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# Corrective Intertrochanteric Osteotomy of the Femur for Aseptic Necrosis of the Femoral Head after Bloodless Reduction of Congenital Dislocation in School-Age Children

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**ABSTRACT**

The immediate results of treatment of 72 children aged 7 to 12 years with aseptic necrosis of the femoral head after bloodless reduction of congenital hip dislocation were analyzed. When treating patients, the following types of surgical treatment were used:extra-articular or open centering of the femoral head with intertrochanteric-torsion-varizing or devarizing and rotational osteotomy of the femur with bringing down the greater trochanter in the caudal direction. In all patients, pain and lameness disappeared, internal rotation of the lower extremities when walking, and the range of motion in the hip joint improved. Improved radiometric parameters characterizing the ratio of the acetabulum and the head of the femur and the angular values of the hip joint and proximal femur.

**KEYWORDS:** Congenital Hip Dislocation, Aseptic Necrosis, Proximal Femur, Growth Zone, Osteotomy, Centering.

## INTRODUCTION

One of the most formidable complications in the treatment of congenital hip dislocation is aseptic necrosis of the femoral head (ANFH), which significantly lengthens the follow-up period for children and largely determines the functional and anatomical outcome [14, pp. 196-202; 22]. Undoubtedly, repeated attempts at reduction, which end in vain regardless of the cause, in combination with prolonged immobilization in a plaster cast in the ante-physiological position of the lower extremities lead to iatrogenic damage to the joint structure, cause vascular disorders, which ultimately initiates the emergence of various deformities of the femoral head [1, pp. 6-13; 3, p. 225; 5, p. 182; 8, p. 248; 12,pp. 54-59]. According to the literature, the incidence of this complication in closed reduction of hip dislocation varies from 10 to 60% [11, pp. 552-562; 16, pp. 62-67; 22]. It becomes obvious not only purely medical, but also the enormous social significance of the problem under study [10, pp. 361-362; 11, pp. 552-562; 15, pp. 4-12]. The formation of the proximal femur is provided by the genetically programmed friendly function of three growth zones: the epiphysis of the femoral head, the upper edge of the neck, and the greater trochanter [24]. According to S. Porat et al., The apex of the greater trochanter should normally be at the level of the center of the femoral head [21, pp. 434-439]. Violation of the growth and formation of the proximal end of the femur depends on the premature closure of the growth zone, its total “epiphysiodesis” or in one or another of its parts after bloodless reduction of congenital hip dislocation [4, p. 66-69].Its consequences in the form of deformation of the head and neck of the femur, acetabular dysplasia, and disorders of articular relationships are recognized as the main reasons for the early development and rapid progression of coxarthrosis [13, pp.242-258]. The severity of residual deformities, according to S.J. Luhmannetal, Z. HeroldH, depends on the severity of the lesion of the ossification nucleus of the epiphysis of the femoral head, at the beginning of the pathological process [18, 20, pp.293-303]. The process of deformation formation occurs gradually, over a long time and is characterized by a progressive course. A decrease in the distance between the greater trochanter, the cartilaginous edge of the acetabulum and the ilium leads to their mechanical conflict, first during abduction and extension of the thigh, and in severe cases in

the middle position [17, 19, pp. 302-314]. Violations of the anatomical relationships in the dysplastic hip joint lead to a change in the biomechanical conditions of the joint functioning and the congruence of the articular surfaces, with an uneven distribution of the load on them, which is a key moment in the development of dysplastic coxarthrosis [2, p. 314; 9, pp.26-30]. To normalize the relationships in the joint, the surgical method is the only one, and N. Clarke [22] saw the main task of treating deformities after AS in their "minimization by surgery", and Y.I. Pozdnikin [7, pp. 170-171] considered the restoration of form and function to be the "ideal of treatment" joint.Surgical correction of multiplanar deformity of the proximal femur is difficult [6, pp. 72-82], in addition, it is often combined with coxaplana, which, according to N. Clarke [22], may become the "main problem" and cause the development of coxarthrosis in the first three decades life. The presence of such a variety of methods of treatment indicates their insufficient effectiveness, the absence of justified criteria for choosing rational methods of surgical interventions.

**The aim of this study** is to assess the effectiveness of the use of corrective intertrochanteric rotational osteotomies of the femur in school-age children with deformities of the proximal femur with ANFH.

## MATERIALS AND RESEARCH METHODS

The immediate results of treatment of 72 children, aged from 7 to 12 years, with deformities of the proximal femur with ANFH after bloodless reduction of congenital hip dislocation were analyzed. All patients had a multiplanar deformity of the proximal end of the femur: subluxation of the femur, varus deformity and shortening of the femoral neck, a decrease in the neck-shaft angle of the femur, valgus deviation of the epiphysis, hypertrophy and high standing of the greater trochanter and a negative value of the articulotrochanteric distance.

