

REVIEW PAPER

Ortopedia dziecięca

Secondary changes of the tibial axis in adolescents treated due to idiopathic genu valgum with minimally invasive methods of blocking growth cartilages. Analysis of factors affecting treatment failure

Wtórne zmiany osi piszczeli u młodzieży leczonej z powodu idiopatycznej koślawości kolan małoinwazyjnymi metodami blokowania chrząstek wzrostowych. Analiza czynników mających wpływ na niepowodzenie leczenia

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Abstract

In their 2016 publication, the authors drew attention to the influence of generalized polyarticular laxity during the treatment and the final effect of the correction of lower limb axis disorder in children and adolescents [1]. In addition to the influence of generalized polyarticular laxity on the outcome and time of treatment of patients, we also observe the flexion of the tibial shaft, occurring in children and adolescents, especially those with increased body weight [2, 3]. Valgus bending of the tibial shaft increases the general valgus of the limb, therefore this parameter should be taken into account when planning the treatment of children and adolescents with lower extremity axis disorders. The authors consider the degree of correction to be achieved and the time to end the treatment. According to the authors, a complete correction of the axial abnormalities of the lower limbs is a mistake, including the valgus bending of the tibial shaft. Eligibility for surgical treatment of a child with a valgus tibial shaft should be done with insight and precision, because in this group of patients the valgus deformity changes quickly into varus deformity and the axis is easily corrected. In our paper we also try to analyze the factors that affect the negative outcomes, taking into account the surgical technique, the type of chosen fusion, as well as the psychological attitude of the patient to surgery and the cooperation of the child and parents with the treating physician.

Key words: genu valgum, valgus bending of tibial axis, minimally invasive procedures, blocking of growth cartilages

Streszczenie

W publikacji z 2016 roku autorzy zwrócili uwagę na wpływ uogólnionej wiotkości wielostawowej na czas leczenia i efekt końcowy korekcji zaburzeń osi kończyn dolnych u dzieci i młodzieży [1]. Poza wpływem uogólnionej wiotkości wielostawowej na wyniki oraz czas leczenia pacjentów obserwujemy również zgięcie trzonu piszczeli, występujące u dzieci i młodzieży zwłaszcza tych ze zwiększoną masą ciała [2, 3]. Koślawe zagięcie trzonu piszczeli powiększa ogólną koślawość kończyny dlatego należy uwzględnić ten parametr w planowaniu leczenia dzieci i młodzieży z zaburzeniami osi kończyn dolnych. Autorzy rozważają stopień korekcji, który chcemy uzyskać i czas zakończenia leczenia. Według autorów błędem jest całkowita korekcja zaburzenia osiowego kończyn dolnych uwzględniając również koślawe zagięcie trzonu piszczeli. Kwalifikacja do leczenia operacyjnego dziecka, u którego występuje koślawe zagięcie trzonu piszczeli winna być wnikliwa i dokładna, gdyż w tej grupie pacjentów szybko dochodzi do przejścia koślawości w szpotawość a tym samym oś łatwo ulega przekorygowaniu. W pracy naszej staramy się również przeanalizować czynniki mające wpływ na niekorzystny efekt końcowy po zakończeniu leczenia, biorąc pod uwagę technikę operacyjną, rodzaj wybranego zespolenia, jak również psychologiczne nastawienie pacjenta do leczenia operacyjnego oraz współpracę dziecka i rodziców z lekarzem prowadzącym.

Słowa kluczowe: koślawość kolan, koślawe zagięcie osi piszczeli, małoinwazyjne zabiegi blokowania chrząstek wzrostowych

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Introduction

Among the patients of the Department of Pediatric Orthopedics and Rehabilitation, in whom genu valgum was corrected, the increased generalized polyarticular laxity occurred in 9.8% of patients (16 people), while valgus bending of the tibial shaft occurred in approximately 5.5% (9 people). These factors increased the valgus of the limb axis in children during standing and walking, therefore they should be considered and included in the process of correction of the valgus of the limbs using the method of temporary epiphysiodesis with the use of eight-plates or cannulated screws. The authors emphasize the need for early diagnosis of valgus of the tibial shaft in order to avoid "overcorrection" of the original deformity. The question arises about the degree of correction of the axial disorder and the time to the treatment. Achieving a complete correction of axial abnormalities in these patients would involve lowering the femoral medial condyle in relation to the lateral condyle, and thus to an oblique position of joint space and actual varus deformity at the joint level. In such cases, frequent follow-up visits are needed with in-depth clinical assessment and the taking control posture images to assess the correction of the axis, the height of the femoral medial condyle and the positioning of the joint space.

