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Surgical treatment using the method of total hip replacement in the system of rehabilitation of adolescents with cerebral palsy

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Purpose Improvement of the results of surgical rehabilitation of adolescent patients with cerebral palsy with subluxation and dislocation of the hip with the help of hip joint arthroplasty. **Materials and methods** The work is based on a retrospective analysis of the treatment outcomes in 12 children with cerebral palsy at the age of 13 to 17 years who underwent a total hip replacement surgery. The indication for the operation was the presence of a severe deformity of the joint components that could not be reconstructed and was accompanied by severe pain, loss of limb weight-bearing, significant limitation of motor abilities in patients over the age of 13 years. The components with cementless fixation were used. All patients underwent adductorotomy on the affected side. **Results** Neurological and vascular complications were not observed. Dislocation of the head and instability of the implant components was not observed. All patients showed an increased motor activity, relief of pain, a significant increase in the joint range of movements. Good and satisfactory functional results were obtained. The best results were obtained in level I–III patients according to the GMFCS system. Children of level IV achieved pain relief, improvement in the sitting posture, facilitation of care for them. Unsatisfactory results were not obtained. There were no complications during the operation and in the postoperative period. **Conclusion** According to the results, hip joint arthroplasty can be recommended for the rehabilitation of adolescent patients suffering from cerebral palsy.
Keywords: cerebral palsy, hip joint, arthroplasty

INTRODUCTION

Cerebral palsy (CP) is a poly-etiological disease of the brain in children that occurs during the period of its intrauterine formation [1, 2]. CP incidence is from 1.71 to 5.9 cases per 1,000 newborns. Some countries report on 8 CP cases per 1,000 newborns [3, 4]. There has been a tendency towards an increase in the morbidity over the last years.

Hip subluxation (SL) and dislocation (DL) are frequent in CP patients. They are closely related to the severity of motor disorders. By GMFCS level V, their incidence reaches 70–75 % and can be congenital or acquired [5–7]. In most cases, SL and DL develop secondarily.

The changes in muscle balance lie in the pathogenesis of these disorders (sometimes due to congenital dysplasia), which lead to progressive decentralization, deformity of the femoral and acetabular components, subluxation and dislocation of the femur. At the same time, flexion-adduction and internal rotational contractures in the hip joint, pelvis inclination, scoliosis and pain rapidly progress. They cause a loss of limb supportability and motor capabilities of the patients. Social and everyday activities impair greatly [3, 8].

Surgical treatment of CP patients is part of their rehabilitation. It should be well understood that the process of rehabilitation of CP children should be continuous [8]. At certain stages of the disease, various surgical interventions for SL and DL are used, depending on the radiographic pattern, patient's age, severity of orthopedic and neurologic changes. They can be both prophylactic or prevent the progression of subluxation (teno- and myotomy), and reconstructive (osteotomy of the femoral and pelvic bones in combination, if necessary, with arthrotomy and plasty of tendons and muscles). The effectiveness of these operations is quite high [9].

However, reconstructive operations are considered ineffective if degeneration of the joint components is significant. The use of total arthroplasty in these cases widens the possibilities of surgical treatment and improves patients' motor abilities [10, 11, 12]. However, there are a number of difficulties in regard to the indications and operation

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technique performance, as well as the tactics of postoperative management and motor rehabilitation of these patients [2, 13]. Due to existing difficulties and fears, the number of such operations is extremely small. In Russia, such cases are very rare. Therefore, studies on the potential use of hip replacement in adolescent CP patients are a relevant topic and evoke a considerable scientific and practical interest [8].

Purpose The aim of this work was to improve the results of surgical rehabilitation of adolescents with cerebral palsy accompanied by femoral subluxation and dislocation with the help of hip joint arthroplasty.

MATERIAL AND METHODS

Our study is a retrospective analysis of treatment with the use of total hip arthroplasty (THA) in 12 CP patients that suffered spastic di- and tetraplegia. There were two patients with level I of motor disorders according to GMFCS, four patients had level II, three – level III, and three patients suffered level IV. The age range was from 13 to 17 years.

Indications for the THA were femur SL or DL with manifestations of stage 3 coxarthritis that were accompanied by severe pain, joint contracture, pelvis inclination, and a significant impairment of the quality of life.

Previous reconstructive surgeries (myo- and tenotomy, correction osteotomy of the femur, double and triple osteotomy of the pelvis) were performed in 8 patients when they were 8 to 12 years old. However, in connection with the presence of pronounced deformities of the joint components, the effects of joint stabilization and pain relief were not achieved. To determine the level of pain, a 5-point verbal pain assessment scale was used (Frank A.J.M., Moll J.M.H., Hort J.F., 1982) [14]. In the study group, the severity of the pain was within 2–4 points.

All patients, in addition to conventional pelvic AP radiographs, underwent computed 3D reconstruction tomography in order to study pelvic and proximal femur deformities and to determine the implant model, its size, and preoperative planning.

Particular attention was paid to the presence of dysplastic changes in the hip joint, in particular, to the degree of femoral neck antetorsion with respect to the position of the femoral head and neck to the frontal plane determined by femoral condyles (in our observations it was 40–90°) which was evaluated during the intervention, to acetabular deformities, severity of osteoporosis, thinning of the cortical layer, and to bone age of patients.

