



Surgical Approaches for Triple Pelvic Osteotomy in Children With Hip Dysplastic Instability: Assessment of Muscle Damage

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Background. The invasiveness of surgical approaches for hip surgeries is primarily determined by the severity of the muscle injury. To date, surgeons use from one to three surgical approaches for osteotomy of the pelvic bones and acetabulum reorientation. An analysis of the scientific literature showed the lack of studies comparing the muscle trauma at different surgical approaches for triple pelvic osteotomy in children.

The aim of the study – to evaluate the degree of muscle injury during triple pelvic osteotomy through various surgical approaches in patients with developmental dysplasia of the hip (DDH).

Methods. The study included 70 patients (70 hip joints) aged 12–18 years (15.2 ± 1.4) with Crowe type I DDH treated between 2020 and 2021. All children were divided into two groups: group I consisted of 35 patients (35 hip joints) who underwent triple pelvic osteotomy using an anterolateral approach, group II – 35 patients (35 hip joints) who underwent triple pelvic osteotomy through two approaches (medial and bikini). In addition to standard radiometry of hip joints, pain severity based on the visual analog scale (VAS) and blood markers levels of muscle injury (lactate dehydrogenase, creatine phosphokinase, aspartate aminotransferase and C-reactive protein) were evaluated before and at 3rd and 7th days after surgery.

Results. Pain severity assessment by VAS was more pronounced ($p < 0.05$) in patients who underwent surgery using an anterolateral access. Values of CPK and C-reactive protein significantly ($p < 0.05$) exceeded those in patients who underwent triple pelvic osteotomy through two surgical approaches. The results of the study indicate greater hip muscles trauma during the anterolateral approach for triple pelvic osteotomy.

Conclusion. The use of anterior-lateral approach when performing triple pelvic osteotomy in children with Crowe type I DDH causes more ($p < 0.05$) muscle tissue trauma compared to two surgical approaches (medial and bikini). This is evidenced by a significant increase of creatine phosphokinase and C-reactive protein, as well as a more severe pain syndrome in the immediate postoperative period.

Keywords: developmental dysplasia of the hip, surgical approaches, triple pelvic osteotomy, pain syndrome, biochemical markers of muscle trauma.

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Оценка травматичности хирургических доступов при выполнении тройной остеотомии таза у детей с диспластической нестабильностью тазобедренного сустава

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Актуальность. Инвазивность и травматичность хирургических доступов при проведении операций на тазобедренном суставе в первую очередь определяется величиной мышечной травмы. На сегодняшний день для осуществления остеотомий костей таза и реориентации вертлужной впадины ортопедами используется от одного до трех хирургических доступов. Анализ мировой и отечественной научной литературы показал отсутствие исследований, посвященных сравнению травматичности различных хирургических доступов для выполнения тройной остеотомии таза у детей.

Цель исследования — определить степень мышечной травматизации при выполнении тройной остеотомии таза различными доступами у пациентов с дисплазией тазобедренных суставов.

Материал и методы. В исследование вошли 70 пациентов (70 тазобедренных суставов) в возрасте от 12 до 18 лет ($15,2 \pm 1,4$) с дисплазией тазобедренных суставов I степени по классификации Crowe, получивших лечение в период с 2020 по 2021 г. Все дети были разделены на две группы: I группу составили 35 пациентов (35 тазобедренных суставов), которым тройную остеотомию таза выполняли из переднебокового доступа, II группу — 35 пациентов (35 тазобедренных суставов), которым тройная остеотомия таза была выполнена из двух доступов — медиального трансдукторного и «бикини». Помимо стандартной рентгенометрии тазобедренных суставов, до операции и на 3-и, 7-е сутки после ее выполнения оценивали выраженность болевого синдрома по ВАШ и уровень маркеров мышечной травматизации: аспаратаминотрансферазы (АСТ), креатинфосфокиназы (КФК), лактатдегидрогеназы (ЛДГ) и С-реактивного белка (СРБ).

Результаты. Интенсивность болевого синдрома по ВАШ была более выраженной ($p < 0,05$) у пациентов, которым операция выполнялась из переднебокового доступа, а значения показателей КФК и СРБ значительно ($p < 0,05$) превышали аналогичные у пациентов, которым тройная остеотомия таза была выполнена из двух хирургических доступов. Полученные данные свидетельствуют о большей травматизации мышц области тазобедренного сустава в ходе выполнения передне-бокового доступа для осуществления тройной остеотомии таза.

