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## Split anterior tibial tendon transfer (Splatt) to the peroneus brevis/tertius for the correction of varus foot deformity in children: A case series

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### Abstract

**Objective:** The purpose of the study was to determine the safety/efficacy of a split anterior tibialis tendon transfer (SPLATT) to the peroneus brevis/tertius in children with varus feet.

**Methods:** This is a case series of 5 children with varus foot who had undergone split anterior tibialis tendon transfer (SPLATT) to the peroneus brevis/tertius. The principal outcome measures were changes in pain (measured by likert scale), difficulty with shoe wear (measured by mean difference in pre and post op scores) and radiological parameters obtained from anteroposterior and lateral radiographs of the affected foot before and after surgery. Each case was followed up for 1 year.

**Results:** After surgery foot pain and problems with shoe wear improved. The radiological criteria also showed a clinically and statistically significant ( $p < 0.001$ ) improvement at follow-up, the majority being in the normal range.

**Conclusion:** Soft-tissue surgery in the form of SPLATT was successful in the majority of children with varus deformity of foot resulting in a plantigrade, flexible foot with minimal pain or limitations in shoe-wear.

**Keywords:** Equinovarus, Split anterior tibial tendon transfer, SPLATT, Likert scale, Tibiocalcaneal angle, Navicular cuboid overlap, Anteroposterior talo-1<sup>st</sup> metatarsal angle

### Introduction

The second most common deformity of the foot and ankle is the cavo varus deformity following equinus [1-3]. The varus component is considered to be the result of muscle imbalance between the inverters and evertors of the foot and ankle [1, 2]. More specifically, tibialis anterior (TA) and tibialis posterior (TP) overpower the peroneal muscles [4-6]. Descriptions of the surgical technique for SPLATT include transfer of the lateral half of the split tendon to a bony tunnel in either the cuboid or the base of the fifth metatarsal [9, 10]. Tendon to bone may require suturing over a plantar button or felt pad and may result in skin ulceration, plantar sensitivity and failure of the tendon transfer. Other techniques include the use of interference screws or a suture anchor [11, 12].

The peroneus brevis (PB) is a widely recognized recipient for transfer for TP for SPOTT procedures but there are few reports of PB being used as a recipient for SPLATT [5, 8, 13]. We considered that PB/peronius tertius would be a good-recipients due to its anatomical consistency in both substance and length providing reliable tendon to tendon healing. The aim of this study is to report the safety and efficacy of soft-tissue surgery, incorporating split transfer of TA to peronius brevis/peronius tertius for children with varus feet.

### Material and methods

#### Patients

The study was conducted in the Department of Orthopaedics, North Eastern Indira Gandhi Regional Institute of Health and Medical Sciences, Shillong from July 2021 to October 2021. A total of 5 children (3 male, 2 female) were included in the study after obtaining informed and written consents from their parents. Our inclusion criteria were: 1. ambulatory or potentially ambulatory patients with cerebral palsy, 2. age no less than 5 years at the time of the operation, 3. flexible varus foot deformity.

The deformity was recognized by the typical clinical appearance, confirmed by physical examination coleman block test, silverskoid test and radiographs of both feet. All

children were followed up for a period of 1 year. (Table 1) Preoperative deformity is shown in Figure 1(A-B)

**Table 1:** Patients included in the study

| Cases  | Age (years) | Sex    | Extremity | Procedure Undertaken      |
|--------|-------------|--------|-----------|---------------------------|
| Case 1 | 5           | Male   | Right     | Splatt +Steindler release |
| Case 2 | 7           | Male   | Left      | Splatt                    |
| Case 3 | 6.5         | Female | Right     | Splatt+TA lengthening     |
| Case 4 | 5.5         | Male   | Right     | Splatt                    |
| Case 5 | 6           | Female | Left      | Splatt                    |