Two models of implanted femoral components were used that were most suitable in the presence of pronounced bone deformities: Wagner cone stem (Zimmer) for cementless fixation and dysplastic CDH (Zimmer-Biomet). Pelvic components of cementless fixation were of minimum possible sizes from 40 mm with additional fixation by screws. If the acetabulum size was 44 mm or more, a friction "ceramic-to-ceramic" pair was used. If the size was 40–42 mm, a friction pair "metal-polyethylene" “cross link "was implanted. This selection of the components did not allow mistakes during installation but achieved a stable relationship between them. The cup was oriented more horizontally and anteriorly than in the standard implantation procedure, an insert with a 10° rim was used. During the operation, all patients underwent adductorotomy on the affected side.

It was possible to install the implant components in all the cases. One patient, due to an extreme grade of acetabular dysplasia, required the upper acetabular rim plasty with a massive autograft from the femoral head removed.

In the postoperative period, to prevent the dislocation of the implant head, and also to eliminate the extensor contracture of the knee joint, the limbs were fixed with plaster abduction splints for up to 3 weeks. From the first day after the operation, exercise therapy was administered. After 3 weeks, the casts were taken off and the patients were verticalized to restore the stereotype of independent ambulation. Multi-component motor rehabilitation was indicated. Control radiography taken after three months postoperatively aided to decide about the possibility of full support on the operated limb.

We monitored the changes in the physical condition, motor activity of the patients and the stability of the radiographic pattern at follow-ups.

RESULTS

The follow-ups were from 9 months to 4.5 years (mean 2.6 years). In all cases, the implantation of the endoprosthesis during the operation was stable.

In the early postoperative period, there was a rapid arrest of pain and a gradual recovery of a functionally significant range of motion in the joint, correction of the pelvis tilt (if it was not associated with the presence of severe scoliosis) within 2-3 weeks. Postoperative period in patients with GMFCS level IV showed a slower recovery of functions, the need for additional elimination of contractures in the knee joints with the use of the method of stepped redressation. No complications were seen. In the long-term period of observation, neither dislocation of the head nor instability of the structural components happened.

During the period of observation, the severity of motor disorders decreased. Moreover, THA in the adolescents with cerebral palsy GMFCS levels I-II provided the restoration of a walking stereotype along with pain relief. Level III-IV CP patients could obviate a constant stay in a wheelchair and severe pain. In 2 patients with GMFCS level IV, the indication for the operation was the presence of severe pain which hindered their care. In these two cases, reduction in the pain and contractures was achieved. Though the surgery did not have an effect on their general motor activity, but the result was assessed as positive.

The outcome examples are shown in **Figures 1** and **2**.

Fig. 1 Patient Z., 13 years old with cerebral palsy, spastic diplegia, dislocation of the right hip (III level according to GMFCS): **a** – radiograph of hip joints before surgery; **b** – photo before operation (front view); **c** – photo before the operation (side view); **d** – radiograph 2 years after right hip joint THA; **e** – patient after surgery (front view); **f** – patient after surgery (back view)

Fig. 2 Patient Sh., 16 years old, with cerebral palsy, spastic diplegia, dislocation of the left hip (GMFCS level IV): **a** – radiograph of hip joints before surgery; **b** – photo before the operation (front view); **c** – radiograph of hip joints 6 months after left hip joint THA; **d** – photo of the patient, 4 months after the operation (side view); **e** – patient at 6 months after the operation (front view)

DISCUSSION

The use of THA for correcting motor disorders and reducing pain is common in a complex of rehabilitative treatment in adult patients with cerebral palsy [7, 9, 11, 13]. In pediatric practice, this method is rarely used, mainly in the older adolescent group [5, 15]. We did not meet any instructions for the THA operation in the literature for children in the age of 12–15 years.

Most authors [10, 13, 15] express an opinion that it is inexpedient to use this method due to an increased risk of pelvic component instability and dislocation of the implant head [16]. We agree with the opinion of the authors. Nevertheless, we believe that the performance of THA may be indicated to patients of early adolescence with a dislocation or subluxation of the femur. It does not result in complications if the conditions and techniques are observed. We believe that the plastic possibilities of children in early adolescence (12–14 years of age) make it possible to achieve the best results with THA in the process of rehabilitation of CP patients.

CONCLUSION

Twelve THA operations were performed in 12 patients aged 13–17 years. In all the cases, it was possible to position the implant components. Additional plasty of the acetabular rim with an autograft was needed in one case. Neurological and vascular complications were not encountered. Dislocations of the head and instability of the components were not observed. All patients showed an increase in their motor activity, relief of pain, and a significant increase in the range of

motions in the joint. Good and fair functional results were obtained. The best outcomes were seen in GMFCS levels I–III. Children with level IV achieved pain relief, improved posture in the sitting position, and facilitation of assistance in their care [3, 6]. Poor outcomes were not seen. There were no complications during the operation and in the postoperative period.

SUMMARY

1. THA operation is a part of complex treatment for CP patients. Optimization of indications for surgery is the most important condition for obtaining good outcomes.

2. All patients have improved their orthopedic status, motor abilities and social adaptation after surgical treatment and subsequent post-operative rehabilitation.

3. Due to an increased risk of dislocation of the implant head, it is necessary to use technological methods that prevent the development of this complication during the operation and in the postoperative period (use of appropriate implant components and their placement in a certain position, use of orthopedic devices and positions, and apply measures that decrease the tonus).

4. The achieved results allow recommending hip joint arthroplasty for patients with cerebral palsy of the adolescence age with hip joint pathology. Observation of specific conditions and methods in the treatment and rehabilitation of these patients is mandatory.

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