

ERRORS AND COMPLICATIONS IN SURGICAL TREATMENT OF NON-STABLE EQUINO-PLANO-VALGUS FOOT DEFORMITY IN PATIENTS WITH CEREBRAL PALSY, WITH USE OF THE CALCANEUS CORRECTING OSTEOTOMY TECHNIQUE

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Aims. To examine the results of treatment for patients with a non-stable form of equino-plano-valgus foot deformity in cerebral palsy with the use of corrective osteotomy of the calcaneus. To further analyze the errors and complications that occurred in patients treated with this technique.

Materials and methods. From 2006 to 2014, 64 patients (103 feet) aged 3 to 17 years were operated using the described method of calcaneus correcting osteotomy. The equinus contracture was eliminated by transection of the gastrocnemius muscle tendon and extending achilloplastic surgery. The abnormal muscle tone was reduced either by administering the drug Dysport into the gastrocnemius muscle or by selective neurotomy of the tibial nerve.

Results. The analysis revealed that there were good results for 75%, satisfactory results for 18%, and unacceptable results for 7% of patients. The unacceptable results of treatment were due to several technical and tactical errors, which were grouped and analyzed.

Conclusion. The analysis of errors and complications of calcaneus corrective osteotomy for patients with cerebral palsy with a mobile form of talipes equinoplanovalgus will enable their future avoidance and improvement of the treatment quality.

Keywords: cerebral palsy, talipes equinoplanovalgus, osteotomy of the calcaneus.

ОШИБКИ И ОСЛОЖНЕНИЯ ПРИ ХИРУРГИЧЕСКОМ ЛЕЧЕНИИ МОБИЛЬНОЙ ЭКВИНО-ПЛАНО-ВАЛЬГУСНОЙ ДЕФОРМАЦИИ СТОП У БОЛЬНЫХ ДЕТСКИМ ЦЕРЕБРАЛЬНЫМ ПАРАЛИЧОМ С ИСПОЛЬЗОВАНИЕМ МЕТОДИКИ КОРРИГИРУЮЩЕЙ ОСТЕОТОМИИ ПЯТОЧНОЙ КОСТИ

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Цель исследования. Изучить результаты лечения пациентов с мобильной формой эквино-плано-вальгусной деформации стопы при детском церебральном параличе с использованием корригирующей остеотомии пяточной кости по авторской методике. Проанализировать ошибки и осложнения, имевшие место при лечении больных с использованием данной методики.

Материалы и методы. С 2006 по 2014 г. с использованием описанного способа выполнения корригирующей остеотомии пяточной кости прооперировано 64 пациента (103 стопы) в возрасте от 3 до 17 лет. Эквинусную контрактуру устраняли посредством пересечения сухожилия икроножной мышцы и удлиняющей ахиллопластики. Патологический мышечный тонус снижали с помощью введения препарата «Диспорт» в икроножную мышцу или селективной невротомии большеберцового нерва.

Результаты. Проведенный анализ показал, что хороших результатов было 75 %, удовлетворительных — 18 %, неудовлетворительных — 7 %. Неудовлетворительные результаты лечения были связаны с рядом технических и тактических ошибок, которые сгруппированы и проанализированы.

Заключение. Анализ ошибок и осложнений, имевших место при лечении пациентов с детским церебральным параличом с мобильной формой эквино-плано-вальгусной деформации стопы с применением корригирующей

остеотомии пяточной кости, позволит избежать их в дальнейшем и повысить качество лечения данной группы больных.

Ключевые слова: детский церебральный паралич, эквино-плано-вальгусная деформация стоп, остеотомия пяточной кости.

Introduction

The possibilities of effective surgical correction of the mobile talipes equinoplanovalgus in patients with infantile cerebral palsy have always been of great interest to specialists who treat patients with spastic paralyses [1, 2]. This is mainly because restoring the shape and function of the foot is more promising in this deformity than in the rigid type deformities. Among the methods of surgical treatment currently available, a special niche has always been occupied by corrective osteotomy of the calcaneus [3, 4], because of its compatibility with normal anatomy and physiology. This is because they improve the cushioning function of the foot and not interfering with normal joint movements of the foot.

For several years, our department has been actively using corrective osteotomy of the calcaneus for surgical correction of the mobile talipes equinoplanovalgus [5].

