Hip arthroplasty in patients with high hip dislocation using a device for shortening subtrochanteric osteotomy of the femur

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Introduction Hip joint arthroplasty combined with shortening osteotomy is a technically difficult surgical intervention. Transection of the femur is possible both with the free-hand method and with the use of special devices. **Purpose** To evaluate the efficiency of using a special device for shortening osteotomy in total hip arthroplasty in comparison with the operations performed without an osteotomy guide. **Materials and methods** There were 16 hip replacement surgeries that included shortening osteotomy performed in patients with high dislocation of the femur. The group was divided into 2 subgroups: the study subgroup (8 cases), in which a special device was used for osteotomy, and the control subgroup (8 cases). We used clinical and radiographic study methods, and assessed the Harris Hip Score (HHS) before and after treatment. **Results** Duration of the intervention and intraoperative blood loss in the first subgroup were shorter than in the control group but the difference was not statistically significant. The mean HHS increased significantly in the whole group. The midterm HHS in the study subgroup was 85.4 ± 1.9 points, which slightly differed from the control (81.9 ± 1.2 points). The mean follow-up period was 40 ± 8 months. There were two cases of nonunion in the osteotomy site and one case of transient sciatic neuropathy. Two patients with nonunion of the femoral fragments were treated by plating and bone grafting. **Conclusion** The use of a special device for subtrochanteric osteotomy technically simplifies the arthroplasty procedure in patients with high dislocation of the femur, shortens the operation time and reduces blood loss.

Keywords: hip arthroplasty, hip dislocation, shortening subtrochanteric osteotomy, femur, device for osteotomy

INTRODUCTION

Hip joint arthroplasty in patients with congenital hip dislocation is a technically difficult surgical intervention [1–7]. Shortening osteotomy is frequently a need for bringing the proximal femur down to a required distance to install the cup into the true acetabulum. It reduces the risk of neurological complications and excludes tension of the surrounding muscles and other soft tissues [1, 3, 8–11]. Several variants of the intervention were described: subtrochanteric osteotomy, Paavilainen proximal osteotomy [12–14], and distal osteotomy of the femur which has been rarely used [15, 16].

The femur can be broken with several techniques, including transverse, oblique, step-like and double

chevron osteotomy [5, 6, 17, 18]. There are no persuading arguments in favour of technically complex osteotomies over the transverse one [19]. However, two parallel transverse osteotomies and resection of the fragment of a definite length should be produced for maximum contact of the femoral fragments and avoid nonunion risk. The manipulation can be performed both with the method of “free hand” or special devices.

Purpose To assess the validity of a special device for shortening osteotomy of the femur in total hip arthroplasty and to compare the outcomes with the intervention performed without any osteotomy guide.

MATERIAL AND METHODS

Sixteen patients (16 hips) with high dislocation of the femur who were treated between 2014 and 2019 were included into the study. Including criteria were Crowe type IV hip dysplasia and the need for shortening osteotomy of the femur while performing total hip arthroplasty. Systemic or local infection and somatic contraindications were exclusion criteria. All patients were females in the mean age of 38.6 ± 2 years (range, 25–55 years). Mean relative limb shortening before the intervention was

5.34 ± 0.3 cm (min – 4 cm, max – 6.5 cm). The whole group was divided into two subgroups: study subgroup and control subgroup (Table 1).

The study subgroup included eight patients in whom shortening osteotomy was produced with a guiding device (RF patent No. 182499). Figure 1 shows the guiding device fixed to a dry femoral bone before producing subtrochanteric osteotomy. The osteotomy was performed without a guide in the control subgroup.

Table 1

Characteristics of the patients

	Total group N = 16	Study subgroup N = 8	Control subgroup N = 8
Age	38.6 ± 2	37.2 ± 1.9	40.1 ± 1.9
Mean relative limb shortening (cm)	5.34 ± 0.3	4.9 ± 0.25	5.7 ± 0.3
Length of the resected fragment (cm)	3.25 ± 0.15	3.2 ± 0.1	3.3 ± 0.2
Harris Hip Score before the intervention (points)	38.1 ± 1.5	39.8 ± 0.9	40.8 ± 1.3

Note: N – number of cases

Fig 1 Guiding device for osteotomy: *a* lateral view; *b* front view

The study was approved by the ethics board of the NIMRC for TO. Cementless Smith&Nephew or Zimmer implants with conical stems of square-angled section were used in arthroplasty. Plating was used in two cases for osteosynthesis of a periprosthetic fracture and nonunion of the femur in the osteotomy zone.

