



# Closed Reduction in Developmental Dysplasia of the Hip in Patients Older than One Year

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## Abstract

**Introduction:** Besides an effective screening method for developmental dysplasia of the hip, there is certain number of children in whom the condition has been overseen or they have never been screened and the parents have noticed the odd walking pattern in their toddler. Treatment of such patients is controversial. One of the recommended treatment methods because of the short-term hospitalization, but often considered unsuccessful is closed reduction of the hip followed by cast immobilization.

**Hypothesis:** Closed hip reduction in late diagnosed developmental dysplasia of the hip gives good results.

**Aim:** Our aim in this retrospective study was evaluation of the success of the treatment with closed reduction of hip dislocation in children older than 12 months.

**Patients and methods:** In the study, we included 20 patients treated at our clinic from June 2004 to May 2017. Of these 20 patients, 8 had bilateral involvement, 12 had unilateral, in a total of 28 hips. In all patients we noted preoperatively the range of movement, the presence of limp, any limb inequality, and hip pain. We used clinical and radiological parameters for evaluation. Clinically, we examined the range of movement, limb inequality as well as limb function and we classified it according to the modified McKay's criteria. Same examinations were done at 1, 3, and 5 years after closed reduction.

**Results:** At the last follow-up examination, using McKay's criteria for clinical evaluation we rated the hips in two patients (7%) as grade III, i.e. fair grade, 10 hips (36%) were grade II – rated good, and 16 hips (57%) were evaluated as grade I. In four hips, there were signs of avascular necrosis of the hip, while in one patient the avascular necrosis developed after the closed reduction. Radiographic assessment (Figs 3, 4) using Severin's scoring system showed no hips with types V and VI, type IV was observed in 7%, type III in 21%, type II in 29%, while most of the hips (12, 43%) were type I.

**Conclusion:** We concluded that the procedure was justified. An advantage of this method is that it is inexpensive; it entails no direct operative changes of the bone structures and gives good results.

## Keywords

closed reduction, developmental dysplasia of the hip, walking age

## INTRODUCTION

Developmental dysplasia of the hip is a sum of hip abnormalities, ranging from instability caused by capsule laxity, diverting to a complete dislocation of the femoral head

connected to abnormality of the acetabulum.<sup>1</sup> Abnormal laxity of the hip leads progressively to dislocation of the hip, resulting in a specific disorder of the acetabular development, marked as dysplasia of the hip.<sup>2</sup> In our country there is a network of orthopaedic surgeons, pediatrics and

radiologists included in the screening of this condition. The screening includes clinical and ultrasonographic examination at about two months of age of the infant. In this early period after getting the diagnosis of DDH, usually a conservative treatment is undertaken and the outcome is usually satisfying. The success of the screening is obvious and unquestionable and is confirmed by the enormously lowered number of operatively treated patients on our clinic. Still, there is certain number of children in whom the condition has been overseen or they have never been screened and the parents have noticed the odd walking pattern in their toddler. Clinically, in these patients that are older than 12 months and are in a process of learning to walk or already walk there is noticeable limp in walking as well as inequality of lower limbs, and also limited abduction of the hip. The definitive diagnosis is made by a radiogram in antero-posterior direction (**Fig. 1**).<sup>3</sup>



**Figure 1.** Radiogram of a two-year-old toddler with bilateral hip dislocation.

Treatment in these patients is controversial. One of the recommended treatment methods because of the short hospitalization, but often unsuccessful is a closed reduction of the hip, followed by a cast immobilization.<sup>4</sup> General meaning is that closed reduction in patients older than a year is unsuccessful and connected with a lot of complication.

## Hypothesis

Closed hip reduction in late diagnosed developmental dysplasia of the hip gives good results.

**Table 1.** DDH types according to Tönnis

Degree	Criteria	Number of hips	%
I	Epiphysis of the femoral head is medially from the Perkins line	0	0%
II	Epiphysis of the femoral head is medially from the Perkins line, but under the degree of the upper margin of the acetabulum	12	43%
III	Epiphysis of the femoral head is medially from the Perkins line, on a level of the upper acetabular margin	14	50%
IV	Epiphysis of the femoral head is medially from the Perkins line, above the upper margin of the acetabulum	2	7%

## AIM

Our aim in this retrospective study was evaluation of the success of the treatment with closed reduction of the hip dislocation in children older than 12 months.

