Single Stage Surgery for Treatment of Congenital Vertical Talus in Children 1 – 4 Years old

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ABSTRACT:

BACKGROUND:

Congenital vertical talus is an uncommon foot deformity that is present at birth and results in a rigid flatfoot deformity if left untreated and is more commonly associated with other neuromuscular conditions which have more rigid deformity and less favorable outcome.

OBJECTIVE:

To find the extent of radiological and clinical improvements after using a single stage surgical treatment for children aged 1 to 4 years having congenital vertical talus.

METHOD:

Single stage surgery was performed on 15 patients (19 feet) with congenital vertical talus starting from October 2008 to September 2010; all the patients were evaluated clinically and radiologicaly by measuring talocalcaneal and tibiocalcaneal angles, and categorized into 2 age groups for sake of treatment selection. Patients younger than 2 years were treated by soft tissue release, tendon lengthening and k-wire fixation of talonavicular joint, while in patients aged 2 years to 3 years and 6 months of age we added a tibialis anterior transfer to the surgery. Postoperatively the cases were evaluated in a way similar to that used prior to surgery. Analytic studies were performed, comparing the postoperative scores to those scores prior to surgery.

RESULTS:

Clinical improvements by increasing of the mean of clinical score from (12.79) preoperatively to (18.50) on last follow up evaluation and radiological improvements after single stage surgery showed by highly significant decrease in mean of lateral talocalcaneal angles with difference of (14.53°) and the highly significant decrease in mean of lateral tibiocalcaneal angles with difference of (35.06°).

CONCLUSION:

Single stage surgical treatment is very useful for treatment of congenital vertical talus in children 1 – 4 years old and can help to avoid the need for two-stage surgical correction and excisional surgeries.

KEYWORDS: congenital vertical talus, rocker bottom foot, single stage surgery.

INTRODUCTION:

Congenital vertical talus is a rare foot deformity with an incidence of 1 in 10,000.[1] It has also been called congenital convex pes valgus, Persian slipper, congenital rigid rocker-bottom foot and dislocated navicular, both sexes are affected equally, and it is bilateral in 50% of cases. [2,3] The exact etiology of vertical talus is unknown and possible causes include muscle imbalance, especially overpull of the anterior tibial tendon in paralytic disorders, and intrauterine compression, particularly when coupled with arthrogryposis.[4] Autosomal dominant transmission through three generations of a Honduran family has been reported[5], as well as transmission from parent to child. [3,6]Suggested causes include defects in central nervous system, muscle abnormalities, genetics and acquired deformities [7, 8, 9].

The main pathology of congenital vertical talus is the dorsolateral dislocation of the navicular in relation to the talus, its articular surface is tilted

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plantarward and usually articulates with the dorsal aspect of the neck of the talus and is locked there.[1,10] The navicular adapts to this position by becoming wedge-shaped with a hypoplastic plantar segment.[9] The talar head and neck are flattened dorsally and deviated medially, the calcaneus is displaced posterolaterally in relation to the talus, is in contact with the distal end of the fibula, and is tilted into equinus.[4] The talus becomes shaped like an hourglass and in so marked equinus position that its longitudinal axis is almost the same as that of the tibia.[11] The talonavicular joint capsule is dorsally contracted and both the calcaneonavicular (spring) ligament and the anterior fibers of the deltoid ligament are stretched, as are the medial fibers of the bifurcate ligament, There are corresponding contractures of the tibialis anterior, long toe extensors, peroneus brevis, and triceps surae. The posterior tibial and peroneal tendons may be displaced anteriorly so that they act as dorsiflexors rather than plantar flexors. [5, 9 ,12)

Figure 1 : Bilateral Congenital vertical talus deformity

Clinically involved foot is usually smaller than the opposite side (in unilateral involvement) with decreased circumference of the calf. It is characterized by hindfoot equines and valgus, forefoot abduction, and forefoot dorsiflexion at the midtarsal joint, this is usually recognized in the newborn period by the rigidity of the deformities but it must be differentiated from the more common calcaneovalgus foot, posterior medial bowing of the tibia, and flexible flatfoot. [1] In congenital vertical talus, the plantar surface of the foot is convex creating a rocker-bottom appearance (Figure 1). Unlike calcaneal valgus, however, this position is rigid, and the foot cannot be flexed in a plantar direction. [13]

Also there are deep creases on the dorsolateral aspect of the foot anterior and inferior to the lateral malleolus, the peroneal and tibialis anterior tendons are contracted, and the foot is everted into a valgus, externally rotated, position [1, 4, 9]