Aim

To analyze the most common tactical and technical errors associated with corrective osteotomy of the calcaneus for the treatment of mobile talipes equinoplanovalgus in pediatric patients with infantile cerebral palsy

Patients and Methods

From 2006 to 2014, we operated on 64 patients (103 feet) aged 3 to 17 years. A written, informed consent to participate in the study and to perform a surgical intervention was signed by each patient's parent or guardian.

Indications for corrective osteotomy of the calcaneus included patients with infantile cerebral palsy, age 3 to 17 years, mobile form of talipes equinoplanovalgus with the absence of the longitudinal arch, and valgus position of the heel $>10^\circ$.

The surgical intervention proposed by us is based on the principle of extraarticular implementation of calcaneus osteotomy in the space between the posterior and middle facettes of the subtalar

joint. According to some anatomical studies [6], in 99% of cases, the area of intersection of the calcaneus was located outside the articular facettes of the subtalar joint. The surgical intervention was performed from the lateral and medial sides of the foot. The first incision was performed on the medial surface of the foot from the projection of the talocalcaneonavicular articulation to the posterior edge of the inner malleolus. After incision of the skin, the subcutaneous adipose tissue and the dorsal fascia of the foot, the tendons of the posterior tibial muscle, the long flexor muscle of the toes, and the long flexor muscle of the first toe were mobilized. Then, arthrotomy of the talocalcaneonavicular articulation was performed to ensure that a powerful fragment of the joint capsule remained attached to the sustentaculum tali. Then, arthrotomy of the subtalar joint was performed to visualize its articular facettes and to select an optimal direction for future osteotomy. After dissection of the periosteal covering, a "stepped" osteotomy of the calcaneus was performed (Fig. 1). On the lateral surface of the foot, the incision was made from the posterior edge of the lateral malleolus to the distal end of the ankle sinus. After incision of the skin, the subcutaneous adipose tissue and the dorsal fascia of the foot and the tendons of the peroneal muscles were mobilized. Arthrotomy of the subtalar joint was performed, followed by dissection of the talocalcaneal ligament. The plantar ligament was bluntly separated and dissected. After incision of the periosteal coverage, osteotomy of the calcaneus was performed in the direction opposite to the osteotomy performed from the internal access (Fig. 2). A fragment of the calcaneus (including the sustentaculum tali) obtained from osteotomy was transposed superomedially and externally rotated. The purpose of these displacements was to create a reliable support for the head and neck of the ankle bone in the form of the sustentaculum tali, which normalized the ratio of the bones in the subtalar joint and talocalcaneonavicular articulation. After adequate displacement, fragments of the calcaneus were fixed with Kirschner's wires (Fig. 3). Before

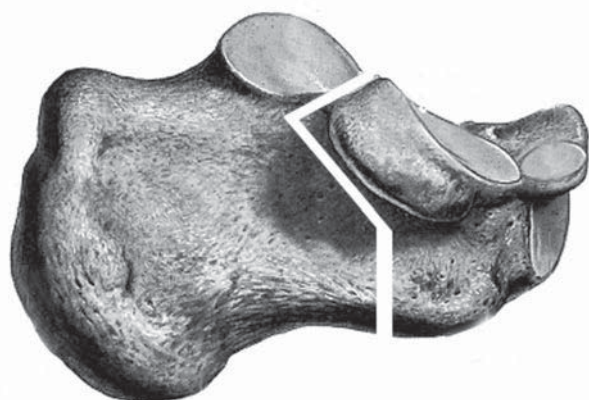


Fig. 1. Direction of osteotomy of the calcaneus from access on the medial surface of the foot

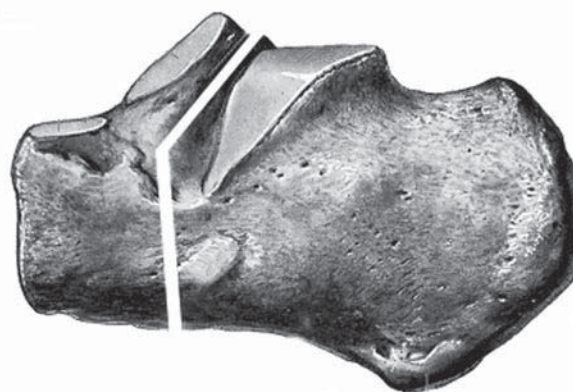


Fig. 2. Direction of osteotomy of the calcaneus from access on the lateral surface of the foot

suturing the wound along the medial surface of the foot, the inner part of the capsule of the talocalcaneonavicular articulation was strengthened with the use of its duplication which was formed by sutures using thick lavsan threads.

