Tarsal decancellation in the residual resistant arthrogryptic clubfoot

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ABSTRACT

INTRODUCTION Conservatism is well recognised after Ponseti's method in the treatment of congenital clubfoot; however, this is not applicable to the complex and resistant arthrogryptic type which challenges the orthopaedic surgeon. In such a type, soft tissue releases as fasciotomies, tenotomies, and capsulotomies, as well as osteotomies are insufficient, and joint fusions are not suitable in early childhood before skeletal maturity.

PATIENTS AND METHODS Twelve children (15 feet) with residual resistant arthrogryptic clubfeet between 2–4 years of age were analysed clinically and radiographically. All of the cases received previous conservative Ponseti's method of treatment in their first year of life followed by soft tissue releases (plantar fasciotomy, posteromedial tenotomies, capsulotomies, and abductor hallucis release) before treatment by decancellation of the cuboid, the calcaneus, and the talus to correct the complex adduction, supination, varus, and equinus deformities. Pre-operative measurements of certain foot angles were compared with their corresponding postoperative values.

RESULTS A grading scheme for evaluation of the results using a point scoring system was suggested to evaluate accurately both clinical and radiographic results after a follow-up period of an average of 3.3 years. Six feet (40%) had excellent, six (40%) good, three (20%) fair, and no poor (0%) outcome. There was no major complication. There was significant improvement in the result ($P > 0.035$).

CONCLUSIONS Tarsal decancellation is particularly applicable to residual resistant clubfoot such as the arthrogryptic type at an early age. It shortens the period of disability, improves the range of foot motion, and does not interfere with the foot bone growth.

KEYWORDS

Tarsal decancellation – Arthrogryptic clubfoot

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Arthrogryposis multiplex congenita (AMC) is a generic term used to describe the presence of multiple congenital contractures, with several fixed deformed joints, which are present at birth. It includes replacement of muscles by fibrofatty tissues causing gross atrophy, hypoplasia or complete absence (amyoplasia). It may also include nerve and connective tissue disorders. Hip, knee, ankle/foot, hand, forearm, elbow, shoulder joint contractures and deformities, less commonly spine scoliosis, and absence of skin flexor creases over the joints are common features.¹

Clubfoot deformity or talipes equinovarus occurs in more than 90% of infants with arthrogryposis. It is one of the most disabling deformities, as it is highly resistant and will cause severe disability if uncorrected. The deformity includes several components (Fig. 1). There is medial deviation of all of the elements of the foot from the subtalar

joint. Equinus is severe and includes contracture of all of the posterior musculature including the posterior capsules of the ankle and subtalar joints. The hindfoot is in varus position, with the calcaneus positioned medially under the talus. The forefoot is adducted and supinated. The foot and lower leg are smaller than normal (Fig. 2).²

The aim of this study is to reveal the role of decancellation or removal of cancellous bone from the anterolateral aspect of the foot using a curet, after conservative Ponseti's method and preliminary soft tissue releases, as a well-established method of reducing the width of the cuboid, calcaneus, and talus, particularly applicable to residual resistant arthrogryptic clubfoot in early childhood. It allows full correction at an early age, good range of foot motion, short period of treatment, and no interference with foot growth.³

Figure 1 The components of the deformity: the forefoot cavus (left), the forefoot adduction (middle), the hindfoot varus (middle), and the ankle equinus (right).

Figure 2 The adduction, varus, and equinus position, and the small calf.

Patients and Methods

Fifteen cases (feet) in 12 children, who presented to the National Institute of Neuromotor System between September 2005 and September 2006 with resistant arthrogryptic clubfoot, after previous conservative treatment using Ponseti's method and preliminary soft tissue releases, were operated upon and followed-up for at least a period of 3 years, using previous medical records, history, and physical and radiographic examinations.

Inclusion criteria

Moderate-to-severe residual fixed (rigid) forefoot adduction, midfoot supination, and hindfoot equinovarus deformities in ambulatory but with support children between 2–4 years of age with arthrogryptic clubfeet were chosen.

Exclusion criteria

Idiopathic, secondary clubfoot, non-ambulatory children below 2 years old, and flexible (correctable) foot deformity, were excluded.

Physical examination, original disease and treatment

The average age at the time of surgery was 3 years and 2 months (range, 2–4 years). Three children (3 feet) were in

the age group < 3 years, and nine children (12 feet) in the age group of 3–4 years. There were 10 boys (3 of them in both feet) and two girls (all of them in a single foot). The right foot was operated upon in eight children and the left foot in seven children (Table 1).

Pre-operative clinical evaluation

Using previous medical records, history of consanguinity was evident in all of the children. Two of them (a boy and a girl) underwent previous hip surgery for open reduction. All of them underwent previous conservative treatment in the form of serial manipulation and casting, and operative soft tissue release.