Заключение. Сравнительный анализ травматичности хирургических доступов, основанный на оценке биохимических показателей маркеров мышечной травмы и интенсивности болевого синдрома в послеоперационном периоде показал, что передне-боковой доступ при выполнении тройной остеотомии таза у детей с дисплазией тазобедренных суставов I степени по Crowe приводит к большей травматизации мышечной ткани ($p < 0,05$), чем применение двух хирургических доступов (медиального трансдукторного и «бикини»), о чем свидетельствуют значительное повышение КФК и СРБ в крови, а также более выраженный болевой синдром в ближайшем после операционном периоде.

Ключевые слова: дисплазия тазобедренных суставов, дети, хирургические доступы, тройная остеотомия таза, болевой синдром, биохимические маркеры мышечной травматизации.

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BACKGROUND

The incidence of DDH does not tend to decrease over time and, despite the modern possibilities of its earliest possible detection, the percentage of underdiagnosis remains at a fairly high level [1, 2, 3, 4]. Underdevelopment of the acetabulum arch creates conditions for cranial displacement of the femoral head with the formation of hip subluxation, and its first clinical symptoms appear already in adolescence due to the presence of a site of local pathological load on hyaline cartilage [5, 6, 7].

Many domestic and foreign authors have scientifically proven the high effectiveness of triple pelvic osteotomy in the complex treatment of DDH and coxarthrosis in children, adolescents and young adults [8, 9, 10, 11, 12, 13]. Orthopedic surgeons use from one to three surgical approaches to perform osteotomies of the pelvic bones and to reorient the acetabulum [14, 15, 16, 17]. In addition, there are works devoted to the implementation of triple osteotomy from minimally invasive approaches [18, 19, 20, 21]. However, it should be noted that today there are contradictions in the concept of "minimally invasive approach". Thus, number of authors have formed the opinion that approach with a cut of the skin up to 10 cm is minimally invasive or minimally traumatic, even if there is significant injury to the periarticular muscles [22, 23, 24, 25]. In contrast to this opinion, other authors believe that the term "minimally invasive/minimally traumatic approach" means surgical approach, in which no dissection of muscles and tendons is performed, and the length of the skin incision does not matter much [26, 27]. In addition, number of authors who perform triple pelvic osteotomy from more than one skin incision, insignificant in length, also consider this technique minimally invasive [28]. At the same time, the invasiveness and traumaticity of approach is primarily determined by the magnitude of muscle injury, one of the ways to determine which is the assessment of biochemical markers of muscle injury: aspartate aminotransferase (AST), creatine phosphokinase (CPK), lactate dehydrogenase (LDH) and C-reactive protein (CRP) [29].

We conducted an analysis of foreign and domestic scientific literature on the comparison of the traumaticity of various surgical approaches for performing triple pelvic osteotomy, which

showed the absence of such studies, which emphasizes the relevance of its implementation.

The *aim of the study* was to assess the degree of muscle injury during triple pelvic osteotomy using various approaches in patients with hip dysplasia.

METHODS

Design of the study

A monocenter cohort prospective comparative controlled study was performed.

The study is based on the results of clinical and laboratory examination in the pre- and postoperative periods of 70 patients (70 hip joints) with Crowe type I DDH aged 12 to 18 years (15.2 ± 1.4), who underwent triple pelvic osteotomy in the period from 2020 to 2021. All patients, depending on the surgical approach used, were divided into two equivalent groups. Group I consisted of 35 patients (35 hip joints) to whom triple pelvic osteotomy was performed by the generally accepted in the Center anterolateral approach. There were 30 female and 5 male patients. Group II included 35 patients (35 hip joints) who used two surgical approaches: medial transadductor and bikini approach. There were 28 female and 7 male patients.

Criteria for inclusion in the study:

- the presence of hip instability in the form of hip subluxation (type I according to the Crowe classification);
- no need to the proximal femur correction surgery;
- absence of neurological, systemic and genetic diseases;
- consent of the patient or his legal representative to participate in the study.

Exclusion criteria from the study:

- the presence of hip instability in the form of marginal, supraacetabular and iliac hip dislocation (types II–IV according to the Crowe classification);
- the need to perform intra-articular manipulations and osteotomy of the femur;
- the presence of neurological, systemic and genetic diseases;
- refusal to fill out an informed consent to participate in the study;
- the occurrence of surgical site infections in the postoperative period.