## PATIENTS AND METHODS

In the study 20 patients were enrolled that were treated at our clinic from June 2004 to May 2017. In those 20 patients, 8 had bilateral involvement, 12 had unilateral, and total of 28 hips. The group with unilateral involvement consisted of 7 patients with left hip dysplasia, and in 5 it was right hip dysplasia. The gender distribution was 13 female and 7 male and mean age at presentation was 26.3 months (12-48 months). Exclusion criteria were age less than 12 months, patients with concomitant neuromuscular diseases, infections or previous hip interventions. The study included patients that had relevant radiographs and follow up of at least a year. In all patients preoperatively the range of movement was noted, the presence of limp, limb inequality, hip pain. The degree of dislocation was categorized by the Tönnis classification, i.e. the relation between the bony nucleus to the Perkins line and the horizontal line on level of the lateral acetabular rim. 14 hips (50%) were classified as third degree (**Table 1**). Same examinations were done at 1, 3, and 5 years after closed reduction.

## Treatment protocol

The diagnosis was made using anteroposterior radiogram of the pelvis, because in patients older than 5 months the radiograph is more relevant than ultrasonography.

The treatment that we used was closed reduction of the hips and spica cast placement. The intervention is done in a patient with spinal anesthesia with sedation or general anesthesia (**Fig. 2**).

After obtaining satisfactory reduction of the hips with good retention with hip flexion angle of 90 degrees and abduction less than 70 degrees, the patient is placed on a special casting table. In patients where hip abduction is limited, subcutaneous adductor tenotomy was performed. C-arm radiography is performed, before and after the spica cast placement. The spica cast is replaced every 6 weeks in a period of immobilization of 3-4 months. Directions for



**Figure 2.** Patient prone on casting table, in-patient in sedation with spinal anesthesia.

hygiene regimen are given to the parents and they are informed for the possible side effects that can occur because of the long immobilization period. After the immobilization period the patient is placed in abduction brace for the hips and flexion movements of the hips are commenced, adduction movements are avoided. The abduction brace is worn for three weeks and afterwards an Atlanta brace for walking is used in order to begin the mobilisation process.

### Follow-up period

We used clinical and radiological parameters for evaluation. Clinically we examined the range of movement, limb inequality as well as limb function and we classified it according to the modified McKay's criteria (**Table 2**).

**Table 2.** McKay criteria modified by Berkeley et al. for clinical evaluation of the results<sup>5</sup>

Degree	Grade	Description
I	Excellent	Painless, stable hip, no limping, more than 15 degrees internal rotation
II	Good	Painless, stable hip, slight limping or decreased range of movement, negative Trendelenburg sign
III	Mean	Minimal pain, some limping or decreased range of movement, positive Trendelenburg sign
IV	Bad	Significant pain

**Table 3.** Tönnis and Collman classification of avascular necrosis of the proximal part of the femur

Degree	Criteria
I	The ossifying nucleus is slightly granulated and irregular, self-limited and with no sequestrs.
II	The edges of the ossifying nucleus are more irregular, there is more granulation than in the first degree, there can be cystic changes in the ossifying nucleus, self-limited for more time and sometimes ends with flattening of the head.
III	The ossifying nucleus is completely fragmented and looks like a flat tearing. This change can show up even after the ossifying nucleus has appeared. The deformity retreats if the physis is not damaged.
IV	Damage of the physis that leads to serious growth impairment. Irregularities are seen on the both edges of the physis, in some cases metaphyseal involvement is not noticed until growth abnormalities are clinical evident, like varus/valgus deformities and femoral neck deformity and shortening.

The radiological evaluation was performed on every spica cast change, at the end of the treatment, then on every 6 months in the follow up period. The physical therapy and free movement were allowed right after cast or plaster removal. The preoperative presence of avascular necrosis of the head of the femur was analyzed by Salter's criteria<sup>6</sup> and was classified by the Tönnis-Collman criteria (**Table 3**).