The final outcome after treatment of lower limb disorder depends not only on the aforementioned factor in the form of valgus bending of the tibia but also on the operative technique, tolerance and mental attitude of the patient and the cooperation of the treatment team with the child and his parents

Disorders of the lower limb axes are the second most frequent cause (after trauma) of the occurrence of early degenerative knee joint pathologies in adults, with the varus deformity more often leading to the occurrence of degenerative changes than the several-degree valgus deformity. The knee joint is the most common place for degenerative changes [4]. Osteoarthritis of the knee joints is associated with a significant impairment of motor function, severe pain and often requires surgical treatment.

In the population of patients in the Department of Pediatric Orthopedics and Rehabilitation, we notice an increase in axial disorders of the lower limbs, primarily in the form of persistent valgus and varus deformity within the knee joint. This is related to the gradual change in the lifestyle of children to a more sedentary and growing number of overweight and obese children.

The axis of the lower limbs in the frontal plane is subject to changes during the developmental period. Immediately after birth, the limbs are bent inwards, then they are extended to become valgus in most at around the age of 2 [4]. The final alignment of the limbs is about at 6-7 y.o. [5, 6]. The axis of the lower limbs shows variability with age, which should be remembered when assessing axial disorders of the

limb. In newborns and infants, a physiological varus deformity occurs, which then becomes valgus deformity to finally get at 7 y.o. the angular value at about 6-7 degrees typical of adults.

Assumptions and purpose of the work

The aim of our study is to evaluate treatment outcomes, to determine the time to complete blocking the growth cartilage by minimally invasive methods in patients who also suffer from valgus bending of the tibial shaft. We present a real change in the valgus angle of the tibia during treatment. In these patients the correction occurs very quickly, it is easy to overlook the moment when valgus deformity becomes varus, as is the case with patients with joint hypermobility syndrome [1]. We focus on this group of patients in order to avoid mistakes and therapeutic difficulties, because it is easy to obtain hypercorrection. The study is also an opportunity to look not only at the etiopathogenesis of the defect, but also to analyze the factors that affect the treatment efficacy with a unique assessment of the consequences of the parents' decision to stop the treatment and the situation of these patients, which in the future can be used to modify existing treatment procedures.

Materials, methods and results

The research was carried out on a group of children and adolescents operated in the Department of Pediatric Orthopedics and Rehabilitation in Lublin, who underwent surgical treatment due to lower limb disorder. From 2010 to 2016, surgical procedures were performed for temporary epiphysiodesis in 162 patients aged from 8 years 10 months to 15 years 9 months. A generalized increased joint laxity occurred in 16 patients (9.8%), while valgus bending of the tibial shaft was present in 9 patients (5.5%). Currently, the treatment was completed in the group of about 66% of patients, with over 87.9% of good and very good outcomes. In 107 children (205 limbs) the bonding material was removed on average after 13.4 months, and the correct axis of the lower limb was achieved. The valgus correction range was on average 7.3° for each distal femoral epiphysis and 3.9° for the proximal tibial epiphysis. No abnormalities of the growth cartilage function were observed after removal of the screws and plates. Patients underwent pre-operative and final assessment including examination of the range of motion, axis disorder, and limb length difference. In each patient at the stage of planning the operative treatment, a model X-ray of the lower limbs was taken with the calculation of the difference in the length of the lower limbs with an accuracy of 1 mm in the case of misalignment of the lower limbs and



determination of the femorotibial angle in the case of limb axis disorder [7, 8].

