Original Article

New method of defining existing deformities and new operative procedure for correcting the deformities in the congenital clubfeet (Hussain's procedure)- early results in primary surgery.

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Abstract:
Introduction: A new method of defining the existing/persisting deformities in congenital clubfoot and a new operative procedure for correcting the deformities has been proposed.

Methods: We retrospectively evaluated 43 feet of 30 patients (12 girls, 18 boys) who underwent the new surgical procedure for congenital clubfoot. The patients were evaluated with Cummings' modification of Laaveg and Ponseti score. The mean duration of follow-up was 10.7 months.

Results: 81.3% of the cases of the idiopathic congenital clubfoot had excellent results, 16.2% had good results and 2.3% had fair results, when managed primarily with the new method of clubfoot treatment.

Conclusion: While using the new method, exact existing/persisting deformities can be pointed out and adequate correction of the deformities can be done; thus there is less risk for over-and under-correction. The early results show that this method is effective. Long term results are awaited.

Keywords: congenital clubfoot, new method, deformity definition, operative procedure

Introduction

While specific trends were reported and great variability exists in the management of congenital clubfoot, certain principles are found to be universal: initial nonoperative management followed by surgery for persisting deformities.[1]

The use of surgery for primary clubfoot correction today should be limited to an "a la carte" approach[2], where structures are released only as needed to obtain correction as an adjunct to a more conservative treatment approach.[3]

A new method of defining the existing/persisting deformities in congenital clubfoot has been proposed by Dr. Afzal Hussain, consultant orthopedic surgeon, PSRD orthopedic hospital. He has also developed a new surgical procedure for congenital clubfoot, which is tailored according to the existing/persisting deformities thus pointed out.

The new procedure objectively describes three different existing deformities i.e. dorsolateral hump, midfoot crease and equinus, and corrects the three deformities by three different steps of surgery i.e. lateral release, abductor and planter release; and posterior and medial release respectively. This is a new development in 'a la carte' approach for clubfoot surgery and helps the surgeon to make the decision of the surgical procedure easy. For example, when the clubfoot has rigid midfoot crease and equinus , and reducible dorsolateral hump, the surgeon would opt for abductor-planter release and posterior-medial release.

The procedure is being used extensively at PSRD orthopedic hospital for the correction of the congenital idiopathic clubfeet which fail the conservative management.

Methods

Method of defining the persisting/ existing deformities

A new method of defining the existing/persisting deformities in congenital clubfoot has been proposed.

This system first defines the type of clubfoot. In presence of other congenital deformities, clubfoot is classified as syndromic while in presence of neurological abnormalities like cerebral palsy and meningomyelocele, it is described as neurogenic. If there are no other abnormalities, it is considered idiopathic.

This system consists of recording the following existing deformities in foot.

A	dorsolateral hump
B1	half midfoot crease
B2	full midfoot crease
C	equinus
D	thin skin
E	short first ray

Dorsolateral hump is the talar head which is palpable on dorsolateral aspect of clubfoot while midfoot crease is the crease on the sole. Record of whether the dorsolateral hump is reducible i. e. whether it disappears on abducting the foot with firm pressure over the bony prominence or it is rigid/ irreducible is made. Reducibility of mid-foot crease i. e. whether it disappears on supinating first ray is also noted. Reducibility of equinus i. e. whether the foot can be brought into normal dorsiflexion by manipulation is also noted.

Presence of thin skin asks for the extra vigilance in soft tissue dissection, and short first ray tells that the deformity of the foot is more severe. This system of defining the deformities is used for the residual and neglected clubfoot as well.

The operative procedure

The operation is tailored according to the existing/ persisting deformities thus defined. Lateral release is done to reduce the rigid dorso-lateral hump, posterior and medial release is done in presence of the rigid equinus, while abductor-planter release is done for rigid mid-foot crease. For an instance, when midfoot crease and equinus are rigid and dorsolateral hump is reducible, the operative procedure would be abductor-planter release and posterior-medial release. Another example is when there is reducible mid-foot crease, but rigid equinus and dorsolateral hump; the operative procedure in this situation would be posterior-medial release and lateral release.