The radiographs were classified according to the Severin evaluation criteria, i.e. type I: normal hips; type II: concentric reduction of the joint with deformity of the femoral neck, femoral head or the acetabulum; type III: dysplastic hip without subluxation; type IV: subluxation; type V: the head articulates with secondary acetabulum proximally from the original acetabulum; type VI: redislocation. In two patients preoperatively on the radiographs there were no present ossifying nuclei.

## RESULTS

On the last follow up according to McKay's criteria in two patients with unilateral affection there was positive Trendelenburg sign, placing them in the third degree (7%), i.e. mean grade; 10 hips (36%) had decreased range of motion and a slight limp, with second degree, i.e. good grade and 16 hips (57%) were marked as excellent, clinically stable and painless, first degree. In four hips there were signs of avascular necrosis of the hip, while in one patient the avascular necrosis developed after the closed reduction. On the radiographic evaluation (figure 3,4) according to Severin there were no hips with types V and VI, type IV was noticed in 7%, type III in 21%, type II in 29%, while most of



3a



3b

**Figure 3.** a) Preoperative radiograph of a 22-month-old infant (Tönnis classification Gr. III), b) two and three years after treatment (Tönnis classification Gr. I).



4a



4b

**Figure 4.** a) Preoperative radiograph of a 4-year-old child (Tönnis classification Gr. IV), b) one and two years after treatment (Severin classification Gr. II).

the hips (12, i.e. 43%) were type I. The correlation of the final result was conducted with a group of patients less than 12 months (randomly selected 28 patients). The variables compared were the radiological degrees according to Severin criteria of the radiological signs in every patient and they were evaluated with Student t-test, no statistically significant difference was noted ( $p=0.181$ ).

## DISCUSSION

Besides the thorough screening ultrasound program for hip dysplasia, still there are a small number of cases where this disease remains an unresolved problem. The clinical examination alone is insufficient and a number of children that miss the ultrasound examination show up for the first time in our office with congenital hip dislocation when they start walking.<sup>8</sup> The problem that occurs in the late appearing patients is the high position of the head of the femur, the contracted soft tissue and the dysplastic acetabulum. Current approach in these patients consists of surgical management

in these patients - open reduction, accompanied by femoral and/or acetabular procedures. There are a number of operative interventions that include femoral shortening in combination with acetabuloplasty. Still, these operations can have consequences like decreased postoperative range of movement and increased incidence of avascular necrosis.<sup>9</sup> Our approach is an obligatory attempt to achieve closed reduction which is different from the present standpoint for open reduction to be performed first. Besides the expected complications from the closed reduction which are high incidence of redislocation and the need for further interventions, we decided to conduct closed reduction in above-mentioned cases in order not to traumatize the vulnerable pediatric skeleton. Placing the hip spica cast was performed with abduction no greater than 70 degrees and flexion of 90 degrees in both hips. In that case avascular necrosis of the hip is avoided, as it can be very often in this type of procedures. In hip reduction the basic concept is to determine the "safe zone" of dislocation and to reduce the degree of abduction to a stage of dislocation. The hip flexion to 90 degrees is important in order to reduce the pressure on the