The group of patients treated at our Department for lower limb disorder in which the hypermobility syndrome was diagnosed is 16 people (9.8%). In identifying the syndrome, we used the Wynne-Davies' criteria. In 9 patients (5.5%), however, there was a valgus bending of the tibial shaft, which additionally increased the valgus deformity. Eligibility for surgical treatment in these children is very accurate and in-depth. Frequent monitoring is advisable because overcorrection is easily made during treatment.

An example of a patient whose genu valgum coexists with a valgus bending of the tibial shaft is a 13-year-old boy whose genu valgum before the treatment was about 13 degrees and valgus bending of the tibial shaft was about 5 degrees (Fig. 1). After the end of treatment, valgus of the tibia remained at a similar level of about 5 degrees while the axis of the entire lower limbs was significantly corrected at the level of 2 degrees of valgus. (Fig. 2). The treatment is completed with valgus still present in the tibia, but which according to our observations will undergo spontaneous correction within 2-3 years.



Fig. 1. Pre-operative tibial valgus of 5 degree. Valgus deformity of the whole lower limbs at 13 degrees



Fig. 2. After treatment, the axis of the shin is still valgus at 5 degrees. The axis of the whole lower limb was corrected from 13 to about 4-5 degrees

From a large group of patients operated on in our Department we noted several cases of treatment failures whose etiology is multifactorial. In 1 patient (0.62%) the bonding material (eight-plates and screws) was removed 2 weeks after surgery due to local paresthesia. Four patients (2.47%) required reoperation due to the migration of the eight-plates and screws, which was related to the intraoperative technical error. The migration of both the cannulated screws and eight-plates as well as the stabilizing screws is, according to our observations, the result of an intraoperative error. In two cases, the cannula screw was pushed out of the femoral canal, while in the next two cases, the screws stabilizing the eight-plate were pushed out of the femoral epiphysis and metaphysis. An excellent example is a patient aged 11 treated for genu valgum knees with epiphysiodesis with eight-plates. In the postural X-ray made before the surgery, the valgus was 13 degrees. Then, temporary epiphysiodesis

of the femoral distal epiphysis on the medial side. X-ray pictures taken intraoperatively showed the correct position of the anastomosis. Then the child was discharged home with a recommendation of follow-up visit at the Orthopedic Outpatient Clinic in 2 weeks. After 2 weeks the patient came to the orthopedic clinic with her parents, she did not report any complaints, the range of motion in the knee joints was full and painless. During the visit, it was found that the wound healed properly and stitches were removed. The parents came with the child to the next follow-up visit after 9 months. On examination complete valgus correction on the right side was noted, while on the left, valgus of about 13 degrees was still present. Follow-up x-ray revealed a protruded eight-plate (Fig. 3). The child was deemed eligible for removal of the anastomosis from the right lower limb and replacement of the plate and screws on the left lower limb. After another 10 months, a symmetrical correction of the valgus bending of the lower limb axis was obtained and the anastomosis was removed. An example of a bad clinical outcome of valgus correction with cannulated screws according to Metaizeau is a 12-year-old female patient who was eligible for surgical treatment due to approximately 12-degree valgus deformity. As mentioned above, cannulated screws were used in the treat-



Fig. 3. Correction of valgus deformity on the right side, no clinical effect on the left side due to implant removal



Fig. 4. Correction of valgus deformity on the left side, on the right side there is a protrusion of the cannulated screw from the femoral growth region

ment. As in the case of the previous child, the parents came to the Orthopedic Clinic 11 months after the operation concerned about the asymmetrical axis of the lower limbs. The x-ray revealed complete valgus correction on the left side, while on the right side there was still a 10-degree valgus as a result of protrusion of the cannulated screw from the distal femoral epiphysis on the medial side (Fig. 4). Subsequently, the child was eligible for removal of the screw from the left femur and the decision was made to use the eight-plate on the right side. After 12 months, the binding material was removed to obtain a symmetrical correction of the valgus bending of the lower limb axis.

The majority of recurrences relate to children with overweight and obesity, in the hypermobility syndrome of the joints in which genu valgum has been corrected by minimally invasive methods of blocking growth cartilages below the age of 10.. Among the patients operated on in our Department, this problem concerned 8 patients, which constituted 4.9% of the whole study group. All of these children underwent another procedure to block the growth cartilage around 12-13 years of age, with the normal axis of the lower limbs occurring after an average of 13 months of treatment.