**Fig 1:** (A, B) Preoperative foot A. Posterior and B. Anterior view. Right feet show varus deformity

### Surgical Technique

The procedures were performed under tourniquet control. Three incisions were made: a 3 to 4 cm oblique incision over the distal course of the anterior tibial tendon, a 4 to 5 cm longitudinal incision lateral to the tibial crest over the anterior lower leg, and a 1.5 to 2 cm oblique incision just distal to the ankle joint, immediately lateral to the toe extensor tendons (Figure 2, A). The plantar half of the anterior tibial tendon was harvested through the distal, medial incision and a whip stitch was placed through the distal stump. A tendon passer was passed from the lower leg incision (deep to the extensor retinaculum) to retrieve the whip stitch previously placed through the distal stump of the split AT tendon. Because the suture was retrieved, the tendon split in half. This was brought proximally, although with a tendon-to-tendon transfer, obtaining sufficient tendon length was almost never an issue (Figure 2, B). The peroneus tertius was located deep to the extensor retinaculum, immediately adjacent to the long extensor to the fifth toe. (Figure 2, C) For accurate tendon identification, tension was exerted the peroneus tertius to (1) make the distal course of the tendon evident, (2) evert the

foot, and (3) ensure it did not move the fifth toe. If the peroneus tertius was either absent or quite hypotrophic, the dorsal half of the peroneus brevis was used to receive the transfer. In such cases, the peroneus brevis was split longitudinally, left connected distally, and the dorsal half was transected proximally in the hindfoot. A whip stitch was placed in the tendon stump. The split anterior tibial tendon was passed outside the retinaculum to the dorsolateral hindfoot and attached to peroneus tertius (Figure 3, A and B). All incisions, except that through which the tendon transfer was to be completed, were closed in a standard fashion. After all other incisions were closed, the tendon transfer was completed in a side-to-side fashion with two or three nonabsorbable 3-0 sutures, with the ankle held in neutral dorsiflexion and the foot in eversion. The final incision was closed, and the foot was maintained in this position until short leg casting was completed. Casting was for 6 weeks and part-time brace wear (for at least 6 to 8 hours daily) was used until at least 6 months postoperatively. All patients were again followed up at 1 year.

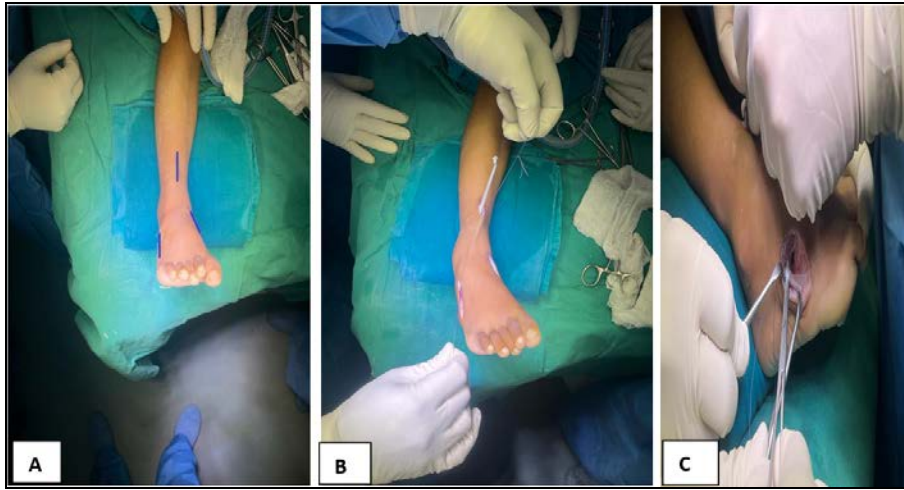


Fig 2: (A, B, C) A: The three incision sites. B: Tibialis anterior tendon harvested and split C. Peronius tertius located