## THE MAIN FINDINGS AND RESULTS

During X-ray examination of children, X-ray of the hip joints was performed in the anteroposterior projection with the middle position of the hips and with internal rotation and abduction of the lower limb. On radiographs, the parameters characterizing the angular values of the hip joint and the proximal femur were measured: the angle of the vertical inclination of the depression, the angle of vertical correspondence, the acetabular angle, the cervico-diaphyseal angle, the angle of anteversion, the Alsberg angle, the coefficient of bone coverage and the indicators characterizing the ratio of the femoral head to the greater trochanter in frontal plane: articulo-trochanteric distance (ATD); trochanter-trochanter distance (TTD); articulo-rotational distance (ARD). The indications for the use of corrective osteotomies were a set of clinical and radiological data: lameness, faulty positioning of the lower extremities, significant limitation of hip abduction, weakness of the gluteal muscles, impaired relationships in the hip joint, subluxation of the hip, deformity of the proximal femur: plow valga (caudal position of the greater trochanter) , plow vara (cranial position of the greater trochanter), plow breva, high position relative to the head of the thigh (relativeovergrowthofthegreatertrochanter), plow magna, and not the shortening of the lower limb itself.When treating patients, the following types of surgical treatment were used: extra-articular or open centering of the femoral head with intertrochanteric-torsion-varizing or devarizing and rotational osteotomy of the femur with bringing down the greater trochanter in the caudal direction. In case of acetabular dysplasia, correcting intertrochanteric rotational osteotomies of the femur with acetabuloplasty, which is advisable to perform simultaneously with the osteotomy of the femur.

**Clinical example No. 1.** Patient N.M. was admitted to the department with complaints of walking with internal rotation of the lower extremities, getting tired quickly during long walks, fatigue in the legs and increased lumbar lordosis and pelvic tilt. Anamnesis: congenital dislocation of the hips was diagnosed at 6 months. She was treated with the imposition of a plaster cast according to the Sheptun's method for a period of 2 months. After removing the plaster cast, a Vilensky splint was put on the lower extremities. After 2 years, she began to walk. The ANFH developed in dynamics and for 3 years received inpatient treatment in the imina sanatorium of N.K. Krupskaya. In 2020, she filed the above complaints with the RCDO.According to the parents, the intensity of the aforementioned complaints increased in dynamics. After examination, the diagnosis was made: Congenital dislocation of the hips. Condition after bloodless reduction. Residual subluxation of the hips due to aseptic necrosis of the femoral heads. Deformity of the proximal femur of type IV according to Kalamchi, coxa vara, coxa breva et antetorsia, high position of the greater trochanter. Clinically: the patient walks with internal rotation of the lower extremities, limping on the right leg, there is an increase in lumbar lordosis and pelvic tilt. The length of the lower limbs is the same, the axis is even. Trendelenburg's symptom is positive. Movement in the hip joints: extension-$180^0/0^0/180^0$, flexion-$120^0/0^0/120^0$, abduction-$40^0/0^050^0$, internal rotation-700/00/600, external rotation-$40^0/0^0/40^0$.

The development of deformity is based on vascular disorders with the involvement of the physis and metaphysis of the epiphysis of the PHBK in the process. A characteristic feature is varus deformity and a sharp shortening of the femoral neck and the anterior formation of the epiphysis with epiphyseal anteversion.

Radiographically: there is a classic deformity of the proximal femur by the type of shortening of the femoral

neck (plow breva), rotation of the proximal femur anteriorly (*antetorsia*), high standing of the greater trochanter (relativeovergrowthofthegreatertrochanter). The stability of the joints is reduced, the head and neck of the femurs are shortened, SDA: $100^0/110^0$, the tops of the greater trochanters are located above the joint space (ATD: has a negative value of -25mm / 8mm), the Shenton line is broken by 1.0 cm, incongruence of the articular surfaces is noted and multiplanar deformity of the proximal femur. Fig. No. 1 (a).

**Fig. No. 1** (a) X-ray and MSCT of the hip joints. On September 16, 2020, surgery was performed: *Extra-articular centering of the femoral head with intertrochanteric detorsion-valgus-posterior rotational osteotomy of the femur with transposition of the greater trochanter of the femur*. Rice. No. 1 (b).

Rice. No. 1 (b). SPO. Corrective intertrochanteric osteotomy of the left femur was performed with fixation of bone fragments with a Blount-type fixator and 3 screws, the head of the left femur was centered on the bottom of the acetabulum, the femoral neck was lengthened, the articular surfaces were congruent, the articular gap was of sufficient height, the position of the greater trochanter was brought down to a normalized position caudal direction with fixation with 2 screws, SDA: 1250, ATD: 25mm. The continuity of the Shenton line has been restored.

