

## FEET INJURIES IN CHILDREN WITH TARSAI COALITIONS

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**Introduction.** Tarsal coalition is a foot bone malformation, characterized by bony, cartilaginous or fibrosis fusion between the tarsal bones. It clinically appears as decreased mobility of the tarsal joints. This feature can be predicting factor for feet injuries.

**Aim:** This study analyzed the frequency and nature of the injuries of the feet in patients with tarsal coalitions.

**Materials and methods.** The article presents data on the frequency and nature of feet injuries in patients with tarsal coalitions (22 patients (30 feet) with talocalcaneal coalitions and 28 patients (45 feet) with calcaneonavicular coalitions) aged 12 to 18 years. The control group included 50 patients (80 feet) with flatfeet without tarsal coalitions, aged 12 to 15 years. The study was a retrospective analysis of anamnestic data of feet injuries.

**Results.** The study found patients with tarsal coalitions had a significantly higher incidence of ankle sprains (the general group – 26 patients (52%) versus the control group – 12 (24%).

**Conclusion.** Tarsal coalition can be predicting factor to feet injuries. Patients with tarsal coalitions should consider this concern for sports activities. They can use different orthoses, tape, or choose not to engage in traumatic sports to avoid ankle sprains.

**Keywords:** tarsal coalitions, feet injuries, ankle sprains.

## ТРАВМЫ СТОП У ПАЦИЕНТОВ С ТАРЗАЛЬНЫМИ КОАЛИЦИЯМИ

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**Введение.** Тарзальные коалиции — это порок развития костей стопы, характеризующийся костным, фиброзным или хрящевым сращением между несколькими костями предплюсны. Клинически данная патология проявляется ограничением мобильности суставов предплюсны. Эта особенность может выступать предрасполагающим фактором к травмам стоп.

**Цель исследования:** анализ частоты и характера травм стоп у пациентов с тарзальными коалициями.

**Материалы и методы.** В статье представлены данные о частоте и характере повреждений стоп у пациентов с тарзальными коалициями в возрасте от 12 до 18 лет; из них 22 пациента (30 стоп) имели таранно-пяточную, 28 пациентов (45 стоп) — пяточно-ладьевидную коалицию. В контрольную группу были включены 50 пациентов (80 стоп) с plano-вальгусными деформациями стоп без тарзальных коалиций в возрасте от 12 до 15 лет. Исследование представляло собой ретроспективный анализ анамнестических данных, при котором выполнялось сопоставление полученных результатов между пациентами основной и контрольной групп.

**Результаты.** В процессе исследования установлено, что у пациентов с тарзальными коалициями достоверно чаще встречались эпизоды растяжения связок голеностопного сустава: основная группа — 26 пациентов (52 %), контрольная — 12 (24 %). В обеих группах преобладал инверзионный механизм травмы.

**Заключение.** Тарзальная коалиция может выступать предрасполагающим к травме стопы фактором. Пациентам с тарзальными коалициями следует учитывать данную особенность при занятиях спортом, использовать различные ортезы, тейпирование и не заниматься высокотравматичными видами спорта при наличии эпизодов растяжения связок стопы в анамнезе.

**Ключевые слова:** тарзальные коалиции, травмы стопы, растяжения связок голеностопного сустава.

### Introduction

A tarsal coalition is a congenital bone, fibrous tissue, or cartilaginous fusion between two or more tarsal bones [1]. Tarsal coalitions are frequently

combined with planovalgus deformities, but this disease may not be accompanied by a change in the shape of the foot [2]. The main clinical feature in patients with this disease is restricted mobility

of the joints in the middle and rear parts of the foot [3, 4]. This feature can be a predisposing factor for foot trauma. On examining patients visiting an injury care center with ligament sprains, Snyder et al. revealed that 63% of them have radiographic signs of tarsal coalitions [5]. On the other hand, Boland has raised many questions while reviewing this article: first, based on the data submitted by the author, an excessively high frequency of tarsal coalitions in the population can be discussed; second, it seems strange that patients with tarsal coalitions in addition to episodes of ligament sprains have no other clinical manifestations such as periodic pains in the feet and peroneal spasm; and third, the authors have not explained the prevalence of damage to the lateral ligaments of the ankle joint.