Surgical technique

Anterolateral approach. The patient's position on the table is lying on the contralateral side of the affected joint. An angular incision of the skin and subcutaneous fat is performed from the anterior superior iliac spine to the border of the femur diaphysis upper thirds 15-20 cm long. Dissection of tensor fascia lata repeats the incision of the skin with an additional cross section posteriorly at the level of the greater trochanter in order to perform manipulations on the sciatic bone. After dissection of the gap between M. gluteus medius and M. tensor fascia lata and the iliac wing isolation dissection of the cartilaginous apophysis of the iliac crest is performed, followed by subperiosteal isolation of the iliac bone body, into which a jiggly saw is carried out. The next stage is performed subperiosteal isolation and osteotomy of the pubic bone medial to the Y-shaped cartilage or crest-shaped tubercle as close as possible to the acetabulum. After dissection of n. ischiadicus subperiosteal isolation and periacetabular osteotomy of the sciatic bone cranial to the attachment site of lig. sacrotuberosus are performed.

After that, an osteotomy of the iliac bone body is performed, followed by reorientation of the liberalized acetabulum (Fig. 1).

Medial transadductor approach and bikini approach. The patient's position on the table is supine. On the lower limb, in the flexion and abduction position on the affected side, a transverse incision of the skin and subcutaneous fat is performed in the projection of the tendon m. adductor longus up to 4 cm long. A channel to the sciatic bone is formed bluntly in the intermuscular space. After subperiosteal isolation with an osteotome, its periacetabular osteotomy is performed. The next step is an incision of the skin and subcutaneous fat 1 cm below the iliac wing along the inguinal fold up to 15 cm long. After the fascia dissection the n. sutaneous femoris lateralis is visualized, isolated widely and displaced. In the interval between m. tensor fascia lata and m. sartorius, the iliac wing is isolated, followed by dissection of its cartilaginous apophysis, subperiosteal isolation of the iliac body and the jiggly saw insertion into the sciatic notch. Further manipulations did not differ from similar ones performed from an anterolateral approach (Fig. 2).

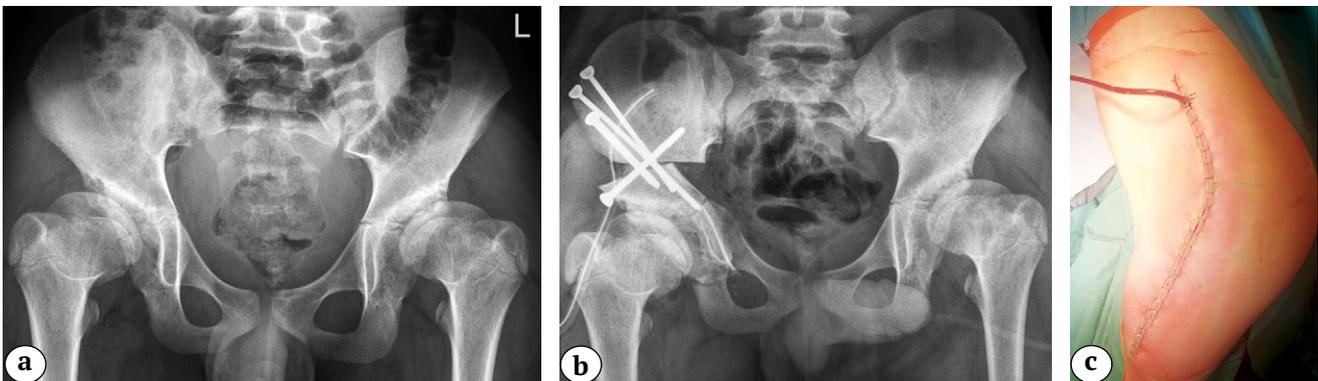


Fig. 1. A triple pelvic osteotomy through an anterolateral surgical approach:
 a – X-ray of patient 12 y.o. with Crowe type I developmental dysplasia of the hip before surgery;
 b – X-ray after restoring the correct ratios between the pelvic and femoral hip components by reorientation triple pelvic osteotomy;
 c – surgical access after suturing