Congenital vertical talus does not delay walking; it may be apparent for the first time when the child starts to walk and in older children usually presented with awkward gait [9] and weakness in push-off power. [14]

In addition to the clinical examination, the diagnosis should be confirmed by radiological examination in which dorsal dislocation of the navicular bone on to the head or neck of the talus is shown to be maintained in the position of greatest plantar flexion.[1]

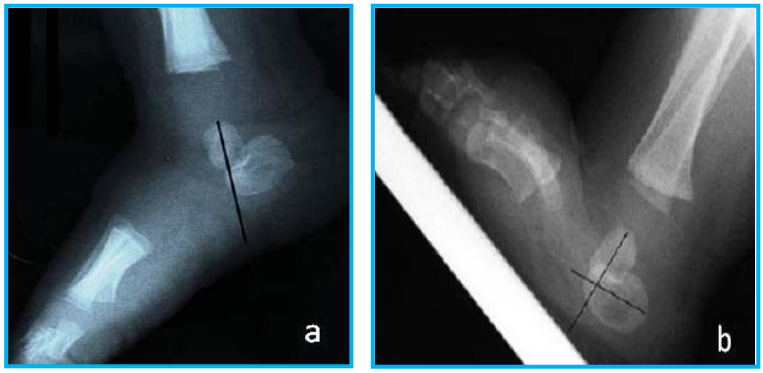

Figure 2: a. Plantar flexion lateral radiograph of a 12- week-old male with congenital vertical talus, showing persistent dorsal translation of the forefoot on the hindfoot
b. Lateral dorsiflexion radiograph of the same foot, showing persistent plantar flexion of the talus and calcaneus.[1]

Congenital vertical talus is difficult to correct and tends to recur, and serial casting has been recommended and attempted by many but is ineffective because of the rigidity of the deformity. [9]

Surgical correction is the mainstay of treatment. The exact upper age limit for a successful open reduction is not known. The difficulty of surgical correction depends on the severity of the deformity, the associated diagnosis, and the age of the patient. Children 1 to 4 years old generally are best treated by open reduction and realignment of the talonavicular and subtalar joints which can be performed through either a one-stage or two-stage operation.Some children after the age of 3 years require excision of the navicular at the time of open reduction. Children 4 to 8 years old can be treated by open reduction and soft - tissue procedures combined with extraarticular subtalar arthrodesis. Children 12 years old or older are best treated by triple arthrodesis for permanent correction of the deformity.[1,12]

The single-stage correction can be done through a dorsal approach or a posterior approach.[1] There are four basic components to the single-stage correction release: first is reduction of the navicular on the talus; second is lengthening of the toe extensors and peroneal tendons; third is release of the equinus contracture (lengthening of the Achilles tendon, and division of the ankle and subtalar joint capsules). The fourth component ,which can be added or not ,include the transfer of the tibialis anterior tendon to the talus to dynamically stabilize the correction.[1,4 ,9]

PATIENTS AND METHODS:

A prospective study was conducted in Al-Wasity Teaching Hospital for Reconstructive Surgeries between October 2008 and September 2010, collecting 15 cases(19 feet) of congenital vertical talus and treated with single surgical procedure for correction of the deformity without initial conservative treatment. After surgery, all cases were followed up regularly for a mean period of 14 months (minimum of 10 months and maximum of 22 months), during this period they were clinically evaluated for subjective complaints and objective findings focused on the range of movement at the ankle joint, equines deformity, position of the hindfoot and the lateral and medial boarders of the foot. A special score system (table 1) already used by Colton (1973)[15] was used as a baseline indicator for the clinical improvement . The patients were also evaluated on the basis of radiographs of foot and ankle made in standard projections.

Table 1: **Clinical scores reflect the overall quality of the result and are classed as**

	4 points	3 points	2 points	1 point
Heel posture	Neutral	Trace of valgus	Moderate valgus	Gross valgus
Equinus	Dorsiflexion above square	Dorsiflexion to square	Slight equinus	Gross equinus
Lateral boarder	Convex	Straight	Slight concavity	Gross forefoot abduction
Medial talar prominence	None	Slight prominence	Callosity over prominence	Ulceration over prominence
Mobility	Useful range all tarsal joints	Subtalar joint stiff, Other tarsal joints mobile	Stiffness of whole tarsus	Rigidity of whole tarsus
Range of plantar-flexion(degrees)	Over 20	11 to 20	0 to 10	Fixed dorsiflexion

excellent (21-24 points), good (16-20 points), fair (14-15 points) and poor (13 points or fewer).