The operation is done by 3 different incisions. Lateral release is done by Ollier's approach, posterior and medial release is done through a longitudinal incision and abductor/ planter release is done through a horizontal incision along the first metatarsal extending proximally to first metatarso-cuneiform joint. Extreme caution is taken while elevating skin flaps in the presence of the thin skin.

Lateral release:

A straight incision is given from a point 1cm below lateral malleolus to the dorsolateral hump. Flaps of skin are elevated protecting sural nerve. Release of peroneal tendon sheath is done from the lateral border of foot to superior peroneal retinaculum. This serves two other purposes: peroneus longus tendon can then be mobilized and protected while releasing inferior capsule of calcaneocuboid joint; lateral capsule of the subtalar joint lying beneath peroneal tendon sheath can also be released.

Extensor digitorum brevis is elevated from its origin.

Lateral, superior, medial and inferior capsules of calcaneocuboid joint are released. Bifurcate and cubonavicular ligaments are also released.

Dorsal, lateral, medial and inferior capsules (along with the spring ligament) of talonavicular joint are released under direct vision. Extreme care is taken to not to dissect in neck of talus so as to preserve the vascularity of the bone. Extensor digitorum longus tendons and dorsalis pedis artery and nerve are protected during the release.

Lateral capsule of subtalar joint is released. Interosseous talocalcaneal ligaments are not released.

Postero-lateral part of capsule of subtalar joint along with calcaneo-fibular ligament and talofibular ligament are released.

Posterior and medial release:

A longitudinal incision of 5-6 cm is given mid-way between medial malleolus and tendoachilles. The distal extent of the incision is curved medially just proximal to the insertion of tendoachilles.

Approach is made to tendoachilles and skin flap is elevated along with sheath of tendoachilles. This assures adequate thickness of the skin flap- thus preventing flap necrosis. Sheath of tendoachilles is sharply incised.

Plantaris is released if present. Z-.lengthening of tendoachilles is done.

Tibialis posterior and flexor digitorum longus tendon sheaths are exposed and sharply opened up. Release of superficial deltoid ligament is done. Z-lengthening of tibialis posterior tendon is done. Z lengthening or tenotomy of flexor digitorum longus tendon is done as required, depending upon severity of the deformity. Flexor hallucis longus tendon sheath is opened up with a sharp incision. The sheath is opened up from the region above the ankle to the canal of flexor hallucis longus below the talus. The tendon is reflected along with neurovascular bundle anteriorly. Dissection of the neurovascular bundle is not done. Ankle and subtalar joint capsulotomies are done. Location of flexor hallucis longus tendon helps to identify subtalar joint. In extreme equinus, subtalar joint is released first, since talus is wedged anteriorly due to equinus of calcaneus. Release of ankle joint is meticulously done. Z-lengthening of flexor hallucis is done. Deep part of deltoid is generally not released. Posterior one- third of the deep part of deltoid ligament is released in the most rigid clubfeet only.

Abductor and planter release:

Abductor and planter release is done through a different medial longitudinal incision along first metatarsal extending proximally to metatarso-cuneiform joint. Structures released include aponeurosis of abductor hallucis brevis, first metatarso-cuneiform joint and planter fascia. It has been observed that aponeurosis of abductor hallucis brevis lies at planter aspect of the muscle in case of rigid cavus. Tibialis anterior tendon is identified and protected while releasing first metatarso-cuneiform joint. Release of the planter fascia is done through the same medial longitudinal incision.

Reduction of the talonavicular joint is then done under direct vision. Talonavicular joint is fixed with a1.5mm K-wire if the reduction is unstable. Calcaneocuboid joint also needs fixation if the reduction is unstable.

The ends of flexor hallucis longus tendon is sutured with chromic catgut. Tendoachilles is sutured with the foot at 5 degrees dorsiflexion. Tibialis posterior and flexor digitorum longus tendons are realigned in the tendon sheaths and are not sutured.

Extensor digitorum brevis muscle origin is snugly repaired with chromic catgut.

Subcutaneous tissue and skin are meticulously closed with interrupted sutures.