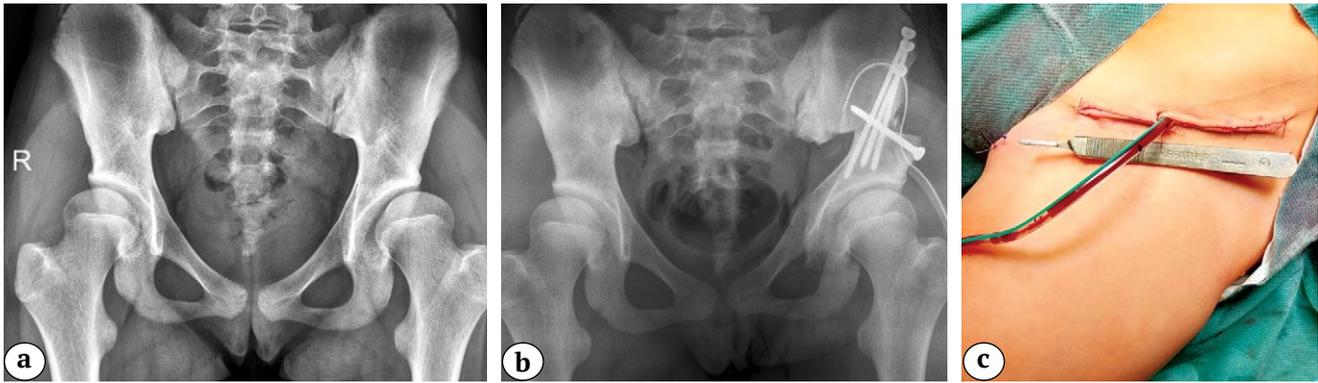


Fig. 2. A triple pelvic osteotomy from two surgical approaches:
 a – X-ray of patient 16 y.o. with Crowe type I developmental dysplasia of the hip before surgery;
 b – X-ray after restoring the correct ratios between the pelvic and femoral components by reorientation triple pelvic osteotomy;
 c – surgical access after suturing

Research methods

In addition to the generally accepted clinical examination with the filling out of the VAS questionnaire and radiological research methods, which included radiography in anteroposterior and axial projections and computed tomography of the hip joints, all patients were analyzed for biochemical markers of muscle injury before surgery and on the 3rd and 7th days of the postoperative period: LDH, CPK, AST, CRP. In addition, the analysis of the surgery duration and the volume of intraoperative blood loss was carried out.

Statistical analysis

Statistical analysis was carried out using the IBM SPSS v 26 software package. The analysis of indicators during treatment within groups of patients was carried out using the nonparametric Wilcoxon criterion, comparison of indicators in groups with different surgical approaches was carried out using the nonparametric Mann–Whitney U-test with an error probability of the first kind less than 5% ($p < 0.05$).

RESULTS

Patients of both groups, upon admission to the clinic, presented complaints of pain with an intensity of 4.5 ± 0.8 points according to VAS, typical for DDH. Gait disorder in the form of lameness was noted in 100% of patients, and the average shortening of the lower extremities was 1.4 ± 0.3 cm. Excessive rotational movements, a positive impingement test

(FADIR) was detected in 29 (83%) patients in the first group and in 30 (85%) patients in the second.

The main indicators of the pelvic and femoral joint components state obtained after radiometry, as well as their ratios, are presented in Table 1.

The X-ray anatomical structure of the hip joint in patients of both groups was characterized by changes typical of the dysplastic nature of pathology and had no statistically significant ($p > 0.05$) intergroup difference [13, 30].

A biochemical study of the above-mentioned markers of muscle injury, the results of which are presented in Table 2, showed that their values before surgery were within the reference interval and had no statistically significant differences ($p > 0.05$) between the groups of patients.

All surgical interventions were performed by experienced surgeons.

The average surgery time and the amount of blood loss in group I were 93 ± 10 minutes and 200.4 ± 36.2 ml; in group II — 92 ± 8 minutes and 166.7 ± 38.0 ml, respectively. The average surgery duration had no differences ($p > 0.05$). At the same time, the volume of intraoperative blood loss in patients who underwent triple pelvic osteotomy from two approaches was statistically significantly lower ($p < 0.05$) than in the group of patients who underwent a similar intervention from an anterolateral surgical approach. There were no neurocirculatory complications.

As a result of surgical treatment, hip joint stability was achieved in all patients of both study groups (Table 3).

