.
11. Dias LS, Stern LS. Talectomy in the treatment of resistant talipes equinovarus deformity in myelomeningocele and arthrogryposis. *J Pediatr Orthop*. 1987; 7:39–41.
12. Williams PF, Menelaus MB. Triple arthrodesis by inlay grafting –A method suitable for the undeformed or valgus foot. *J Bone Joint Surg*. 1977; 59(B):333–336.
13. Olney BW, Menelaus MB. Triple arthrodesis of the foot in spina bifida Patients. *J Bone Joint Surg*. 1988; 70(B):234–235.
14. Sharrard WJW, Grosfield I. The management of deformity and paralysis of the foot in myelomeningocele. *J Bone Joint Surg*. 1968; 50(B):456–465.

15. Brunner R. Conservative treatment of neurogenic foot deformities. *Orthopade*. 1999; 28:143–150.
16. Flynn JM, Herrera-Soto JA, Ramirez NF, *et al*. Clubfoot release in myelodysplasia. *J Pediatr Orthop B*. 2004; 13:259–262.
17. Oganesyan OV, Istomina IS, Kuzmin VI. Treatment of equinocavovarus deformity in adults with the use of a hinged distraction apparatus. *J Bone Joint Surg*. 1996; 78(A):546–556.
18. Saltzman CL, Fehrle MJ, Cooper RR. Triple arthrodesis: twenty-five and forty-four year average follow-up of the same patients. *J Bone Joint Surg*. 1999; 81(A):1391–1402.
19. Beaty JH, Canale ST. Orthopaedic aspects of myelomeningocele. *J Bone Joint Surg*. 1990; 72(A):626–630.
20. Shingade VU, Shingade RV, Ughade SN. Correction of neglected or relapsed clubfoot deformity in an older child by single-stage procedure: early results. *Cur Orthop Pract*. 2012; 23:122–129.
21. Dimeglio A, Bensahel H, Souchet P, *et al*. Classification of clubfoot. *J Pediatr Orthop*. 1995; 4-B:129–136.
22. Bensahel H, Kuo K, Duhaime M, *et al*. Outcome evaluation of the treatment of clubfoot: the international language of clubfoot. *J Pediatr Orthop*. 2003; 12-B:269–271.
23. Hayes JT, Gross HP, Dow S. Surgery for paralytic defects secondary to myelomeningocele and myelodysplasia. *J Bone Joint Surg*. 1964; 46(A):1577–1597.
24. Carroll NC. Assessment and management of the lower extremity in myelodysplasia. *Orthop Clin North Am*. 1987; 18:709–724.
25. Qin SH, Ge JZ, Guo BF. Clinical analysis of 107 patients with foot and ankle deformities caused by spinal bifida. *Zhonghua Wai Ke Za Zhi*. 2010; 48:900–903.
26. Frischhut B, Stockl B, Landauer F, *et al*. Foot deformities in adolescents and young adults with spina bifida. *J.Pediatr Orthop B*. 2000; 9:161–169.
27. Maynard MJ, Weiner LS, Burke SW. Neuropathic foot ulceration in patients with myelodysplasia. *J Pediatr Orthop*. 1992; 12:786–788.
28. Penny JN. *The Neglected Clubfoot*. Techniques in Orthopaedics. Vol 20:Philadelphia: Lippincott Williams & Wilkins Inc.; 2005: 153–166.
29. Pell RF, Myerson MS, Schon LC. Clinical outcome after primary triple arthrodesis. *J Bone Joint Surg*. 2000; 82(A):47–57.
30. Graham GP, Dent CM. Dillwyn Evans operation for relapsed club foot: long term results. *J Bone Joint Surg*. 1992; 74(B): 445–448.
31. Laaveg SJ, Ponseti IV. Long term results of treatment of club foot. *J Bone Joint Surg*. 1980; 62-A:23–31.
32. Wynne-Davies R. Talipes equinovarus: A review of eighty –four cases after completion of treatment. *J Bone Joint Surg*. 1964; 46-B:464–476.