Neurological examination was done to exclude paralytic disorders with assessment of the muscle tone, motor power, sensation, and reflex activity.

Orthopaedic examination included the gait, the presence of deformities other than that of the foot, the presence or absence of flexor skin creases, the components of the foot deformity, the range of motion (ankle/foot flexibility), and the skin condition. All of the children were ambulatory with support. The foot was evaluated for forefoot adduction deformity by Bleck's method assessing the position of the forefoot with respect to the midline axis of the hindfoot.⁴ The ankle/foot was evaluated for foot alignment and its flexibility. All cases had rigid inward deviation of the foot (*i.e.* forefoot adduction deformity), supination, hindfoot varus and equinus, ranging from moderate to severe. Using Dimeglio score,⁵ ten feet got 3 marks (*i.e.* severely deformed) and five feet got 2 marks (*i.e.* moderately deformed). Using Pirani score,⁶ ten feet got 4 marks (*i.e.* severely deformed) and five feet got 3 marks (*i.e.* moderately deformed). All cases had skin scar of previous soft tissue release operation, healed by primary intention.

Table 1 Choice of patients

Age group	< 3 years of age	3 children
	3–4 years of age	9 children
Gender	Boys	10 boys
	Girls	2 girls
Side	Right foot	8 feet
	Left foot	7 feet
Bilateralism	Boys	3 children
	Girls	No child
Total	Children	12 children
	Feet	15 feet

Pre-operative radiographic evaluation

Weight-bearing anteroposterior and lateral X-ray views of the ankles and feet were taken for all children.⁷ In the anteroposterior view of the foot, the anterior talocalcaneal angle TCA1 or Kite's angle (normally 20–40°),⁸ anterior talo-first metatarsal angle TFMA1 (normally 0° to –10°, adduction positive),⁸ and calcaneo-fifth metatarsal angle CFMA (normally 0–5°)⁹ were measured. In the lateral view of the foot, the lateral tibio-calcaneal angle TibCA (normally 55–95°),¹⁰ lateral talocalcaneal angle TCA2 (normally 25–50°),⁸ and the lateral talo-first metatarsal angle or Meary's angle TFMA2 (normally 0–5°)⁸ were measured. The variable range of measures of these weight-bearing radiographic angles was recorded; and the mean calculated. The pre-operative mean anterior talocalcaneal angle TCA1 measure was 18° (range, 0–33°), mean anterior talo-first metatarsal angle TFMA1 measure 41° (range, 18–76°), mean calcaneo-fifth metatarsal angle CFMA measure 24° (range, 15–48°), mean lateral tibio-calcaneal angle TibCA was 110° (range 100–120°), mean lateral talocalcaneal angle TCA2 measure 14° (range, 0–32°), and mean lateral talo-first metatarsal angle TFMA2 measure 16° (range, 0–40°).

Operations

All feet underwent decancellation of the cuboid, the calcaneus, and the talus, respectively.

Operative techniques

A longitudinal skin incision was made in the anterolateral aspect of the ankle joint extending from just above the malleoli to the midfoot at the level of the cuboid¹¹ (Fig. 3A). The peroneus longus and brevis tendons were retracted toward the sole of the foot. The extensor digitorum brevis was separated from its origin on the lateral side of the calcaneus and retracted towards the top of the foot, thus giving exposure of the cuboid, anterior portion of the calcaneus, and the neck of the talus. A small puncture was made in these three bones (Fig. 3B). With successively larger curets, the cancellous portion of these bones was removed. All the cancellous bone was removed from the cuboid, while from the calcaneus and talus only the anterior portion was removed.¹² The foot was then overcorrected by manipulation (Fig. 3C). When visible collapse of the bones was not evident after manipulation, the outer shell of the cortical bone of the cuboid and calcaneus was split vertically, with scissors, to allow collapse. If necessary, in older children, a section of the outer shell was removed from these two bones mentioned; and the articulating surface was not disturbed.¹⁵ Intra-operative C-arm image was of help to assess the correction of the bony deformity. The dissected muscle was then sutured in place. The skin was sutured with 0/3 white vicryl subcuticular sutures.

Postoperative care

A well-padded, non-weight-bearing, below knee plaster of Paris (POP) cast was applied in all feet. It was advisable to split the cast in the immediate postoperative period to avoid the complications of oedema. Sutures were removed at 2 weeks and a better fitting, non-weight-bearing cast was applied for a further 4 weeks. A weight-bearing cast was applied till radiographic evidence of bony union, usually at 8–12 weeks. Plastic ankle/foot orthosis (AFO) was worn to prevent relapse. AFO were used for a minimum of 12 months, till the child was able to perform active dorsiflexion and eversion of the foot. Types of AFO and their methods of use were not a part of the current study.