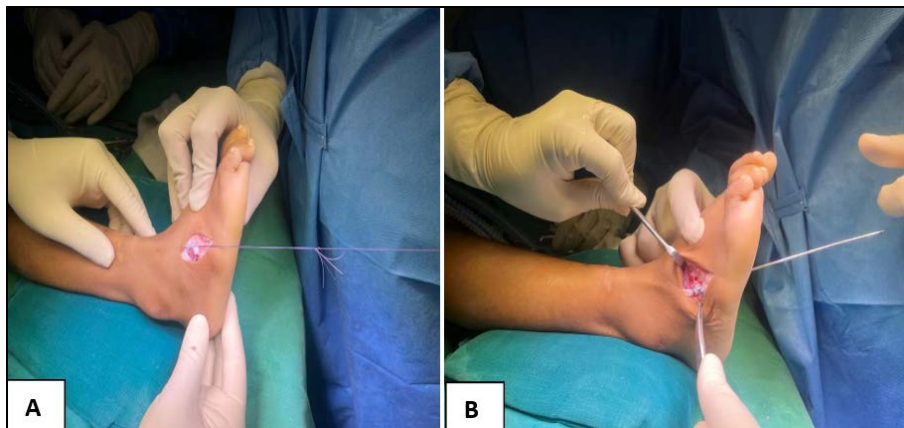


Fig 3: (A, B): Attachment of split tibialis anterior to peronius tertius

**Outcome Assessment**

Symptoms related to pain and difficulties with brace or shoe-wear were assessed using a nine-point Likert Scale, with 0 indicating no pain or no difficulties with shoe-wear or brace-wear and 9 indicating either severe pain or being unable to use a brace or regular shoes. Radiological parameters were measured from digital radiographs (Figure 4) using the Patient Archive Communication System (PACS, Fujifilm Medical System USA, Lexington, Massachusetts, United States) and associated online tools. The radiographic criteria were chosen

to permit assessment of the hind foot, midfoot and forefoot. The measures were: hindfoot: tibiocalcaneal angle and lateral tibiocalcaneal angle; midfoot: navicular cuboid overlap and talonavicular coverage angle; forefoot: lateral talo-1st metatarsal angle, anteroposterior talo-1st metatarsal angle and the metatarsal stacking angle. All angles were measured by one observer (bd) using tools on the PACS and all radiographic measures were performed as described by Davids *et al.* [15].

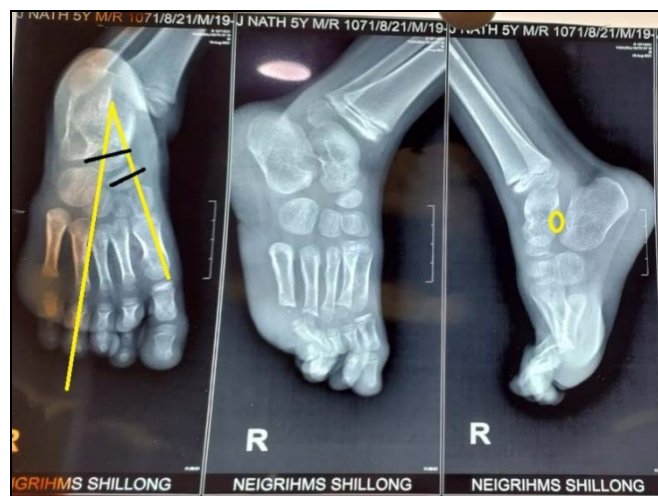


Fig 4: Digital radiograph of the patient from which all radiological parameters were calculated. AP view: The landmarks for measuring the talonavicular-coverage angle is indicated in black. The talo 1<sup>st</sup> metatarsal angle is indicated in yellow. LAT view: The wide opening of the sinus is noted.

## Result

### Pain and function

The change in pain scores as measured by the Likert scale, on mean shifted by one unit (95% confidence interval (CI) 0.5 to 1.4;  $p < 0.001$ ) from 2.7(SD=1.2) to 1.7(SD=0.8). For shoe

wearing difficulty the mean difference between pre-and post-scores was 2.46 (95% CI 2.1 to 2.8;  $p < 0.001$ ; pre-score 4. (SD=1.3), post-score 1.8(SD=0.9). The changes on both measures are considered clinically important.



Fig 5 (A, B): A: At 6 month follow up. B: At 1 year follow up

### Radiographic outcomes

The mean pre- and post-values for the six radiographic measures are compared. The mean preoperative values differ substantially compared with normal. There is an overall trend towards normal for postoperative means [14, 15].

The TCA and LTCA are positive values and a reduction is interpreted as a move from varus towards normal. NCO can

be negative (no overlap) in a severe varus foot and moves into the positive range after surgery. LT1stMTA and APT1stMTA are negative in most varus feet and move into positive range after surgery. (Table 2). These improvements are significant clinically and statistically ( $p < 0.001$ ). During follow up in no case did we encounter skin ulceration, plantar sensitivity or failure of the tendon transfer.