Despite a large number of publications on diagnostics and treatments of tarsal coalitions, studies detailing the frequency and nature of foot injuries in patients are few and fragmented. Moreover, there are data in the literature indicating that platypodia can be a predisposing factor for ankle joint damages [6]. Because platypodia is typical for most patients with tarsal coalitions [3], the significance of tarsal coalitions itself as a predisposing factor for foot trauma remains unresolved.

Therefore, the aim of this study was to analyze the frequency and nature of foot injuries in patients with tarsal coalitions.

## Materials and methods

We conducted a retrospective analysis of the frequency and nature of foot injuries in patients with tarsal coalitions. Participants of this study included 50 patients (75 stops) (29 males and 21 females; age, 12–18 years) with spastic flat foot who had tarsal coalitions verified by radiological examinations (radiography and computed tomography). Among 50 patients, 22 (30 feet) had talocalcaneal coalitions and 28 (45 feet) had calcaneonavicular coalitions. The control group included 50 patients (80 feet) with planovalgus deformities of the feet without tarsal coalitions (27 males and 23 females; age, 12–15 years). Patients in the control group visited the polyclinic of the Turner Institute for platypodia; however, the possibilities of tarsal coalitions were excluded by similar imaging examinations. All patients (or their representatives) voluntarily signed

the informed consent to participate in the study and underwent surgical interventions.

In terms of weight growth characteristics, degree of foot deformities, nature of motor activity, sports, and use of orthopedic footwear, there were no significant differences between the groups.

The criterion for establishing the injury (both primary and repeated) was the availability of extracts from medical records (outpatient card of the child, conclusions established by traumatologists and surgeons after examining patients with injuries, and a radiograph or its description). Upon taking the history of patients in the study and control groups, the number and nature of foot trauma as well as circumstances under which such injuries occurred were revealed. Given the retrospective nature of the study, it was not possible to objectively determine which ligamentous structures were damaged. In this context, we made a conditional division of the injury mechanism depending on the position of the foot while experiencing the traumatic force and leading mechanism of the trauma, which was elucidated retrospectively based on the patient's and parents' interviews. The division was made on the basis of inversion and eversion mechanisms of injuries. In case of inversion mechanism, traumatic force was exerted when the foot was positioned inward in combination with the external rotation of the tibia (inversion), which resulted in damages to lateral collateral ligaments, including the anterior and posterior astragalofibular ligaments and the fibulocalcaneal ligament. In case of the eversion mechanism, the foot was positioned outward and the tibia was rotated inward, which resulted in damages to the medial collateral ligaments (portions of the deltoid ligament, anterior and posterior tibiotalar ligament, tibionavicular ligament, and calcaneotibial ligament).

The data obtained were analyzed by methods of variation statistics. The normality of data distribution was determined using the Kolmogorov–Smirnov test, and differences between the two independent (study and control) groups were determined using the Mann–Whitney U test. Differences between the groups were considered significant at  $p \leq 0.05$ .

## Results

Analysis of medical records of the patients in the study and control groups (both platypodia and

tarsal coalition and platypodia without coalition, respectively) revealed no fractures and open lesions in the foot bones and ankle joint at the time of the study. Traumatic injuries (diagnosed as “ligament sprains,” “soft tissue injuries,” “bruises,” etc.) were noted in 26 patients (52%) in the study group and in 12 (24%) in the control group. It should be noted that only in eight patients (16%) in the study group and in five patients (10%) in the control group, these injuries were the reason for emergency visit to the trauma unit where radiographs were taken and patients were diagnosed with ligament sprain of the ankle joint. The remaining patients were diagnosed by a traumatologist or a surgeon in the polyclinic. In most patients with tarsal coalitions (92%), ligamentous apparatus injuries of the ankle joint were observed after the age of 12 years.