Postoperative evaluation

A period of at least 6 weeks of gait training was instructed to all feet. All feet were assessed clinically and radiographically. A grading system with a total score of 20 marks was suggested. Clinical evaluation included the presence or absence of forefoot adduction (2 marks), supination (2 marks), varus heel (2 marks), ankle equinus (2 marks), tolerability to orthosis (1 mark), and child/parents satisfaction (1 mark). Radiographic evaluation included the degree of

correction of the angle measures by comparing the postoperative measures with those of the pre-operative, giving the anterior talocalcaneal angle (TCA1) measure (1 mark), the anterior talo-first metatarsal angle (TFMA1) measure (2 marks), the calcaneo-fifth metatarsal angle (CFMA) measure (1 mark), the lateral tibio-calcaneal angle measure (2

marks), lateral talocalcaneal angle (TCA2) measure (2 marks), and the lateral talo-first metatarsal angle (TFMA2) measure (2 marks). The feet were graded into four categories as excellent with a total score of 19–20, good with a total score of 16–18, fair with a total score of 10–15, and poor with a total score < 10 (Table 2).

Table 2 Scoring system

Item	Score (marks)
Clinical evaluation (10 marks)	
Adduction deformity (2 marks)	Full correction (no adduction) 2
	Partial correction (adduction < 20°) 1
	Adduction > 5° 0
Supination (2 marks)	Full correction 2
	Partial correction (supination < 20°) 1
	Supination > 20° 0
Hindfoot varus (2 marks)	Full correction 2
	Partial correction (varus < 20°) 1
	Varus > 20° 0
Ankle equinus (2 marks)	Full correction 2
	Partial correction (equinus < 20°) 1
	Equinus > 20° 0
Tolerability to orthosis (1 mark)	Tolerable 1
	Intolerable 0
Patient/parents satisfaction (1 mark)	Satisfied 1
	Unsatisfied 0
Radiographic evaluation (10 marks)	
Anterior talocalcaneal angle TCA1 (1 mark)	20–40° 1
	< 20° 0
Anterior talo-first metatarsal angle TFMA1 (2 marks)	< 10° 2
	10–20° 1
	> 20° 0
Calcaneo-fifth metatarsal angle CFMA (1 mark)	< 10° 1
	> 20° 0
Lateral tibio-calcaneal angle TibCA (2 marks)	< 60° 2
	60–90° 1
	> 90° 0
Lateral talocalcaneal angle TCA2 (2 marks)	20–50° 2
	10–< 20° 1
	< 10° 0
Lateral talo-first metatarsal angle TFMA2 (2 marks)	10–20° 2
	> 20° 1
	< 10° 0
Total score (20 marks)	
Excellent	19–20
Good	16–18
Fair	10–15
Poor	< 10

Results

The twelve children (15 feet) were followed-up for a mean period of 3 years and 4 months, ranging from 3–4 years. The degree of forefoot adduction improved in 12 feet. Only three feet had residual adduction $< 5^\circ$ at the last follow-up. The reasons were severe pre-operative forefoot adduction (two feet), and failure to maintain correction (one foot). The supination, hindfoot varus and equinus improved in all feet (Fig. 4). The range of motion (ankle/foot flexibility) was improved in 12 feet as compared with the pre-operative rigid deformed state. The other three feet remained rigid but plantigrade. There was better tolerability to the foot orthosis in three feet, while all other feet showed no complaints of the footwear. In 12 feet, the patient and/or the parents were satisfied due to the correction of the foot deformity, better footwear, and the overall improvement of the gait. Only in three feet, were the patient and/or the parents dissatisfied because of residual forefoot adduction $< 5^\circ$.

The radiographic weight-bearing angle mean measures

Table 3 Pre- and postoperative radiographic angle measures

Angle	Mean measurements $\pm$ STD (degrees)	
	Pre-operative	Postoperative
TCA1	18 ± 9.2	24 ± 12.3
TFMA1	41 ± 8.9	6 ± 2.1
CFMA	24 ± 6.3	8 ± 3.4
TibCA	110 ± 18.9	70 ± 10.2
TCA2	14 ± 8.4	23 ± 9.4
TFMA2	16 ± 4.6	11 ± 2.2