Initial immobilization is done with an above knee back slab in cases with extensive release. If the release is not extensive, corrective above knee cast is applied.

Postoperative management:

Postoperative manipulation and casting is given importance, as this corrects the reducible deformities of the clubfoot which had not been corrected surgically.

Removal of stitches along with manipulation is done under general anaesthesia after two weeks of operation. K-wire is removed after 4 weeks The cast is changed during these procedures

Next cast is applied after 4 weeks for non-rigid foot and after 2 weeks for the rigid one, which remains for 2 weeks. The final cast is then applied which remains for 2 more weeks. The foot remains in cast for a duration of 8-12 weeks after operation, depending upon its rigidity.

Ankle Foot Orthosis is then prescribed. The child wears AFO full time till he/she begins to walk. Then, the child wears the AFO at night and during afternoon naps till the age of 5-6 years. The child wears CTEV shoes when walking. Manual exercises are also taught to the parents.

43 cases of congenital idiopathic clubfeet of age at or below 5 years, which had been managed with the new method were evaluated. The children who underwent the primary surgery at age beyond 5 years were considered those with neglected clubfoot and were excluded from this study.

For evaluation of the result, Cummings [4] modification of Laaveg and Ponseti [5] score was used.

The feet which got 85-100 points were classified as the feet with excellent correction, the ones with 70-84 points were marked good, those with 60-69 points were marked fair and those with less than 59 points were classified as the feet with poor correction.

Results

43 feet of the follow-up cases which had been managed with the new method were evaluated. Those 43 feet were of 30 children. Among them, 18 were male and 12 were female. 14 of the children had their right foot involved while 5 of the children had left congenital clubfeet. 12 of them had bilateral involvement.

Among the children, 4 underwent surgery at age less than 6 months, 7 at age between 6 months and 1 year, 17 at age between 1 year and 3 years and 2 between 3 and 5 years.

Among the cases, Posterior and medial release had been done in 1 foot, 17 feet had undergone posterior, medial and abductor/planter release and 25 of them had undergone posterior, medial, abductor/planter release and lateral release.

The follow-up was for the duration of 3 months to 36 months with the mean duration of follow-up of 10.7 months.

The case which had undergone posterior and medial release had the excellent result.

Among the cases with posterior, medial and abductor-planter release, 3 had good result and 14 had the excellent result.

Among the cases with posterior- medial, abductor-planter release and lateral release 1 had fair, 4 had good and 20 had the excellent results.

Table I. Age-wise distribution of cases and their results.

age	Posterior and medial release			Posterior and medial+ planter-abductor release			Posterior and medial+ planter-abductor+ lateral release		
	fair	good	excellent	Fair	good	excellent	fair	good	excellent
< 6 months						3			3
6months-1year						2			6
1year -3 years			1		3	9		3	10
> 3years							1	1	1

81.3% (35) of the cases had excellent results, 16.2% (7) had good results and 2.3% (1) had fair results. The cases with good results had adductus deformities in the forefoot and talo-first metatarsal angle greater than 10 degrees. The case which had undergone operation at age greater than 3 years and had good result, had subtalar joint motion less than 15 degrees along with the adductus deformity and talo-first metatarsal angle greater than 10 degrees. The case with fair result had varus, decreased subtalar motion, adductus and talo-first metatarsal angle greater than 10 degrees.

None of the feet had overcorrection and skin problems. None of the cases had infection.

Discussion

Wider use the Ponseti technique has improved the outcome of the non-operative treatment, but surgical treatment may be necessary in resistant or recurrent deformities[6]. Because there will probably always be patients with clubfoot deformity who are treated surgically, an operative plan that minimizes frequent or invasive surgical intervention may result in greater long-term results. [7]

When considering surgery for CTEV, one must first determine what should be released. In 1980s, McKay[8] and Simons[9] both reported success with aggressive, wide subtalar release. More recent studies have indicated a return to a more limited release for CTEV. [4]

Although some think that any surgery requires a comprehensive release of all soft tissues, Carroll[10], Bensahel et al[2], and Grant and Atar[11], among others, plan for and approach each case individually. In his classification scheme, Catterall[12] suggested what Grant and Atar[11] stated, "Surgeon should identify what failed in conservative treatment" because these are the structures that need release. The new method of defining the existing/ persisting deformities in clubfoot is of great help in deciding the further operative steps.