After receiving 2 courses of rehabilitation treatment, 5 months after surgery on the left hip joint on February 16, 2021, the following surgical intervention was performed: Extra-articular centering of the head of the right femur with intertrochanteric detorsion-valgizing-posterior rotational osteotomy of the femur and transposition of the greater trochanter of the femur. Fig. No. 1 (c).

Fig. No. 1 (c). SPO. Corrective intertrochanteric osteotomy of the right femur was performed with fixation of bone fragments with a Blount-type fixator and 3 screws, the head of the right femur was centered on the bottom of the acetabulum, the femoral neck was lengthened, the articular surfaces were congruent, the articular gap was of sufficient height, the position of the greater trochanter was normalized - caudal direction with fixation with 2 screws, SDA: 1250, ATD: 22mm. The continuity of the Shenton line has been restored.

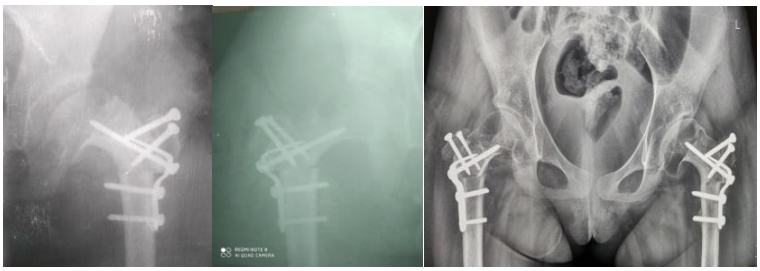

Fig.№1(b) Fig.№1(v) Fig.№1(g)

Result 8 months after surgery, the patient walks with crutches. He receives rehabilitation treatment in a planned manner. Movements in the hip joints: extension-$180^0/0^0/180^0$, flexion-$100^0/0^0/100^0$, abduction-$50^0/0^0/60^0$, internal rotation-$30^0/0^0/40^0$, external rotation-$30^0/0^0/40^0$. Fig. No. 1 (d).

Fig. # 1 (d): SPO. The femoral heads are centered on the bottom of the acetabulum, the femoral necks are lengthened, the articular surfaces are congruent, the Shenton line is restored, and the position of the greater trochanters of the femurs is normalized (ATD: 25 / 22mm). Satisfactory consolidation of bone fragments in the area of intertrochanteric osteotomy. The ratios in the joint achieved after osteotomy are preserved, the joint space is of sufficient height.

**Clinical example No. 2.** Patient B.F. 11 years old: 07.12.2020 was admitted to the department with complaints of fatigue and fatigue in the left lower limb, walking with internal rotation of the left lower limb and restriction of movement in the left hip joint. From the anamnesis: congenital dislocation of the hips was diagnosed at 4 months of age. She was treated with the imposition of a plaster cast according to the Sheptun method for a period of 3 months. After removing the plaster cast, a Vilensky splint was put on the lower extremities for 2 months. 2 months ago, before contacting our clinic, the parents noticed the child's rapid

fatigue during prolonged physical exertion, fatigue in the legs and impaired walking. In dynamics, the above complaints were joined by pain in the hip joint and lameness in the left leg.In 2020, she turned to our clinic with the above complaints and was hospitalized in the department of hip joint pathology. After examination, the diagnosis was made: Congenital dislocation of the hips. Condition after bloodless reduction. Subluxation of the left femur due to aseptic necrosis of the left femoral head. Kalamchi type IV proximal left femur deformity; femoral neck varus (coxa vara), femoral neck shortening (coxa breva), anterior proximal femoral rotation (antetorsia), high standing of the great trochanter (relative over growth of the great ertrochanter).

The development of deformity is based on vascular disorders with the involvement of the physis and metaphysis of the epiphysis of the PHBK in the process. A characteristic feature is varus deformity and a sharp shortening of the femoral neck and the anterior formation of the epiphysis with epiphyseal anteversion.

Clinically: the patient walks with internal rotation of the left lower limb, limps on the left leg. The left lower limb is hardened by 3.0 cm due to the femoral component. The greater trochanter of the left femur is located above the Roser-Nelaton line. Trendelenburg's symptom is positive on the left. Movements in the hip joints: extension-$180^0/0^0/180^0$, flexion-$120^0/0^0/120^0$, abduction-$60^0/0^0/30^0$, internal rotation-$40^0/0^0/80^0$, external rotation-$30^0/0^0/50^0$.