improved in all of the 15 feet. The mean anterior talocalcaneal angle (TCA1) measure was 24° (range, $16\text{--}40^\circ$) postoperatively as compared with 18° (range, $0\text{--}33^\circ$) pre-operatively. That of the anterior talo-first metatarsal angle (TFMA1) was 6° (range, -10° to -25°) postoperatively as compared with 41° (range, $18\text{--}76^\circ$) pre-operatively. That of the calcaneo-fifth metatarsal angle (CFMA) was 8° (range, $6\text{--}20^\circ$) postoperatively as compared with 24° (range, $15\text{--}48^\circ$) pre-operatively. That of the lateral tibio-calcaneal angle was 70° (range, $55\text{--}100^\circ$) as compared with 110° (range, $100\text{--}120^\circ$) pre-operatively. That of the lateral talo-calcaneal angle (TCA2) was 23° (range, $0\text{--}30^\circ$) postoperatively as compared with 14° (range, $0\text{--}32^\circ$) pre-operatively. That of the lateral talo-first metatarsal angle (TFMA2) was 11° (range, $0\text{--}29^\circ$) postoperatively as compared with 16° (range, $0\text{--}40^\circ$) pre-operatively (Table 3 and Fig. 5).

There was no major complication. Superficial skin sloughing occurred in two feet; both were controlled by debridement, dressing, and antibiotic administration for 2 weeks; and were followed-up for 24 months without recurrence.

Using the grading system for evaluation, six feet (40%) had excellent, six (40%) good, three (20%) fair and none (0%) poor outcome. There was significant improvement in the result ($P > 0.035$).

Discussion

Management of arthrogryptic clubfoot is challenging, as the foot is rigid, and the condition tends to recur.¹⁴ The risk of recurrence continues throughout the period of growth but is more pronounced in infancy.¹⁵

Conservatism by manipulation and casting using Ponseti's method with or without percutaneous Achilles' tenotomy, though instituted soon after birth, is not successful in most of the cases. It is stressful for the family, as it consumes their energy and resources. It should not be continued if improvement has plateaued.¹⁶

Figure 5 Pre- and postoperative angle measures. Pre-operative angle measures (above): (A) anteroposterior view (above, left): TCA1 0°, TFMA1 70°, CFMA 45°; (B) lateral view (above, right): TibCA 100°, TCA2 28°, TFMA2 15°. Postoperative angle measures (below): (C) anteroposterior view (below, left): TCA1 35°, TFMA1 10°, CFMA 18°; (D) Lateral view (below, right): TibCA 80°, TCA2 35°, TFMA2 10°.

A major decision in surgery of the arthrogryptic clubfoot in early childhood is the choice between soft tissue releases, talectomy (astragalectomy) and tarsal decancellation. Soft tissue releases can be used as a preliminary procedure; however, it is insufficient alone in most of the cases to correct the deformity due to joint contracture and rigidity.¹⁷ Talectomy, either as a primary or as a salvage procedure, relaxes the contracture of the hindfoot and midfoot, allowing immediate plantigrade positioning of the foot, is followed by lost normal ankle joint. Recurrence following talectomy is difficult to manage as the primary salvage procedure has already been performed.¹⁸⁻²⁰

The Ilizarov method of external fixation and gradual distraction for treatment of resistant clubfoot deformities results in poor outcome associated with residual or recurrent deformity, often requiring revision surgery.²¹

Triple fusion of the foot by removal of bone and articular cartilage from the subtalar and midtarsal joints, though considered one of the most effective foot operations in orthopaedics, shortens the foot, restricts subtalar and midtarsal motion, and limits subsequent foot growth.²² It is the procedure of choice after skeletal foot maturity in adolescence, but not in early childhood.

The current study shows that tarsal decancellation of the cuboid, anterior part of the calcaneus, and neck of talus in residual resistant arthrogryptic clubfoot corrects all the components of the deformity with neither foot shortening nor deteriorated limited foot motion. Other than two feet with controlled superficial wound slough, no complication was recorded. The future foot growth is by no means affected.

In 1934, Frank *et al.*²³ had 65 out of 69 satisfactorily corrected clubfeet by decancellation. In 1984, Spires *et al.*²⁴ had nine out of 13 satisfactorily corrected clubfeet by similar technique, but with two recurrent feet that necessitated revision of tarsal decancellation.

The clinical and radiographic improvements of the current study are satisfactory as evident by the evaluation pre-set scoring system.

Conclusions

Tarsal decancellation in residual resistant arthrogryptic clubfoot offers many advantages. It allows full correction of the clubfoot at an early age. It is particularly applicable to the resistant and neglected clubfoot. It leaves the foot with a good range of motion; and there is no stiffness which

results from multiple procedures. It shortens the period of treatment, and avoids the dissatisfaction of parents who tire of the length of time taken by the multiple procedures and, therefore, neglect the child. In all the cases, the final results of the current study are satisfactory and the tendency to recurrence, which is found in the manipulative method, has not been evident. There is no interference with the growth of the bones operated upon, but checking the growth might be advisable as there would be fewer tendencies to recurrence of the deformity.

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