Extensive surgical release may lead to decreased range of movement in the foot and ankle which compromises the functional result.[13] The essence of the new operation is evaluation of reducibility of the deformities in a congenital clubfoot. Only rigid deformities are corrected by surgery and the reducible deformities are taken care by post-operative serial casting.

I Hudson and A Catterall [14]have emphasized the rotatory process involved in the dorsiflexion in the normal infant foot. They released the postero-lateral structures: calcanofibular ligament, talofibular ligament and peroneal tendon sheath along with the lengthening of tendoachilles and release of the posterior capsules of ankle and subtalar joint, for the hindfoot equinus of

the foot, described as 'the tendon contracture causing fixed equinus'.

Another operation has been described for residual equinus which consists of tendoachilles lengthening and posterior capsulotomy of ankle and subtalar joints only. Physical examination and radiographs are reviewed to ensure that only hindfoot equinus requires correction.[15]

In the new operative procedure, for persistent rigid equinus, tendoachilles lengthening and release of posterior capsules of the ankle and subtalar joint is done together with the lengthening of the tibialis posterior, flexor digitorum longus and flexor hallucis longus tendons, and release of the medial subtalar joint capsule as well as the posterolateral tethers.

The considerable deforming force of tendon of tibialis posterior, which is often equivalent in power to the calf muscle in resistance, is addressed while managing persistent equinus.

Turco[16] reported about his finding of medial displacement of the navicular and calcaneus around the talus in congenital clubfoot. According to him, the talus is forced into equinus by the underlying calcaneus and navicular, whereas the head and neck of talus are deviated medially. The calcaneus is inverted under the talus, with the posterior end displaced upward and medially.

McKay[8] described the three dimensional aspect of bony deformity of the bony deformity of the subtalar complex in clubfoot. According to him, the relationship of the calcaneus to the talus is characterized by abnormal rotation in the sagittal, coronal, and horizontal planes. As the calcaneus rotates horizontally around the interosseous ligament, it slips beneath the head and neck of the talus anterior to the ankle joint and the calcaneal tuberosity moves toward the fibular malleolus posteriorly. The proximity of the calcaneus to the fibula is caused not only by the equinus but also by horizontal rotation of the talocalcaneal joint. The heel appears to be in varus because the calcaneus rotates through the talocalcaneal joint in a coronal plane and horizontally. The talonavicular joint is in an extreme position of inversion as the navicular moves around the head of the talus. The cuboid is displaced medially on the calcaneus.

For the reduction of the dorsolateral hump, the lateral release done i.e. the posterolateral tethers talonavicular joint, calcaneocuboid joint and bifurcate as well as spring ligaments are released. This procedure results in the reduction of the talonavicular joint, derotation of the calcaneus and alignment of the calcaneocuboid joint.

McKay[8] released the calcaneocuboid joint only if the adduction could not be corrected by the subtalar release. Simons[9] released calcaneocuboid joint in children aged less than 3 years. He released medial, planter and medial part of the dorsal capsule of the joint. He did not release the lateral and the lateral part of the dorsal capsule of the joint. JG Thometz and GW Simons[17] found that the calcaneocuboid joint subluxates with reduction of talonavicular joint and needs release as well. In the new operation, entire capsule of calcaneocuboid joint is released, which is one of the early steps of the lateral release. It was observed that calcaneum could not be mobilized and the dorsolateral hump could not be reduced without this vital step. There was no dorsal subluxation of the calcaneocuboid joint due to the complete release and if in the case, could be fixed with a K-wire.

Talonavicular joint is released from lateral side. It has been noticed that because of medial deviation of talar neck, subluxation of talonavicular joint and extensive contracture of soft tissue, it is difficult to release talonavicular joint from medial side. There is a great danger of damaging articular cartilage and even amputating talar neck and sustentaculum tali.[9,16] This difficulty is not encountered while releasing talonavicular joint from lateral side. The joint can be easily localized and complete release can be done under direct vision.