Radiographically: there is a classic deformity of the proximal left femur according to the type of shortening of the femoral neck (plow breva), rotation of the proximal femur anteriorly (antetorsia), high standing of the greater trochanter, joint stability is reduced. SDA: 1300/1000, the apex of the greater trochanter is located above the joint space (ATD: has a negative value and is -21 mm.), Shenton's line rupture by 1.5 cm. Pronounced shortening of the head and neck of the femur, incongruence of the articular surfaces (Fig. No. 2a, b).

Fig. No. 2 (a) Fig. No. 2 (b) Fig. No. 2 (c) Fig. No. 2 (d)

Fig. 2 (a). X-ray of the hip joints in the anteroposterior projection.

Fig. No. 2 (b). X-ray of the hip joints performed in the position of maximum internal rotation and abduction of the left lower limb.

On October 23, 2020, a surgical intervention was performed: *Extra-articular centering of the left femoral head with intertrochanteric detorsion-valgizing-posterior rotational osteotomy of the femur and transposition of the greater trochanter*. Fig. 2 (c).

Fig. No. 2 (c). Intraoperative radiograph: the head of the left femur is centered on the bottom of the acetabulum, the femoral neck is lengthened, the articular surfaces are congruent, SDA: 1300, the position of the greater trochanter is normalized - reduced in the caudal direction of ATD: 28mm, the Shenton line is restored.

Fig. No. 2 (d). Radiograph 6 months after surgery: the left femoral head is centered on the bottom of the acetabulum, the femoral neck is lengthened, the articular surfaces are congruent, the position of the greater trochanter is normalized (ATD: 28 mm), the Shenton line is restored. Satisfactory consolidation of bone fragments in the area of intertrochanteric osteotomy. The ratios in the joint achieved after osteotomy are preserved, the joint space is of sufficient height. The patient is currently walking with crutches. There is a relative shortening of the left lower limb by 1.5 cm. The greater trochanter of the left femur is below the Rother-Nelaton line. Movements in the hip joints: extension-$180^0/0^0/180^0$, flexion-$120^0/0^0/100^0$, abduction-$60^0/0^0/40^0$, internal rotation-$40^0/0^0/30^0$, external rotation-$30^0/0^0/30^0$.

Results and their discussion. The results of treatment were analyzed over a period of 8 months to 3 years. Clinical outcomes were assessed by McKey. Any adverse effect on one of these growth zones disrupts the normal development of the proximal femur. As a result of damage, one section of the bone growth zone and the normal functioning of the other are suppressed, as a result of which multiplanar deformities of the proximal femur are formed. Multiplanar deformities of the proximal end of the femur in aseptic necrosis of the femoral head develop as a result of improper formation of the epiphysis, due to local or total damage to the ossification nucleus of the head and growth zone of the femoral neck, a change in the orientation of the growth zone caused by unbalanced growth of its sections. With multiplanar deformities of the proximal end of the femur, there is always a decrease in ATD due to shortening of the femoral neck and head, in this regard, there is a secondary weakness of the gluteal muscles, manifested by a violation of gait. The results of treatment were analyzed in a period of 8 months to 3 years in 29 children. Pain and

lameness disappeared in all patients, internal rotation of the lower extremities when walking, improved range of motion in the hip joint. Radiometric indices characterizing the ratios of the femoral cavity and head, the femoral head, the femoral neck and the greater trochanter have improved: the centering of the head in the cavity has improved, the Shenton line continuity has been restored, the position of the greater trochanter of the femur has been normalized (ATD is 25 mm), the SDA was $120^0$-$125^0$, ATD- 16.2 + _2.5 mm. The ratios in the joint achieved after osteotomy are preserved, the joint space is of sufficient height.

**CONCLUSION**

Violation of the growth and formation of the proximal femur depends on the premature closure of the growth zone, its partial or total "epiphyseodesis" in one or another of its parts after bloodless reduction. Quite often, the formation of deformity is accompanied by a violation of the stability of the joint, both due to the valgus deviation of the femoral head and in connection with secondary dysplasia of the acetabulum, decentering of the femoral head, incongruence of the articular surfaces, and proximal migration of the greater trochanter. Surgical intervention in childhood must be carried out not only taking into account the existing deviations, but also those deformities that will inevitably arise as a result of the continued functioning of the damaged growth zones of the proximal femur. Corrective transtrochanteric rotational osteotomies of the femur can be successfully used in the treatment of deformities in schoolchildren.For acetabular dysplasia, they can be supplemented with acetabular plastic surgery. The operation allows you to change the spatial position of the head and neck of the femur in three planes and normalize the position of the greater trochanter. As a result, the clinical and radiometric parameters of the hip joint are improved and thereby restore normal relationships in the hip joint and normalize the biomechanical conditions of the functioning of the muscles of the hip joint. All children who have undergone aseptic necrosis of the femoral head, even without signs of impaired stability of the hip joint, need dynamic observation to select the optimal timing for correction of the emerging deformity, if necessary.

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