Radiographic assessment of congenital talipes equinovarus: strapping versus forced dorsiflexion

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ABSTRACT
Purpose. To compare 2 radiographic assessment methods for congenital talipes equinovarus: strapping the ankle with tapes versus dorsiflexion with a wooden block.
Methods. Anteroposterior and lateral radiographs were taken with the ankle strapped by tapes or dorsiflexed by a wooden block. Talocalcaneal and tibiocalcaneal angles were measured and analysed.
Results. 20 radiographic assessments were performed on 14 patients. From the anteroposterior view, the mean talocalcaneal angle with strapping was 19.4 degrees (range, 0–34.0; standard deviation [SD], 11.2 degrees). From the lateral view, the mean talocalcaneal angle with strapping was 22.0 degrees (range, 8.0–38.8; SD, 8.9 degrees) and with forced dorsiflexion was 21.0 degrees (range, 0–52.7; SD, 11.3 degrees), with a mean absolute difference of 9.4 degrees between the 2 groups. The mean tibiocalcaneal angle with strapping was 77.9 degrees (range, 43.2–120.0; SD, 18.8 degrees) and with forced dorsiflexion was 78.2 degrees (range, 29.5–134.0; SD, 24.7 degrees), with a mean absolute difference of 15.7 degrees between the 2 groups. The difference between the tibiocalcaneal measurements in the 2 groups was statistically significant (p=0.026).
Conclusion. Similar results were obtained for talocalcaneal and tibiocalcaneal angles measured with strapping and forced dorsiflexion. However, the strapping method provides better stabilisation while radiographs are taken.

Key words: clubfoot; equinus deformity; foot deformities; radiography

INTRODUCTION
Congenital talipes equinovarus (TEV), or congenital
clubfoot, is a common clinical problem. Assessment typically includes clinical and radiological methods; unfortunately, there is still no universally accepted grading system. The Dimeglio\textsuperscript{1} and the Pirani\textsuperscript{2} classification systems are the more commonly used clinical grading systems. However, Pirani’s system is not sensitive: assessors tend to give a diagnosis of moderate abnormality as there are only 3 levels of scoring (0 for no, 0.5 for moderate, 1 for severe), and clinicians tend to resist scoring extremes. For radiological assessment, anteroposterior and forced dorsiflexion are the most widely used views; however, there is no standard radiographic method. In the 1970s, Simons\textsuperscript{3,4} took radiographs of TEV patients by manually holding the child’s foot in the maximum correction position, but this position may vary.

We describe a strapping method for immobilising congenital TEV patients and compare radiographic measurements of the ankle and foot using strapping and forced dorsiflexion.

**MATERIALS AND METHODS**

We retrospectively reviewed 14 patients (age, <3 months) diagnosed with congenital TEV who underwent treatment programme of the Duchess of Kent Children’s Hospital in Hong Kong between November 1995 and March 2003. All had severe or very severe structural clubfoot deformities according to the Dimeglio\textsuperscript{1} classification. Patients with postural-type TEV or TEV associated with other congenital malformations such as arthrogryposis multiplex congenita and spinal dysraphism were excluded.

Patients received manipulation and strapping by physiotherapist 5 days a week until they underwent surgery at the age of around 6 months. The manipulation method was based on the description by McKay,\textsuperscript{5–7} and the strapping method was developed in our centre. After each manipulation session, the ankle/foot was strapped with a plastic, radiolucent foot plate (Fig. 1) and tapes. Skin Prep wipe (Smith & Nephew, Largo [FL], US) was applied to the foot and leg to reduce allergic reactions and protect the skin. The foot plate was secured to the sole using non-elastic tapes after the wipe dried. Three adhesive tapes were applied: the first was put at the site of the Achilles tendon insertion to grip the calcaneus, the second was placed inferior to the hindfoot to control the ankle, and the last was placed inferior to the forefoot (Fig. 2). Straps were then put around the foot and knee, and cotton wool was placed to the thigh to reduce pressure and irritability from the tapes. The knee was then flexed maximally. The ankle (with the foot plate) was

![Figure 1](https://example.com/figure1.png) Foot plates are made of plastic and are radiolucent.