Table 1

The values of the main radiometric parameters characterizing the anatomical structure and spatial orientation of the acetabulum and proximal femur before surgery

Parameter	Group I M±SD (min-max); Me (25–75%)	Group II M±SD (min-max); Me (25–75%)
Sharp angle, deg.	53±3 (50–58); 52 (51–57)	53.6±3.5 (50–57); 54 (50–57)
Tonnis angle, deg.	22.4±2.6 (18–27); 22 (20–25)	23.1±2.5 (20–28); 23 (21–25)
Wiberg angle, deg.	5.0±2.6 (1–9); 5 (3–7)	4.6±2.7 (2–11); 4 (2–6)
Degree of bone coverage, %	52.4±4.1 (45–59); 52 (50–56)	50.6±3.8 (46–53); 51 (46–53)
Cranial displacement, mm	8±4 (2–16); 7 (5.0–10.5)	8.0±3.7 (3±15); 7.5 (5.0–11.8)
CDA, deg.	138.5±5.8 (125–150); 140 (135.0–141.8)	139.4±6.4 (125–150); 140 (135–142)
AA, deg.	35.5±3.7 (24–40); 36.7 (32.7–38.0)	36±4 (24–42); 36.8 (33.0–38.6)

CDA – cervical diaphyseal angle; AA – antetorsion angle.

Table 2

Values of biochemical markers of muscle traumatization before surgery

Parameter	Group I M±SD (min-max); Me (25–75%)	Group II M±SD (min-max); Me (25–75%)
LDH, Unit/l	244±15 (189–272); 242 (236–258)	247.0±12.8 (226–276); 247 (238–257)
CPK, Unit/l	98.4±30.4 (62–169); 87 (78–114)	97.0±28.3 (68–172); 89 (74–104)
Creatinine, mmol/l	61.0±7.8 (61–169); 61 (54–67)	60.1±9 (45–78); 59 (53–67)
AST, Unit/l	20.9±5.8 (11–32); 21 (15–25)	19.8±5.6 (10–32); 19 (15–24)
CRP, Mg/l	0.8±0.3 (0.3–1.2); 0.9 (0.5–1.0)	0.7±0.3 (0.2–1.3); 0.8 (0.5–1.0)

Table 3

The values of the main radiometric parameters characterizing the anatomical structure and spatial orientation of the acetabulum and proximal femur after surgery

Parameter	Group I M±SD (min-max); Me (25–75%)	Group II M±SD (min-max); Me (25–75%)
Sharp angle, deg.	35.3±4.9 (28–45); 35 (31–38)	36.2±4.8 (30–45); 36 (32–40)
Tonnis angle, deg.	6.1±1.9 (3–9); 6 (5–8)	5.4±2.1 (2–9); 5 (4–7)
Wiberg angle, deg.	31.4±7.0 (18–40); 31 (27–39)	32.7±3.9 (28–40); 33 (30–35)
Degree of bone coverage, %	93.3±5.9 (80–100); 95 (90–100)	94.7±5.2 (85–100); 95 (90–100)
Cranial displacement, mm	–	–
CDA, deg.	138.5±5.8 (125–150); 140 (135.0–141.8)	139.4±6.4 (125–150); 140 (135–142)
AA, deg.	35.5±3.7 (24–40); 36.7 (32.7–38.0)	36±4 (24–42); 36.8 (33.0–38.6)

CDA – cervical diaphyseal angle; AA – antetorsion angle.

As a result of surgical treatment in all patients in both groups, the stability of the hip joint was achieved with the values of the main radiometric indices reflecting the anatomical structure and spatial orientation of the acetabulum, as well as its ratio to the femur, which are located within the normative reference intervals. This, in our opinion, is extremely important in terms of both the possible further development of femoroac-

etabular impingement of the “pincer” type, and the complexity of positioning and implantation of the endoprosthesis cup when it is necessary to perform total hip arthroplasty in adulthood as a result of hypercorrection of the acetabular fragment position [13, 31].

The analysis of the pain syndrome severity according to VAS in the postoperative period, as well as the dynamics of its change, showed the presence of statistically significant differences ($p < 0.05$) between the groups of patients (Fig. 3).

So, patients of group I on the 3rd day after surgery noted severe pain, while patients of group II had moderate pain. On the 7th day after surgery, pain gradually stopped, but statistically significant differences in the severity of pain syndrome between patients of groups I and II ($p < 0.05$) remained.

Changes in the markers of muscle injury are presented in Table 4.