The problem of hypercorrection of lower limb axis deformity during treatment with minimally invasive methods of blocking growth cartilage concerned children with valgus of the lower limbs and was always associated with the lack of cooperation on the part of the child's parents. The problem described above referred to 14 children, which accounted for 8.64% of all patients operated on in our Department (Fig. 5). In these cases, the parents reported with an overcorrected axis of the lower limbs on average after 15 months after surgery and in most cases it was the first visit in the outpatient clinic after the removal of the stitches. When asked about the reason for not reporting for follow-up visits to the clinic, parents reported satisfaction with the outcome of surgical treatment, no complaints reported by the child, improvement of the child's fitness.

Discussion

The problem of valgus deformity of tibia in children treated in our Department by temporary epiphysiodesis significantly advances the valgus of the whole limb. In the literature available to us, this issue has not been given much attention. On the basis of our research, we believe that it is advisable to correct the axial deformity of the limb, which will ensure horizontal positioning of the knee joint space and leave a valgus bending at the level of the tibia. Our several-year observations prove that in most cases the valgus bending of the tibial axis undergoes a gradual correction.

Temporary epiphysiodesis in the course of valgus causes a reduction in the medial condyle height, therefore during the



Fig. 5. Hypercorrection of valgus deformity. After treatment, there is a 4-degree varus deformity

treatment, the knee joint plane and the medial condyle height should be constantly monitored to prevent hypercorrection connected therewith. The valgus bending of the tibia accompanying genu valgum does not require surgical correction because, according to our observations, it improves slightly during treatment and after correction at the level of the knee joint. It is very important to avoid hypercorrection because a varus position is not very good for the knee joint causing pain and early degenerative changes. A small, several-degree varus has much more serious complications than valgus.

In cases of patients with valgus of the tibial shaft, our observations suggest that surgical treatment with temporary epiphysiodesis should be started at 10-11y.o. at the latest. However, after the end of treatment, a small, several-degree valgus should remain, which should be observed, because in our experience, a partial spontaneous correction occurs within 1-2 years. If there is no desired correction, one can perform another procedure temporary epiphysiodesis at the level of the proximal tibia just before the growth ends. Therefore, we warn against too much correction of valgus, in which the valgus of the tibial shafts are not taken into account.

In the Polish and world literature many methods of minimally invasive procedures in growth cartilage region have been presented: the Phemister method, Blount stapling, the Metaizeau technique, the eight-plate method [9-14, 16].

The Metaizeau method in children over 12 years of age and the use of eight-plates in younger children allow minimally invasive procedures on growth cartilage, protecting the children against increased deformity. Temporary epiphysiodesis facilitates a controlled monitoring of axial disorder correction without the child being denied normal activity [11, 12, 15].

Conclusions

Valgus bending of the tibial shaft contributes to the advancement of the apparent valgus and varus observed during standing and walking. The treatment should be terminated and the bonding material should be removed, leaving a slight valgus of the shin without hypercorrection at the level of the knee joint space. Indications for correction of lower limb disorder in children with valgus bending of the tibial shaft should be very accurate and in-depth and the treatment process carefully supervised by a physician with active participation of parents. Stopping the treatment by parents of our patients or failure to report to post-operative follow-up every 3 to 4 months often results in hypercorrection of the disorder. Frequent follow-up visits are recommended at the Orthopedic Outpatient Clinic to avoid errors like hypercorrection. It is extremely important to constantly monitor the knee joint plane and the height of the medial femoral condyle to avoid hypercorrection. In patients with joint hypermobility syndrome and valgus bending of the tibial shaft during the treatment we observe a sudden change of the axis from valgus to varus, especially during pubertal spurt, therefore the treatment should be terminated at the appropriate time leaving a valgus of few degrees with horizontal position of the joint space. Temporary epiphysiodesis is a very effective, minimally invasive method of treating lower limb axis disorder in children and adolescents without excluding a child from normal activity.

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