The equinus contracture was eliminated by lengthening achilloplastic surgery or the recession of the gastrocnemius muscle tendon (Strayer surgery) simultaneously with corrective osteotomy of the calcaneus. In cases where the triceps muscle of the lower leg was highly spastic, muscle tone was reduced by intramuscular injections of abobotulinumtoxinA (Dysport®) into the gastrocnemius muscle or by selective neurotomy of the branches of the tibial nerve. We administered Dysport in five cases and performed selective neurotomy in three cases.

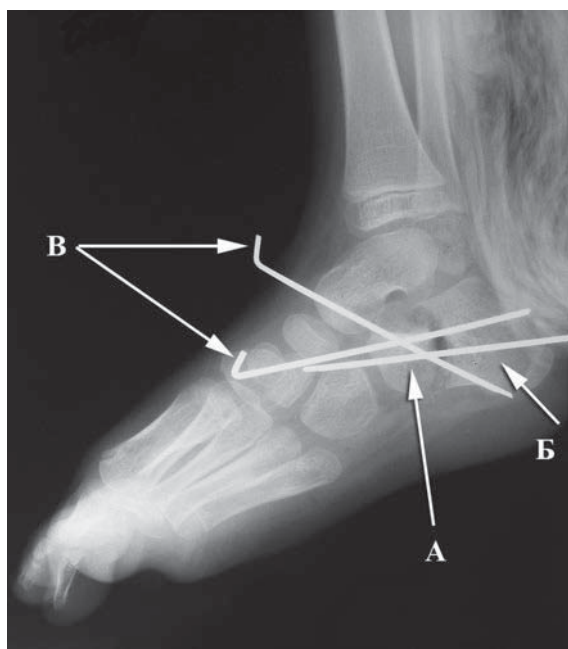


Fig. 3. Intraoperative X-ray image of the foot after corrective osteotomy of the calcaneus. A - anterior fragment of the calcaneus; B - posterior fragment of the calcaneus; B - fixing wires

Indications for neurotomy included included triceps muscles of the lower leg having a score of higher than 3 on the Ashworth scale in combination with pronounced clonus of the foot.

Results

Treatment results were evaluated six or more months after the start of walking. The observation period was from six months to eight years.

Equinus was present in 92.0% of cases (95 feet). Achilloplastic surgery was performed in 26 feet, and Strayer surgery was performed in 69 feet. The following parameters were used to evaluate the procedure's success: 1) the degree of correction of the heel valgus; 2) the degree of correction of the longitudinal arch of the foot relative to the initial; 3) the absence/presence of complications; 4) the degree of correction of the angle of the longitudinal arch; and 5) the degree of correction of the angle of the astragalocalcaneal divergence.

The results were considered good if the heel valgus was 0°–6°, the longitudinal arch was enlarged by more than 70% relative to the baseline, there were no complications, the angle of the longitudinal arch was enlarged by no more than 5°, and the angle of the astragalocalcaneal divergence was increased by no more than 5°.

The results were considered satisfactory if the heel valgus was 6°–10°, the longitudinal arch is enlarged by less than 70% but no more than 50% relative to the baseline, there were no complications, the angle of the longitudinal arch was enlarged by no more than 15°, and the angle of the astragalocalcaneal divergence was no more than 10°.

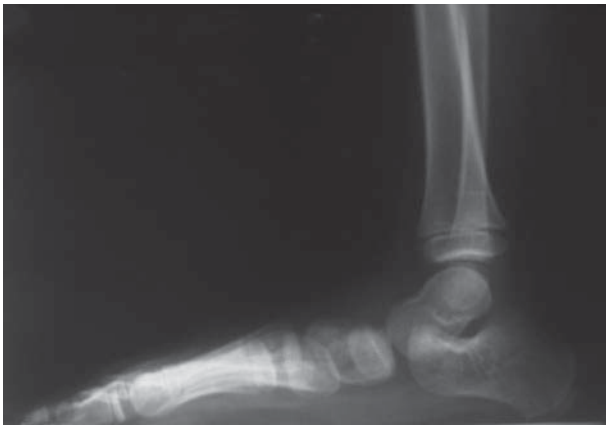


Fig. 4. X-ray image of the right foot in the lateral projection before surgery in a 5-year-old patient with cerebral palsy, spastic diplegia, and talipes equinoplanovalgus



Fig. 5. X-ray image of the right foot of the same patient 1 year 7 months after corrective osteotomy of the calcaneus and the recession of the tendon of the gastrocnemius muscle

The results were considered poor if the heel valgus was more than 10° , the longitudinal arch was enlarged by less than 50% relative to the baseline, there were complications with any clinical result of treatment, the angle of the longitudinal arch was enlarged by more than 15° , and the angle of the astragalocalcaneal divergence was increased by more than 10° .