femoral nerve and the side effects that its compression can cause if the flexion is above 90 degrees. In 11 hips it was necessary to perform a subcutaneous tenotomy of the hip adductors because of the adductor contracture. In that way forced reduction is avoided and the pressure of the femoral head is reduced. That's why there is a low number of femoral head osteochondritis after removal of the spica cast. The position of the extremities after reduction should be in the so called "human position". Cast placement according to Lorenz is considered as past in the treatment of the developmental disorders of the hips. The placement of the Atlanta brace is used in order to achieve axial pressure above the acetabulum and to correct the dysplasia that is residual and that is actually the biggest problem after this intervention. That's why we recommend this brace to be worn for a year in order to analyze the acetabular dysplasia progression on the control radiographs and to assess the need for further correction of it. The possible dysplasia correction is part of our next work on this problem. In the literature there aren't many data for closed hip reduction in patients above 12 months. Our oldest patient was 48 months old when the treatment was begun and there we had an excellent result. An additional element of security was the age between one and two years that allows further operative intervention if the results of the closed reduction are not satisfying. In the follow up period in none of our patients further intervention was necessary. Regarding residual dysplasia Li Y and al. have retrospectively reviewed the records of 89 patients with DDH (mean age  $16.1 \pm 4.6$  months; 99 hips) who were treated by closed reduction, divided into three groups according to final outcomes: satisfactory, unsatisfactory and operation.<sup>10</sup> They compared the groups for the acetabular index (AI), centre-edge angle of Wiberg (CEA), Reimer's index (RI) and center-head distance discrepancy (CHDD) over time. Satisfactory and unsatisfactory hips show different patterns of acetabular development after reduction. AI, CEA and RI are all predictors of final radiographic outcomes in DDH treated by closed reduction, although AI showed the best results. AI continues to improve until seven years after closed reduction in hips with satisfactory outcomes, while it ceases to improve three to four years after closed reduction in hips with unsatisfactory outcomes. According to their results, surgery is indicated if  $AI > 28^\circ$  1 year following closed reduction or  $AI > 25^\circ$  two to four years after closed reduction. CEA and RI should be used as a secondary index to aid in the selection of patients requiring surgery. Our intention is to wait for at least three years after the satisfactory closed reduction in order to determine the rate of dysplasia as well as the need for operative treatment.

## CONCLUSION

The main goal of this study was to evaluate the validity of the closed hip reduction in late diagnosed developmental dysplasia of the hip. Our conclusion was that the procedure is justified. Another advantage of this method is that

it isn't expensive, there isn't direct operative change of the bone structures and gives good results.

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## Закрытая репозиция врождённой дисплазии тазобедренного сустава у пациентов старше одного года

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### Абстракт

**Введение:** Помимо эффективного метода скрининга на врождённую дисплазию тазобедренного сустава, существует определённое количество детей, у которых было пропущено это состояние или никогда не проходили скрининг, а родители заметили странную походку своих детей. Методы лечения таких пациентов являются противоречивыми. Одним из рекомендуемых методов лечения ввиду кратковременной госпитализации, но который часто оказывается неудачным методом, является закрытая репозиция тазобедренного сустава с последующей иммобилизацией в гипсе.

**Гипотеза:** Закрытая репозиция тазобедренного сустава при поздней дисплазии тазобедренного сустава во время развития приводит к хорошим результатам.

**Цель:** Наша цель в этом ретроспективном исследовании состояла в том, чтобы оценить успех лечения закрытой репозицией среди детей старше 12 месяцев.

**Пациенты и методы:** В исследование было включено 20 пациентов, которых лечили в нашей клинике с июня 2004 года по май 2017 года. Из этих 20 пациентов 8 были поражены двусторонне, 12 - односторонне, и в общей сложности 28 тазобедренных суставов. В отношении всех пациентов были установлены диапазон движений, хромота, любая разница в длине конечностей и боль в тазобедренных суставах. Мы использовали клинические и рентгенологические параметры для оценки. Мы клинически рассмотрели диапазон движения, разницу в длине и функции конечностей и классифицировали их в соответствии с модифицированным критерием Маккея. Такие же исследования были проведены через 1,3 и 5 лет после закрытой репозиции.

**Результаты:** При последнем клиническом осмотре с использованием критерия Маккея для клинической оценки мы определили тазобедренные суставы у двух пациентов (7%) как стадию III, т.е. умеренная стадия, 10 тазобедренных суставов (36%) были оценены как стадия II, т.е. хорошие, и 16 суставов (57%) были определены как стадия I. В четырёх тазобедренных суставах были признаки сосудистого некроза тазобедренного сустава, в то время как у одного пациента некроз сосудов развился после закрытой репозиции.

Рентгенологическая оценка (рис. 3, 4) по системе оценки Северина не установила тазобедренные суставы типов V и VI, тип IV наблюдался у 7%, тип III у 21%, тип II у 29%, тогда как большинство тазобедренных суставов (12, 43%) были типа I.

**Вывод:** Мы пришли к выводу, что процедура оправдана. Преимущество этого метода в том, что он не дорогой; не требует прямых хирургических изменений костных структур и приводит к хорошим результатам.

### Ключевые слова

закрытая репозиция, врождённая дисплазия тазобедренного сустава, возраст начала хождения