From the 15 cases collected 4 cases (26.6%) were bilateral and there were 8 males and 7 females and of the 19 feet treated, 10 were right sided and 9 were left sided (Table 2)

Table 2 : Table showing the age, sex, and side of involvement. M for male, F for female, R for right, L for left & B for bilateral.

Case №	Age (months)	Sex	Involvement
1	30	M	B
2	11	F	R
3	36	M	R
4	14	M	L
5	44	F	L
6	11	M	B
7	30	M	L
8	18	F	R
9	12	M	R
10	20	F	L
11	14	M	R
12	35	M	R
13	12	F	B
14	25	F	L
15	12	F	B

The age of the patients ranged from 11 to 44 months with a mean age of (21.6 months), and of the 15 patients treated, 9 patients (60%) were below 2 years and considered as group 1 while 6 patients (40%) were between 2 years to 3 years and 6 months of age and considered as group 2 . We divide the cases into 2 groups not for comparison between them but to select the best surgical steps for them based on a literature review study conducted by Bosker in (2007).[16]

Preoperative clinical evaluation using Colton score system showed that there were 3 cases with fair grading while the rest of cases were graded as poor(Table 3).

Table 3 : Table represents the clinical preoperative scoring all cases (✳=bilateral).

Case No.	Side	Points scored (preoperative)						Score & Classification
		Heel	Equinus	Lateral boarder	Talar Prominence	Mobility	Plantar Flexion	
1 ✳	R	2	1	1	2	2	2	10 (poor)
	L	2	2	2	3	2	2	13 (poor)
2	R	2	2	2	3	2	2	13 (poor)
3	R	2	2	2	3	2	2	13 (poor)
4	L	2	2	2	3	2	2	13 (poor)
5	L	2	2	2	3	2	2	13 (poor)
6 ✳	R	2	2	2	3	3	2	14 (fair)
	L	2	2	2	2	2	3	13 (poor)
7	L	2	2	2	3	3	2	14 (fair)
8	R	2	1	2	3	3	2	13 (poor)
9	R	2	2	2	3	2	2	13 (poor)
10	L	2	2	1	2	2	2	11 (poor)
11	R	2	2	2	3	2	2	13 (poor)
12	R	2	2	2	3	2	2	13 (poor)
13✳	R	1	3	2	3	2	2	13 (poor)
	L	3	2	2	3	2	3	15 (fair)
14	L	2	1	2	3	2	1	11 (poor)
15✳	R	2	3	1	3	2	2	13 (poor)
	L	1	2	2	3	2	2	12 (poor)

Radiological evaluation preoperatively included AP and lateral radiographs, and from the radiographs we obtained the two most important angles for radiological assessment, the talocalcaneal angle and tibiocalcaneal angle.

Figure 3: Radiographs showing talocalcaneal and tibiocalcaneal angles measurement.

Single staged surgical procedure was used for all patients. Each one of the age groups were treated by different surgery according to Bosker et al. literature review study (2007).[16]

For group 1 (aged < 24 months) we did soft tissue release (peritalar release) with tendons lengthening and fixation of talonavicular joint by k-wire. For group 2 (aged 24 to 44 months) we did same as for group 1 but we added a tibialis anterior transfer to talar neck.

Medial straight incision (Figure 4) about 5 cm parallel to the sole of the foot, subcutaneous dissection was done and the talonavicular capsule is incised (found to be very thick dorsally in most of the cases) exposing the head of the talus, subtalar release along with division of spring

ligament was done, the tibialis anterior tendon was lengthened by Z-plasty if found to be contracted, also the contracted dorsal talonavicular ligament was divided , while the tibialis posterior is tagged and divided for later shortening

Figure 4: Medial incision over talonavicular joint

Figure 5: Incision along the medial boarder of heel cord

Posterior incision (Figure 5) 5 cm along the medial boarder of heel cord, through which elongation of Achilles tendon was performed with the distal end of the lateral half is detached from the calcaneus (the suture of the z-plasty was done after full reduction of talonavicular joint) this was followed by wide posterior capsulotomy of ankle and subtalar joints, the contracted calcaneofibular ligament should be divided to correct the valgus heel, the isolation and protection of the neurovascular bundle is very important step.