![Figure 2](https://example.com/figure2.png) (a) Lateral and (b) anteroposterior views: 3 adhesive tapes are applied: the first is placed at the site of the Achilles tendon insertion to grip the calcaneus (1). The second is placed inferior to the hindfoot to add control of the ankle (2). The last is placed inferior to the forefoot (3).

![Figure 3](https://example.com/figure3.png) (a) Anteroposterior and (b) lateral views: transverse tapes were applied anterior to the ankle joint and shin to achieve further anchorage.
stretched to the best correctable position (Fig. 3). Care was taken to avoid applying pressure at the forefoot to prevent the mid-foot from breaking.

Three long tapes were then applied from the plantar surface, along the lateral side surrounding the thigh, and back to the plantar surface. The first tape began at the heel and was used to control the subtalar joint eversion. The second began slightly towards the toes and served to control eversion and dorsiflexion. The third began around mid-foot and served to provide a maximum amount of dorsiflexion. Finally, transverse tapes were applied anterior to the ankle joint and shin to achieve further anchorage (Fig. 3). If the child was too irritable, the tapes could be loosened manually by adjusting the transverse and long tapes. The tapes and foot plate were kept in place overnight and removed the next morning.

Radiographs were usually taken at 3 months of age (range, 1–7 months). Lateral radiographs were taken with the strapping in situ (Fig. 4a), whereas anteroposterior radiographs were taken with the transverse and long tapes loosened or removed so
that the knee and tibia did not block the X-ray (Fig. 4b). Lateral radiographs of forced dorsiflexion were taken with an assistant holding a wooden block against the sole of the foot (Fig. 5a), whereas anteroposterior radiographs were taken in a standard fashion (Fig. 5b).

Radiographs were measured by a senior orthopaedic surgeon. The talocalcaneal angle was the angle formed by the long axes of talus and calcaneus in the anteroposterior and lateral radiographs. The tibiocalcaneal angle was the angle between the long axes of the tibia and calcaneus in the lateral view.

RESULTS

20 radiographic assessments were performed on 14 patients: 4 had bilateral congenital TEV, 2 had 2 sets taken at different ages. All patients eventually received surgical release. In anteroposterior radiographs, only the talocalcaneal angle using strapping produced usable measurements (mean, 19.4°; range, 0°–34.0°; standard deviation [SD], 11.2°). The talocalcaneal angle using forced dorsiflexion and the tibiocalcaneal angle using either strapping or forced dorsiflexion were not available because it was very difficult to hold the block and feet while the radiograph was taken. Even when the children could be held stationary in the proper position, the holder’s hands would block the X-ray. In lateral radiographs, the mean talocalcaneal angle using strapping was 22.0° (range, 8°–38.8°; SD, 8.9°), whereas using forced dorsiflexion the mean was 21.0° (range, 0°–52.7°; SD, 11.3°), with a mean absolute difference of 9.4° between the 2 groups. The mean tibiocalcaneal angle using strapping was 77.9° (range, 43.2°–120.0°; SD, 18.8°), whereas using forced dorsiflexion the mean was 78.2° (range, 29.5°–134.0°; SD, 24.7°), with a mean absolute difference of 15.7° between the 2 groups (Table 1).

Data were analysed using paired t-test of the Statistical Package for the Social Sciences (Windows version 10.0; SPSS Inc, Chicago [IL], US). Three paired data sets were used to compare strapping versus forced dorsiflexion: talocalcaneal angle in anteroposterior view, talocalcaneal angle in lateral view, and tibiocalcaneal angle in lateral view. There was a significant difference between strapping and forced dorsiflexion in tibiocalcaneal angle from the lateral view (p=0.026) [Table 2].

DISCUSSION

Radiographic assessment for congenital TEV is a common practice.\(^3,4,8\) In the Nuffield Orthopaedic Centre in Oxford, UK, congenital TEV patients were assessed using anteroposterior radiographs with the foot held in 20° equinus after receiving one month of strapping and manipulation.\(^9\)

Napiontek\(^10\) also used radiographs—both lateral and anteroposterior views—to assess congenital TEV. He found a mean tibiocalcaneal angle of 77.9° (range, 55°–94°) among 49 feet. The mean tibiocalcaneal angle obtained in the present study was 77.9° for strapping and 78.2° for forced dorsiflexion. Other clinicians have used more sophisticated imaging techniques to assess the deformity of congenital TEV. Cahuzac et al.\(^11\) investigated hindfoot deformity using 3-dimensional magnetic resonance imaging (MRI) and found no statistically significant medial deviation of the talus. Although 3-dimensional MRI can give more information about the orientations of the subtalar joint, it is not cost-effective or clinically useful. MRI can provide a detailed configuration of the clubfoot deformity and progression of conservative treatment; however, surgical decision-making does not depend on diagnostic images but rather on clinical appearance.