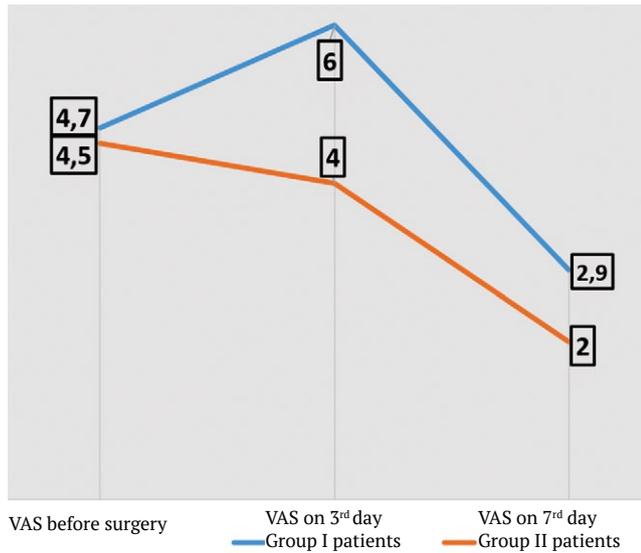


Fig. 3. Dynamics of pain syndrome in the postoperative period in patients of study groups

Table 4

Dynamics of changes in biochemical markers of muscle traumatization in the postoperative period

Parameter	Group I M±SD (min-max); Me (25–75%)	Group II M±SD (min-max); Me (25–75%)
3rd day		
LDH, Unit/l	266.0±14.7(240–291); 267 (254–278)	262±12 (241–282); 264 (253–273)
CPK, Unit/l	753.0±123.2 (540–1012)* ; 751 (657–845)	358.0±82.6 (180–493)* ; 368 (321–413)
Creatinine, mmol/l	59.0±9.9 (42–81); 57 (53–64)	58.6±10.9 (39–85); 57 (51–67)
AST, Unit/l	34.7±6.8 (20–46); 35 (29–41)	34±5 (23–42); 34 (31–39)
CRP, Mg/l	177.0±17.6 (146–222)* ; 178 (164–187)	67±24 (20–112)* ; 69 (46–84)
7th day		
LDH, Unit/l	248.0±22.8 (151–285); 251 (243–261)	253±14 (226–282); 254 (245–264)
CPK, Unit/l	193.3±50.6 (75–278)* ; 198 (163–234)	164.4±31.6 (75–234)* ; 1649 (143–186)
Creatinine, mmol/l	58.7±11.7 (41–81); 56 (49–69)	60.8±10.0 (39–81); 62 (53–69)
AST, Unit/l	23.0±7.2 (11–42); 22 (17–26)	21.6±5.4 (11–30); 22 (18–26)
CRP, Mg/l	29.0±13.6 (8–51)* ; 29 (16–39)	16.5±8.0 (1.3–32.1)* ; 14.6 (10.2–23.4)

Statistically significant values are highlighted in bold; * $p < 0.05$.

The analysis of the data presented in Table 4 showed that in patients who had triple pelvic osteotomy performed from an anterolateral surgical approach, there was a significant ($p < 0.05$) increase in the values of CPK and CRP compared with patients who had triple pelvic osteotomy performed from two approaches. This fact allows us to conclude that during all surgical manipulations on the pelvic bones from the anterolateral approach, there is a significantly greater traumatization of the muscles, which can have a negative impact on static-dynamic function in the long-term postoperative period. For the remaining biochemical markers of traumatization, we did not reveal statistically significant differences ($p > 0.05$).

DISCUSSION

In 1981, D. Tönnis first described his modification of triple pelvic osteotomy, which has gained great popularity around the world for the treatment of children with DDH and Perthes' disease, for which three separate approaches were used and there was need to change the patient's position on the table during the surgery [32]. Since then, this surgical technique has received numerous modifications, which primarily relate to the number of approaches to the pelvic bones [14, 15, 16, 17]. To date, publications on the use of minimally invasive surgical methods for performing triple pelvic osteotomy are increasingly appearing [18, 19, 20, 21].