Turco[16] did the Steindler's stripping in children older than three to five years old. This consists of the excision of the origin of the planter fascia and stripping of the abductor hallucis, intrinsic toe flexors and abductor digiti quinti subperiostially from the calcaneus in the children.

McKay [8]and Simons[9] released the planter fascia through the axilla between the calcaneal nerve and the lateral planter nerve and artery. There is some risk of the injury to these neurovascular structures during this release. In the operation described, planter fascia is released under direct vision far from the neurovascular structures,

Persistent forefoot adduction results from the inadequate release of the naviculo-cuneiform first metatarsal capsules, the calcaneocuboid joint and the abductor hallucis muscle and becomes more evident with growth.[11]

In the operation described, planter fascia, abductor hallucis muscle and first metatarso-cuneiform joint is released through an incision along first metatarsal extending proximally to metatarsocuneiform joint on

medial side of foot. This corrects cavus deformity which is designated by rigid mid-foot crease and also helps to correct adductus deformity. Medial longitudinal arch remains maintained after this release. Injury to planter nerves and vessels is also prevented.

MacKay[8] and Simons[9] did not release the deep deltoid ligament because the release would cause overcorrection thus developing hindfoot valgus. In the operation described, the deep deltoid ligament is not released.

MacKay[8] released the interosseous talocalcaneal ligament in the rigid cases while Simons[9] released the ligament in all of the cases. In the new operation, these ligaments are not released. They serve as the axis around which calcaneus rotates during the correction and they also prevent overcorrection.

MacKay's[8] and Simons'[9] procedures are done through the Cincinnati incision, which extends from the navicular on the medial foot posteriorly, around the medial malleolus and across the Achilles tendon, ending by the lateral malleolus. This exposure theoretically places the heel flap at risk of ischaemia in addition to providing less than optimal exposure for release of the plantar fascia and Achilles tendon. The new operation is done through three incisions. There is no risk of ischaemia to the skin flaps and Achilles tendon can be released properly.

The effectiveness of the new method of defining the deformities and the new operative procedure is shown by the result that none of the feet had overcorrection. The three- incision for the correction of the rigid clubfeet precluded any skin problems. The meticulous aseptic technique and the sharp dissection prevented the infection.

The surgeries had been done according to the severity of the rigidity of the clubfoot. Posterior and medial release; posterior, medial and planter/abductor release; and posterior, medial, planter/abductor and lateral release had been done according to the increasing rigidity of the deformity. The good results of the operation reflect the result of the new method in the clubfeet with varying degrees of rigidity.

The following table shows follow-up results of the new procedure developed by Dr. Hussain, in comparison with other authors. The results are comparable to or better than those of other authors, although the follow-up period is short.

Table II. Our follow-up results in comparison with other authors.

Authors	Number of feet	Surgical procedure	Rating system	Excellent or good	Fair	Poor	Followup
Bensahel *et al.* [2]	142	posteromedial release	Bensahel	88%	9%	3%	8.5 years
Hudson and Catterall [14]	53	posterolateral release	Green and Lloyd-Roberts	64.1%	28.3%	7.5%	10 years 7 months
McKay [18]	55	pantalar release	McKay	81.8%	2.6%	14.5%	3 years 2 months
V. J. Turco[19]	149	posteromedial release	Turco	84%	10.7%	5.3%	2-15 years
Selmani[20]	56	Turco's posteromedial release	Laaveg and Ponseti	excellent 30% good 50%	16%	4%	5-7 years
Deniz G et al [21]	47	extended soft tissue release	Laaveg-Ponseti	51%	12.7%	10.6%	117.3 months
new procedure	43	release depending upon existing/ persisting deformities	Cumming's modification of Laaveg and Ponseti	excellent 81.3% good 16.2%	2.3%		10.7 months

Conclusion

The proposed method of defining persisting/ existing deformities and the operative procedure described is being used extensively at the PSRD Orthopaedic Hospital. The result of the operation is evaluated with Cummings'[4]modification of Laaveg and Ponseti[5] score and early results are found to be excellent.

Conflict of interest: None declared

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