In the present study, no significant difference was found in the talocalcaneal angle between strapping and forced dorsiflexion on the lateral view. However, the difference shown on the anteroposterior and lateral views of tibiocalcaneal angle was statistically significant (p=0.026) and showed a better correction of equinus using strapping. The strapping method provides a standard means of preparing patients for radiographs and can reliably position the ankle and foot in maximum dorsiflexion to obtain good anteroposterior and lateral radiographs. The foot plate is important in the strapping method. It provides a

| Talocalcaneal angle | Strapping (mean, range) | Forced dorsiflexion (mean, range) |
|--------------------|------------------------|----------------------------------|
| Anteroposterior    | 19.4° (0°–34.0°)       | NA*                              |
| Lateral            | 22.0° (8.0°–38.8°)     | 21.0° (0°–52.7°)                 |

| Tibiocalcaneal angle | Strapping (mean, range) | Forced dorsiflexion (mean, range) |
|---------------------|------------------------|----------------------------------|
| Anteroposterior     | NA                     | NA                               |
| Lateral             | 77.9° (43.2°–120.0°)   | 78.2° (29.5°–134.0°)             |

* NA not available
good grip surface for the tapes to hold the hind foot, protects the child’s skin from tape irritation, and has a vertical extension at the medial side to correct the metatarsal adduction commonly present in congenital TEV.

CONCLUSION

The strapping method is a valuable diagnostic technique for congenital TEV. It provides rigid positioning during radiography and facilitates radiographic assessment. The tibiocalcaneal angle measured from lateral radiographs with strapping is significantly different from that provided by forced dorsiflexion. This is probably due to the improved equinus correction provided by strapping.

Both talocalcaneal and tibiocalcaneal angles measured with strapping and forced dorsiflexion give similar results. However, the strapping method provides a better ankle dorsiflexion angle, and thus is a better way to objectively assess TEV.

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REFERENCES

1. Dimeglio A, Bensahel H, Souchet P, Mazeau P, Bonnet F. Classification of clubfoot. J Pediatr Orthop B 1995;4:129–36.
2. Pirani S, Oterbridge H, Moran M, Sawatsky B. A method of evaluating the virgin clubfoot with substantial inter-observer reliability. POSNA, Miami, Florida, 1995.
3. Simons GW. Analytical radiography of club feet. J Bone Joint Surg Br 1977;59:485–9.
4. Simons GW. Complete subtalar release in club feet. Part II—comparison with less extensive procedures. J Bone Joint Surg Am 1985;67:1056–65.
5. McKay DW. New concept of and approach to clubfoot treatment: section II—correction of the clubfoot. J Pediatr Orthop 1983;3:10–21.
6. McKay DW. New concept of and approach to clubfoot treatment: section III—evaluation and results. J Pediatr Orthop 1983;3:141–8.
7. McKay DW. New concept of and approach to clubfoot treatment: section I—principles and morbid anatomy. J Pediatr Orthop 1982;2:347–56.
8. Beatson TR, Pearson JR. A method of assessing correction in club feet. J Bone Joint Surg Br 1966;48:40–50.
9. Tibrewal SB, Benson MK, Howard C, Fuller DJ. The Oxford club-foot programme. J Bone Joint Surg Br 1992;74:528–33.
10. Napiontek M. Clinical and radiographic appearance of congenital talipes equinovarus after successful nonoperative treatment. J Pediatr Orthop 1996;16:67–72.
11. Cahuzac JP, Baunin C, Luu S, Estivalez E, Sales de Gauzy J, Hobatho MC. Assessment of hindfoot deformity by three-dimensional MRI in infant club foot. J Bone Joint Surg Br 1999;81:97–101.