Thus, B. Balakumar et al. describe the performance of triple pelvic osteotomy from bikini approach with an incision length of 5-7 cm, and W.B. Lehman et al. perform this type of surgery from two "almost percutaneous" cosmetic approaches [18, 19]. At the same time, it should be noted that the effectiveness of triple pelvic osteotomy performed from minimally invasive approaches is judged only by the degree of correction achieved and the length of the skin incision. The analysis of the inflicted muscle injury was not carried out in any of the publications we studied. At the same time, such studies are not uncommon comparing standard and minimally invasive approaches during primary and revision hip arthroplasty in adult patients [29, 33, 34, 35, 36, 37]. However, the results of these studies are quite contradictory, since some authors claim to cause less injury to the muscles performing minimally invasive approaches compared to standard ones. Other authors, conducting a similar bio-

chemical analysis, do not find significant differences in the indicators of muscle injury markers. H.Y. Zhao et al., after comparing anterior and posterolateral surgical approaches to the hip joint, came to the conclusion that performing anterior approach is associated with less muscle injury, as evidenced by differences in both biochemical blood analysis data and less intense postoperative pain syndrome and, as a result, less need for painkillers [35]. A team of authors from Romania, having studied the traumatism of the anterior and lateral approaches, did not find significant differences in the biochemical analysis, but proved less traumatism of the anterior approach in terms of the severity of pain syndrome after surgery and the need for narcotic painkillers [36]. Orthopedic surgeons from the NMIC of Traumatology and Orthopedics named after R.R. Vreden, having conducted a large-scale study of the traumaticity of various minimally invasive and standard approaches during primary and revision hip replacement, came to the conclusion that despite the absence of statistically significant differences in the biochemical markers of muscle injury, minimally invasive anterolateral approach is a priority for young people due to the least intense pain syndrome in the postoperative period. In addition, the authors conclude that the magnitude of intraoperative muscle injury depends, first of all, not on the possible cutting off with subsequent refixation of the hip joint area muscles, but on the pressure of instruments on these muscles to ensure adequate visualization of the surgical wound [29].

Despite the fact, that many orthopedic surgeons in our country have the opinion that the traumatism of triple pelvic osteotomy depends primarily on the number of surgical approaches, the results obtained in our study indicate the opposite. Thus, in patients who had an anterolateral approach made from a single skin incision, the values of the CPK index, which has a high specificity for any changes in human muscle tissue, on the 3rd and 7th days. after surgery, the CPK values were 2 times higher than similar values in the group of patients who had a triple pelvic osteotomy performed from two surgical approaches. The values of CRP in group I patients exceeded those in group II by 2.6 times on the 3rd day after surgery and by 1.8 times on the 7th day. In addition, the intensity of pain syndrome in patients underwent surgery with an anterolateral approach

was significantly more pronounced compared to patients who used two approaches. The results of the study are comparable with the data of H.Y. Zhao et al. and D.V. Nistor et al. [35, 36], since, in our opinion, direct approach and bikini approach, despite the different direction of skin incisions, are largely identical in terms of work in the intermuscular spaces. Besides, we believe that, in addition to the pressure of instruments on the muscles, which effects on the magnitude of muscle traumatization is concluded by A.D. Sineokii et al. [29], the traumaticity of approach also depends on the extent and localization of the dissection of non-vascular intermuscular spaces. So, with an anterolateral approach, the gap between the volumetric and important for static-dynamic function middle gluteal muscle and the tensor fascia lata muscle is dissected for a sufficiently long distance (from the greater trochanter to the anterior superior iliac spine), and with the bikini approach, separation of the gap between the sartorius muscle and the tensor fascia lata muscle is performed for a relatively short length – up to 10 cm, the abductor muscle group remains intact during this approach.

CONCLUSION

A comparative analysis of the traumaticity of surgical approaches during triple pelvic osteotomy in children with Crowe type I DDH, based on the assessment of biochemical markers of muscle injury and the intensity of pain syndrome in the postoperative period, showed that the use of anterolateral approach is statistically significant ($p < 0.05$) has a greater injury to muscle tissue than the use of two surgical approaches (medial transadductor and "bikini"), as evidenced by a significant increase in the level of CPK and CRP in the blood, as well as a more pronounced pain syndrome in the immediate postoperative period. In our opinion, to perform triple osteotomy in patients with Crowe type I DDH, it is preferable to perform surgery from medial transadductor approach and bikini approach.

DISCLAIMERS

Author contribution

Bortulev P.I. – design of the study, literature review, data collection and analysis, manuscript writing.

Baskaeva T.V. – collection of material.

Barsukov D.B. – collection of material.

Pozdnikin I.Y. – collection of material.

All authors have read and approved the final version of the manuscript of the article. All authors agree to bear responsibility for all aspects of the study to ensure proper consideration and resolution of all possible issues related to the correctness and reliability of any part of the work.

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