Figure 6: Lateral incision over the sinus tarsi

A k-wire is then inserted in the talus in a retrograde manner and then used as a joystick to reduce the talonavicular joint by molding the longitudinal arch and manipulation of forefoot into plantar flexion and inversion, after that the k-wire is advanced to secure the talonavicular joint then advanced more to the middle or medial cuneiform. A second k-wire in some cases inserted from the posterior end the heels through calcaneus to the reduced talus to fix the subtalar joint.

Lateral incision (Figure 6) was performed in some cases when the talus was difficult to reduce, by making lateral subtalar release and divide the ligament in sinus tarsi, on need peroneal tendons can be elongated .

In cases aged 2 years to 3 years and 6 months, a single posteromedial incision was used and tibialis anterior tendon was transferred to the talus by drilling a hole in the talus neck

and passing the tendon through the hole then sutured to itself, this provided an extra stability .

Reconstruction of the talonavicular ligament, tight closure of the talonavicular capsule was done

Six weeks after the surgery the k‑wires were removed but the cast were put for other 2 weeks, after which we remove it and the foot put in an Ankle‑Foot orthosis or a Shoewear with medial arch support insole, then we encourage the child to walk.

RESULTS:

There were 15 cases (19 feet), 8 boys and 7 girls and only 4 cases were bilateral. The ages ranged from 11 to 44 months, the mean age being (21.6 months). All the patients had improvement of their foot deformities based on the significant differences between the preoperative measurements of radiological talocalcaneal and tibiocalcaneal angles and the last measurements of these angles, also the significant improvement in the clinical scores that lasted for months after the surgery.

The results (table 4) show highly significant decrease in both lateral talocalcaneal and lateral tibiocalcaneal angles after surgery. The mean of lateral right and left talocalcaneal angles decreases from (42.90°) and (37.00°) before surgery to (25.70°) and (24.78°) respectively on last follow up measurements, while the mean of right and left tibiocalcaneal angles decreases from (132.80°) and (127.80°) before surgery to (89.90°) and (91.67°) respectively. The difference in mean value between measurement before surgery and last follow up measurement of all talocalcaneal angles and all tibiocalcaneal angles are shown in the following (table 5) with the corresponding ***p*** values.

Table 4: Table shows the Mean X-ray angles for both sides before and after surgery with *p* value difference

Radiological Angle	Preoperative mean angles	Postoperative mean angles	*p* value for the difference between angles
Right talocalcaneal X-ray	42.90	25.70	0.002
Left talocalcaneal X-ray	37.00	24.78	0.004
Right tibiocalcaneal X-ray	123.80	89.90	0.002
Left tibiocalcaneal X-ray	127.89	91.67	0.004

Table 5: Table shows the Mean of talocalcaneal and tibiocalcaneal angles for both sides before and at last follow up.

Angle	Preoperative(range)	Postoperative(range)	Difference
Talocalcaneal	39.95	25.24	14.53
Tibiocalcaneal	125.84	90.78	35.06

The clinical picture in most cases were improved and showed significant increase in the result of clinical scores compared to the preoperative assessment by the same system; preoperatively there were only 2 feet with fair grade while the rest 17 feet were graded as poor. After performing the single surgical treatment, the grades of the 19 feet changed to become as: 3 feet (16 %) with excellent results, 10 feet (53%) with good result , 5 feet (26%) with fair results and one foot (5%) was graded as poor.

The mean clinical score of right and left feet has increased from (12.80) and (12.78) preoperatively to (20.00) and (17.00) respectively on last clinical follow up evaluation and for all feet from (12.79) preoperatively to (18.50) on last follow up evaluation. When obtaining the *p* value we found a highly significant increase in clinical scores after surgery.

Table 6: Mean of preoperative clinical scores of each side compared with the score measured on last follow up with corresponding *p* value

Side	Preoperative mean scores	Postoperative mean scores	*p* value for the difference between scores
Right foot	12.80	20.00	0.002
Left foot	12.78	17.00	0.004

corresponding *p* value

Regarding the complications, one case developed a bunion over a migrated k-wire because the k-wire end was not bent properly and this was managed by removal of k-wire with excision of the bunion. One case developed callosity which was left for follow up. One case developed stiffness at midfoot and subtalar joints .One case had pain on walking 5 months after surgery which was recovered after another 3 months.