Surgical technique The Harding approach extended distally was used. The femur canal was

treated with raspatories upon completion of femoral neck osteotomy. Having mobilised the soft tissues distal to the lesser trochanter with a raspatory, the guiding device was fixed to the femur with two wires inserted transcortically (Fig. 1). Next, the shortening osteotomy followed. The proximal fragment of the femur was displaced backwards to increase the approach to the acetabulum.

The cup was implanted considering the hypoplastic edges and specific shape of the acetabulum which are characteristic of the Crowe type IV dysplasia [1]. One to three screws were used for additional fixation of the cup in 75 % of cases.

The femur component was implanted according to the technique described [20]. If the contact of the fragments was not satisfactory, a corrective osteotomy was produced additionally to improve the contact of the fragments.

When a stable joint with a satisfactory range of motion and without excessive soft tissue tensioning had been achieved, the femoral component was implanted. Plating was used in five cases (27.7 %) in doubtful stability of fixation of the femoral fragments.

Clinical and radiographic evaluation

Harris Hip Score was used for functional assessment before and after the operation. Lower limb telemetry capturing the iliac wings down to the ankle joint was used in 14 cases. CT was performed in ten cases preoperatively to visualise the spatial relations in the hip. Radiological methods also evaluated the position of the implant components and consolidation of the femoral fragments. The shift of the rotation centre was determined analysing the radiographs. The change in the limb length after the intervention was checked clinically and telemetrically.

Moreover, the head-to-neck offset before and after the arthroplasty, the angle of inclination of the acetabular component, vertical and horizontal centre of rotation of the acetabular component were evaluated.

StatSoft Statistica 13.0 and Microsoft EXCEL 2010 were used for statistical processing. Wilcoxon non-parametric test defined the significance of differences. The difference was judged significant at $p \leq 0.05$.

RESULTS

All 16 cases (100 %) were followed up for eight to 48 months (mean, 40.8 ± 2.4 months). Mean duration of the intervention was 205 ± 12.2 minutes (range, 90–290 minutes). Intraoperative blood loss was 763 ± 41 ml (range, 300–1100 ml). Preoperative HHS was 38.1 ± 1.5 points (min – 30.9 points, max – 49.5 points). Radiography and clinical tests showed that the femur consolidated in the osteotomy site after a mean of 6.8 ± 0.3 months (range, 6–8 months). Repeated

surgeries using plating and bone allografting were required in two patients (12.5 %) due to femur nonunion. Main parameters of the intervention are given in Table 2.

Mean total inpatient time was 20.5 ± 1.4 days (range, 14–50 days), 18.5 ± 1.3 days in the study subgroup and 22.7 ± 1.5 days in the control subgroup. Relative limb length increased after the intervention by 3.34 ± 0.28 cm (min – 2.1 cm, max – 5.0 cm). Mean offset increased by 0.2 ± 0.03 cm (min – 0.05 cm, max – 0.22 cm) (Table 3).

Table 2

Parameters of surgical intervention and HHS in the groups

	Total group n = 16	Study subgroup n = 8	Control subgroup n = 8
Intraoperative blood loss (ml)	763 ± 41	725 ± 48.5	807 ± 30
Duration of the intervention (min)	205 ± 12.2	180.6 ± 12.6	229.3 ± 8.4
Harris Hip Score after the intervention (points)	83.4 ± 1.8	85.4 ± 1.9	81.9 ± 1.2

Note: N – number of patients

Table 3

Main radiographic parameters in the group

	Total group n = 16	Study subgroup n = 8	Control subgroup n = 8
Increase in the postoperative offset (mm)	0.2 ± 0.03	0.18 ± 0.02	0.21 ± 0.1
Angle of acetabular component inclination(degrees)	36.2 ± 1.3	34.5 ± 1.6	38.2 ± 1.8
Vertical rotation centre of the acetabular component	15.3 ± 1	14.3 ± 0.9	16.3 ± 1
Horizontal rotation centre of the acetabular component	28.8 ± 0.5	28.5 ± 0.7	29 ± 0.8

Note: N – number of patients

Mean HHS in the whole group was 83.4 ± 1.8 points and was significantly different from the initial value ($p = 0.013$). Differences between postoperative and preoperative scores in the study and control subgroups were also significant ($p = 0.017$ and $p = 0.014$). Midterm HHS in the study subgroup was 85.4 ± 1.9 points and 81.9 ± 1.2 points in the control subgroup. The scores differed significantly ($p = 0.09$). Fourteen patients (87.5 %) had HHS over 80 points that corresponded to a good functional outcome.