We observed good, satisfactory, and poor results in 75% (77 feet), 18% (19 feet), and 7% (7 feet) of patients.

We administered abobotulinumtoxinA in five cases and performed selective neurotomy in three cases. Tonus-reducing measures led to a decrease in the tone of the triceps muscle of the lower leg on average to 1.5 points.

A clinical observation is given below as an example of a good result.

Patient B was (age, 5 years) diagnosed with cerebral palsy, spastic diplegia, and talipes equinoplanovalgus; the patient underwent corrective osteotomy of the calcaneus and Strayer recession of the tendon of the gastrocnemius muscle (Fig. 4, 5).

Poor results of treatment were associated with diagnostic errors (reassessment of the degree of the deformity mobility), as well as tactical and technical errors in surgical treatment.

The following tactical errors occurred: 1) incomplete correction of equinus contracture (three cases) and 2) reassessment of the degree of the deformity mobility (two cases).

There were also technical errors. We observed the following: 1) fracture of the calcaneus at the base of the sustentaculum tali during transposition of the distal fragment of the calcaneus (one case)

and 2) excessive displacement of the distal fragment of the calcaneus bone during its lateral movement resulting in hypercorrection (one case).

Discussion

Correction of concomitant equinus contracture was a very important component of the surgical intervention that we used. The method of eliminating the contracture was chosen depending on the results of the Silverskiöld's test. With a negative test result, we performed elongating achilloplastic surgery, and with a positive test result, we intersected the tendon stretching the gastrocnemius muscle. In case of unconvincing results, we always preferred achilloplastic surgery over the other method. In cases where the equinus contracture was tonic, the tone of the triceps muscle of the lower leg was reduced by selective neurotomy of the branches of the tibial nerve or by administration of abobotulinumtoxinA into the gastrocnemius muscle.

The degree of mobility associated with the deformity is partly subjective, and in evaluating the foot by this characteristic, erroneous conclusions are possible. Rotation of the scaphoid bone, which often occurs with severe degrees of deformity accompanied by a change in the position of its tuberosity and hypertrophy of the latter, can create a false impression of the completeness of reduction of the ankle bone head to the talocalcaneonavicular articulation.

Fracture of the calcaneus at the base of the ankle bone retinaculum was the most severe technical error of the surgical intervention we have described. In most cases, we performed corrective osteotomy

of the calcaneus in patients with significantly limited motor activity, and consequently, with varying degrees of osteoporosis of the calcaneus. The presence of osteoporosis predetermines the potential risk of detachment of the sustentaculum tali from the calcaneal body. In the only case when we registered this complication, the sustentacular process was fixed to the calcaneus with wires. However, a part of the deformity correction achieved was already lost on the operating table, and the remaining was lost within the next year after the surgery. Later, the three-joint arthrodesis on the foot was performed for the patient at the age of 16, with favorable results. Notably, despite complete dissociation at the fracture of the retinaculum of the sustentaculum tali, aseptic necrosis did not develop in the latter. To prevent this complication, excessive physical effort should be avoided in the process of displacing the distal fragment of the calcaneus. Its transposition should be performed especially accurately in patients with severe osteoporosis.

Excessive displacement of the distal fragment of the calcaneus with resulting hypercorrection was seen in one case and was most likely associated with pronounced hypermobility in the subtalar joint. After follow-up of the patient for two years, a three-joint arthrodesis on the foot was performed with good cosmetic and functional results. From the preventive point of view, it is necessary to pay special attention to the position of the foot in the process of applying the immobilizing cast in situations where pronounced hypermobility in the subtalar joint is seen.

Conclusions

Corrective osteotomy of the calcaneus is an effective technique for the treatment of mobile talipes equinoplanovalgus in pediatric patients with infantile cerebral palsy. Surgeons should be aware

of the possible causes of errors and complications associated with this technique to minimize their occurrence.

Disclosures

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