When analyzing structures of the ankle joint area susceptible to damage, it was found that lesions to the lateral collateral ligaments predominated in patients with calcaneonavicular coalitions, which was the inverse mechanism of injury (12 of 14 patients). In contrast, lesions in the medial and lateral collateral ligaments were approximately equal in patients with talocalcaneal coalitions (five patients had lesions in the lateral collateral ligaments, whereas seven had lesions in the medial ligaments). In the patients in

the control group, lesions in the lateral collateral ligaments predominated (10 patients). It should be noted that only four patients in the study group and 10 patients in the control group were constantly engaged in sports. Foot injuries occurred because of daily physical activities, such as walking, running, and jumping from a height not more than 50–100 cm, in 22 patients (85% of all injuries) in the study group and in eight patients (67% of all injuries) in the control group. Data on the frequency of lesions in the ligament structures are presented in Table 1.

According to the data shown in Table 1, lesions in the ligaments stabilizing the ankle joint in patients in the study and control groups had certain regularities. There were no differences in the incidences of foot injuries in patients with different types of coalitions, but there was a high incidence of damage to the medial collateral ligaments in patients with talocalcaneal coalitions. It was also noted that foot traumas in patients with planovalgus deformities occurred at the age of 6–7 years and 12 years in patients with tarsal coalitions, which coincided with the average time for ossification of coalitions.

In one patient with a fibrous form of the calcaneonavicular coalition along with repeated sprains of the lateral collateral ligaments of the ankle joint, a fracture of the anterior process of the heel bone was

Table 1

Distribution of lesions between lateral and medial collateral ligaments of the ankle joint in patients in the study and control groups

Injured ligamentous structures	Study group		Control group
	Talocalcaneal coalition	Calcaneonavicular coalition	
Lateral ligaments	10 %/5	24 %/12	20 %/10
Medial ligaments	14 %/7*	4 %/2	4 %/2
Total	52 %/26*		24 %/12

\* $p < 0.05$  compared with the control group



a



b



c

**Fig. 1.** Patient H, 16 years old. Diagnosis: Fibrous form of calcaneonavicular coalition, fracture of anterior process of the heel bone. *a* — a separate fragment of the anterior process of the heel bone is visualized; *b* — cartilaginous model of an elongated anterior process пяточной кости; *c* — a fragment of the anterior process of the heel bone during surgery (arrow)

retrospectively diagnosed. During sports, the girl tucked the foot (inversion mechanism of the injury), which resulted in swelling on the outer surface of the ankle joint and pain. The patient received treatment in a primary care facility for ligament sprain of the ankle joint; however, because of prolonged pain, computed tomography of the foot was performed and a fracture was found, which required surgical intervention, such as removal of the fragment (Figure 1).

## Discussion

We found that ankle joint sprains were significantly higher in patients with tarsal coalitions than in patients in the study group. The predisposition of patients with tarsal coalitions to foot injuries can be explained with impaired biomechanics. Foot injuries occur when the magnitude of traumatic force exerted during inversion/eversion of the foot or relative rotation of the tibia exceeds the strength of the tendon–ligamentous or bone apparatus of the foot. The combined work of the subtalar and the Shopar joints along with the elasticity of the tendon–ligamentous apparatus allows the load to be evenly distributed between all parts of the foot under forced eversion and inversion. Accordingly, the damage should occur only with sufficient traumatic force. In patients with tarsal coalitions, normal movements of the tarsal joints were impaired, which instead of allowing the distribution of intense short-term load evenly, had localized it in separate parts of the tarsus, thereby causing damage. The high frequency of trauma occurred because of the eversion mechanism in patients with talocalcaneal coalitions may be due to their more pronounced planovalgus deformities of the feet, which in the rigid position of the posterior part makes it difficult to perform foot inversion; thus, injuries occurred because of the eversion mechanism.

## Conclusion

The tarsal coalition can be a predisposing factor for foot trauma. It seems that the possibility of foot trauma depends on the degree of decrease in mobility of the

joints in the middle and rear parts of the foot as well as in the decompensation of biomechanical capabilities. Patients with tarsal coalitions should take these features into account while performing sports. They should use various orthoses and taping and avoid engaging in highly traumatic sports if they have a history of ligament sprains in the foot. Moreover, children aged over 12 years with repeated ligament sprains in the foot and ankle joint should undergo in-depth examinations to exclude the possibility of tarsal coalition.

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