Duration of the intervention in the study subgroup was less than in the control one. Intraoperative blood loss was also lower (Table 2). However, the differences were not statistically significant, $p = 0.1$ and $p = 0.44$, respectively.

Complications and re-operations The distal fragment of the femur broke intraoperatively by

installation of the implant in two patients. Cerclage was used for osteosynthesis and the femurs consolidated later. One patient in the control subgroup had transient neuropathy. Clinical symptoms were relieved by application of temporal epineural electrodes and neurotropic therapy.

Two patients, one from each subgroup, had nonunion between the proximal and distal fragments of the femur in the osteotomy site. The nonunion was revealed radiographically at a follow-up after seven and nine months following arthroplasty. Aseptic instability of the femoral component was not detected. Thus, the re-operation included plating and bone grafting. Plates were removed after consolidation in both cases. Radiographic and clinical examination did not reveal signs of aseptic instability of the femoral components.

DISCUSSION

There are various techniques of subtrochanteric osteotomy performance [5, 17, 18]. Almost all the publications available describe the performance of both transverse and oblique osteotomies, along with more complex ones such as chevron and step-cut osteotomies by using the method of “free hand” without special devices [5, 6, 17, 18, 21–25]. However, the “free hand” technique does not always provide a good contact between the femoral fragments that might result in delayed consolidation or even be a reason of nonunion [2, 6, 9, 17, 22, 25].

Only the work of Hotokebuchi et al describes double chevron osteotomy with the use of an original device (Fig. 2) [26].

However, the device described provides the performance of double-chevron (V-shaped) osteotomy only and does not allow rotation of fragments after primary bone sawing. Moreover, only a variation

resection step of 5-mm is possible with the use of this device.

The use of the device patented by us enables correct bone sawing. It also assisted in reducing the duration of the arthroplasty intervention that included the shortening osteotomy and intraoperative blood loss. The differences were not significant ($p > 0.05$), but we believe that it is associated with a small number of patients.

Only one study with the use of a special device for performing subtrochanteric osteotomy in hip arthroplasty has been found by us in the available literature. The results of its authors do not allow conclusions on the efficiency of the method in comparison with the method of “free hand”. The data presented in Table 4 prove that nonunion of the femoral fragments in the osteotomy site and traction neuropathies are typical complications after such operations.

Fig. 2 *a* device for double chevron osteotomy of the femur; *b* diagram of the osteotomy with application of the device

Table 4

Summary data on the hip joint arthroplasty and combined subtrochanteric shortening osteotomy in high dislocation of the femur

Author	Follow-ups (years)	Number of joints	Nonunion (%)	Neuropathy (%)
H. Sofu, 2015 [22]	4.8	73	5.5	0
J. Zhu, 2015 [21]	3.5	21	4.7	3
M. Ollivier, 2016 [6]	28	10	7	0
D. Shang, 2016 [27]	2.7	15	0	13
F. Ozan, 2016 [10]	5.1	32	3.1	0
A. Can, 2017 [28]	3.7	69	1.4	4.3
G. Rollo, 2017 [29]	3.9	17	0	11.7
Mean	7.3 ± 2.2	33.8 ± 8	3.1 ± 0.8	4.6 ± 1.7

The study of Turkish colleagues included 73 arthroplasties with transverse subtrochanteric osteotomies and bone plating with a cable system in all cases. Consolidation in 66 cases (94.4 %) was observed after 5.2 ± 2 months [22].

Rollo et al obtained consolidation in all their patients after 4.5 months. Despite the shortening osteotomy performed, neuropathy happened in 11.7 % of cases. Relative shortening prior to the intervention

was 4.5 cm (min – 3.8; max – 7.0 cm) and corresponds to the initial shortening in our patients [29].

There were two cases of nonunion in the whole group (12.5 %), and one (6.25 %) had sciatic nerve lesion due to traction. Thus, the incidence of complications in our study was similar to the data in the studies published.

Limitation of the study is a small number of cases in both groups.

CONCLUSION

The special device developed for subtrochanteric osteotomy technically simplifies the arthroplasty procedure in patients with high hip dislocation. The results also confirm that the duration of the operation and intraoperative blood loss were lower in the

subgroup with the guiding device used than in the control subgroup. Midterm Harris Hip Score results were insignificantly different ($p > 0,05$). Further study of treatment outcomes in a larger group of patients is needed.

Conflict of interests None

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