During our follow up period (mean of 14 months), no patient has worsening or recurrence of the deformity. Talar necrosis did not occur in any case during the time of follow up

DISCUSSION:

Most of the studied cases were from Baghdad city. Although many articles refer to the deformity of being rare and that Osmond-Clarke (1956) reported only one case out of a total attendance 131[15], we think with high index of suspicion it is not impossible to collect cases of vertical talus. We also convinced that a lot of those patients have serious malformation other than the congenital vertical talus such as malformation in gastrointestinal tract or cardiovascular system that necessitate the parent to ignore the foot deformity for sake of saving child's life. The department of genetic malformation in the "Teaching Laboratories" building in Baghdad Medical city directorate is a good example to find such cases.

We did not found any family history of same problem even in the 2nd and 3rd degree relatives. Also no gynecological problems like infections during pregnancy were reported for the mothers of the patients.

Most references [1,9 and 17] showed that bilateral cases constitute half of the cases of congenital vertical talus, and that is away from what we found in this study that only 26.67% of cases were bilateral.

Conservative treatment by serial casting should be attempted if the child is as young as 3-4 months and as our patients were 11 to 44 months, so we didn't need the serial casting and we treated them all by single surgical surgery.

We compare the results of this study with the results of studies similar or close to it, in this study the mean of preoperative lateral talocalcaneal angle (39.95°) decreased to (25.42°) on last follow up with a difference of (14.53°), while Saini et. al [17] who operated on 20 feet with congenital vertical tallus using dorsal approach single surgical procedure, the mean of preoperative lateral talocalcaneal angle was (47.5°) while last measure was (24.35°) with a difference of (23.15°). The difference that Saini et. al got is more than that in this study may be because the cases he treated were more severe than ours, but the mean of final talocalcaneal angles in both studies were not very much different.

Concerning the tibiocalcaneal angle we got a difference as (35.06°) as we have a decrease of this angle from (125.84°) preoperatively to (90.78°) on last follow up measurement, this is by far more than the difference that Saini got for the tibiocalcaneal angle that he got a difference of (23.05°) with preoperative measure of (107.75°) and final measure of (84.8°), we explained getting a higher difference in mean tibiocalcaneal angle is that the cases we treated had a more severe equinus deformity of the calcaneus and the mean age at surgery for our study was (21.6 months) which is older than the mean age in Saini series which is (16.0 months).

Raap and krauspe from Germany (1997)[18] , operated on 14 feet with idiopathic congenital vertical talus by soft tissue release and tibialis anterior transfer to the talar neck and got a difference of tibiocalcaneal angle of (22°) with the preoperative mean was (93°) and the follow up mean angle was (71°).

Of the 19 feet we operated on we got : 3 excellent clinical results (16%), 10 good results (53%) and 5 fair results (26%) and one foot (5%) with poor result while in an AAOS instructional series that treated 24 feet using 3 seprate incisions making medial and lateral release with tibialis anterior transfer and elongation of achillis tendon the results were : 0% excellent 83% good , 13% fair , and 4% poor.[10] Our approach is much similar to the AAOS series but our follow up periods were shorter.

Clark et al. (1977)[19] in their series of 15 feet treated by naviculectomy showed results of: 3 excellent, 7 good, 4 fair and one poor. We think that naviculectomy is an extensive procedure and should be used only in sever and rigid congenital vertical talus for older age patients.

Striker and Rosen(1997)[20] performed simple one-stage surgical reconstruction on 20 feet with congenital vertical talus with an average follow up of 41 months, there were no excellent , 17 good , 3 fair and no poor results.

Although the size of the sample in this study is small to obtain statistically significant results, yet the numbers and figures of the radiological and clinical improvement are clear. The range of follow up period 14 months is not sufficient to evaluate long term results and remote complications. During the follow up period no worsening of the obtained improvement and no recurrences were encountered.

CONCLUSION:

A high index of suspicion when examining any child or infant with severe flatfeet will help early diagnosis, and management of vertical talus.

We found that Single stage surgery is very useful even in children up to 4 years of age, but when done earlier it will help to avoid a 2nd surgery with its complication and that the extensive surgeries like two stage surgery, naviculectomy and talectomy can be avoided in children aged < 4 years.

Posterior ankle and subtalar capsulotomy is a keystone in the treatment along with the division of the contracted calcaneofibular ligament and adding a tibialis anterior element to the single stage surgery obviates the need for extra-articular subtalar fusion.

In older affected children also a solid ankle foot orthosis - including medial arch posting or built in 15° of plantar flexion at the midtarsal joint - should be worn full time for at least one year postoperatively as it actively prevents recurrence.

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