Table 2: Comparison of normal, preoperative and final postoperative radiographic measurements

| Parameters   | Normal range (+/- 2 SD) | Preoperative mean (range) | Postoperative mean (range) | Change preoperative to postoperative (95% confidence interval) | p-value |
|--|-------------------------|---------------------------|----------------------------|--|---------|
| Tibiocalcaneal angle (TCA), °                            | 67 (52.2 to 85.8)       | 89.2 (48.0 to 128.0)      | 66.5 (44.0 to 86.0)        | 21.3 (16.4 to 28.1)  | < 0.001 |
| Lateral talocalcaneal angle (LTCA), °                    | 50 (35.2 to 62.8)       | 22 (2.0 to 39.0)          | 46.2 (8.0 to 72.0)         | -21.5 (-24.5 to -18.6)   | < 0.001 |
| Navicular cuboid overlap, NCO%                           | 46 (19.4 to 74.6)       | 21 (30.0 to 33.0)         | 43.3 (0.0 to 89.0)         | -42.5 (-47.7 to -35.2)   | < 0.001 |
| Talonavicular coverage angle, °                          | 19 (0.4 to 39.6)        | -28.2 (-49.0 to -11.0)    | 20.3 (-33.0 to 68.0)       | -50.2 (-56.2 to -46.7)   | < 0.001 |
| Lateral talo-1st metatarsal angle (LT1stMTA), °          | 14 (-2 to 28)           | -9.8 (-33.0 to 4.0)       | 12.6 (-28.0 to 40.0)       | -24.7 (-27.3 to -20.1)   | < 0.001 |
| Anteroposterior talo-1st metatarsal angle (APT1stMTA), ° | 11 (-4 to 24)           | -21.5 (-54.0 to 28.0)     | 8.7 (-38.0 to 36.0)        | -30.2 (-36.0 to -26.3)   | < 0.001 |

### Discussion

The results of our study are comparable to the studies conducted in yesteryears. Kling *et al.* [17]. Used a split PT tendon transfer to the peroneus brevis in 31 children with CP (average age 8.0 years) and spasticity of the PT tendon throughout the gait cycle. At an average of 8.0 years of follow-up, there were 34 patients with excellent or good results (91.9%) and two complications (6%), including skin flap necrosis and one superficial wound infection. In a study of 73 feet (69 patients with average age 46.5 years) that underwent a SPLATT to the cuboid for spastic equinovarus foot deformities, Vogt reported notable improvement in patient autonomy at an average follow-up of 44 months, including improved ability to ambulate independently, decreased need to wear orthopaedic shoes and orthoses, and increased ability to wear normal shoes [18].

In this study we included radiographic criteria which can assess the static morphology of the hindfoot, midfoot and forefoot. These criteria described by Davids *et al.* [14] have

been shown to have convergent validity with dynamic pedobarography by Lee *et al.* [15]. It is reassuring to know that these criteria which are easily available, are useful both for surgical planning and as outcome measures [1, 2, 13, 15, 16]. The results of our study are comparable to the findings of the above study.

The strengths of our study included a relatively uniform approach to surgical prescription, combination of patient-reported (likert scale) and objective radiological outcome measures. There were a number of limitations in our study. The sample size was small. The average length of our follow-up was 1 year, which may limit our ability to accurately account for all long-term complications and assess changes in the functional outcomes over the long term as children grow. Also there was a lack of a validated patient reported outcome measures (PROMS) such as the Oxford Foot and Ankle Scale, and investigations such as a segmental foot model for motion analysis and dynamic electromyography EMG [1, 2, 5-7, 19].

In future, the addition of pedobarography, foot alignment

assessments such as the Foot Posture Index, and even the use of a multisegmental kinematic foot model would be useful to assess the magnitude of deformity and surgical outcome.

### Conclusion

Based on the findings of our study we conclude that SPLATT to the peroneus tertius or brevis is a safe and effective for treatment of varus foot deformities in children. Complications are rare, and no major wound issues were seen.

### Declaration of conflicting interests

The authors declared no potential conflicts of interest with respect to the research, authorship, and/or publication of this article.

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### Conflict of Interest

Not available

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