REVIEW ARTICLE

TOTAL HIP JOINT REPLACEMENT USING A CUSTOM TRIFLANGE ACETABULAR COMPONENT (LITERATURE REVIEW)

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ABSTRACT
The aim: The purpose of the article is to analyze the ways of solving the problem of revision hip joint replacement. The article discusses the methods of treatment using a custom triflange acetabular component.
Materials and methods: The analysis of 37 literary sources includes a discussion of the features of the use of individual triflange acetabular components and errors in revision hip arthroplasty, which are associated with various factors.
Conclusions: A review of studies devoted to the use of custom triflange acetabular components confirms the effectiveness in the early postoperative period in the treatment of critical acetabular defects and pelvic ring discontinuity. The CTAC use is particularly relevant in case of the pelvic ring disintegration, as it provides for the appropriate endoprosthesis adaptation with the healthy bone, as well as for the bone defects plastics and recovery of the hip joint biomechanics. So, the use of individual constructions is indicated for the patients with significant bone mass loss, where augment adaptation and adjustment is impossible. This method is used more often when there is no other alternative. Research results showed a trend that special three-flange components of the acetabulum have better long-term results compared to traditional standard components for large bone defects. Improving production and increasing the number of CTACs should reduce their cost. In summary, the custom triflange acetabulum components provide a personalized secure fit that can reduce the risk of complications and improve patient outcomes. In summary, the triple-flange acetabulum components provide a personalized secure fit that can reduce the risk of complications and improve patient outcomes.

KEY WORDS: total hip replacement, custom triflange acetabular component, hip arthroplasty, hip replacement complications

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INTRODUCTION

Finding the effective surgical treatment method of the hip joint injuries and diseases represents a key challenge of modern traumatology and orthopedics. Numerous authors support the idea that the best and often the only possible treatment method for such patients is the pelvis joint endoprosthetics [1]. According to Learmonth I. et al., this operation is "the most successful operation of the 20th century". This surgical intervention provides for the restored joint function, improved life quality and, regarding the working-age patients group, is helpful for resuming the working activity of the last [1-5].

The operation is done to patients of almost any age group, ranging from the teenagers to elderly people [2]. According to the WHO, by 2050, diseases of bones and joint will be observed in 25% of the world population [1]. Nowadays, over 1.5mln hip joint endoprosthetic operations are performed annually [6]. In the USA, scientists predict about 572000 operations a year [7]. An increase in the hip joint endoprosthetics percentage directly leads to increase in the revision interventions worldwide. Thus, in the USA the share of the hip joint endoprosthetic operations is expected to increase by 137%, in the period of 2005-2050 [7]. The specific gravity of such operations within the general structure of the hip joint endoprosthetics makes up from 13 till 18% [8].

Unfortunately, not all patients are eligible for the revision endoprosthetics after the wear or loosening of the endoprosthesis. This is related to numerous factors:

Revision endoprosthetics is a complicated operative intervention which should be performed by an experienced orthopedist, and the need for such operations significantly exceeds possibility of being operated. High cost of the revision interventions, often postponing operations due to low affordability of it, late patients' referrals, when in early referral the problem could be eliminated before clinical symptoms appear – all these lead to increase in severe acetabulum destruction incidence, with vast bone tissue loss and considerable acetabular defects. This makes a significant problem for the hip joint revision operations, making such operations most difficult in endoprosthetic surgery [5, 9]. Some authors state that the incidence of huge acetabular defects is 8.5 % among the revisions of the hip joint [10] and 27 % among the acetabulum revisions [11].

According to the Danish National Endoprosthetic Center, the 3rd class defects by Paprosky and the pelvic ring disintegration are increasing by both absolute and relative values, as well as the expenses for the total endoprosthetic revision of the hip joint. As for the Norwegian Register, the data of acetabular defects have remained steady for the Paprosky 3A and Paprosky 3B defects for the last 5 years [12].

Several suggestions for the reconstruction of the acetabulum stages 2 and 3 by Paprosky, have been described, which include structural allographs [13,14,15], augments and module components from trabecular metal [16], anti-protrusion cages, and the various cup-cage systems [17-22].

Quite often, the standard porous component constructions are not sufficient for the revision endoprosthetics, which results in indications for the individual acetabular components use (CTAC-custom triflange acetabular component). C.C. Berasi et al. state that these indications include: 1) history of faulty use of augments or bands; 2) huge defects of the acetabular part with the disintegration of the pelvic ring; 3) multiple operations on the hip joint, resulting in bone defects and bone deficiency, which are not to be reconstructed in other ways [23].

The CTAC use is particularly relevant in case of the pelvic ring disintegration, *as* it provides for the appropriate endoprosthesis adaptation with the healthy bone, as well as for the bone defects plastics and recovery of the hip joint biomechanics [12, 24-26].

The use of the CTAC-acetabular systems is a modern technology, which has been used for the last 5 years, both in Ukraine and neighboring countries. But this method is already introduced into the surgical practice of numerous countries, being used for 15-20 years. During this time, practical experience regarding surgical facilities, method effectiveness, postoperative complications, and economic benefits of the CTAC has been gained.

The literature review, presented in this article, is dedicated to the data analysis.

THE AIM

The purpose of the article is to analyze the ways of solving the problem of revision hip joint replacement. The article discusses the methods of treatment using a custom triflange acetabular component.

MATERIALS AND METHODS

The analysis of 37 literary sources includes a discussion of the features of the use of individual triflange acetabular components and errors in revision hip arthroplasty, which are associated with various factors.

REVIEW AND DISCUSSION

PECULIARITIES OF SURGICAL TECHNIQUE

The technique of the hip joint revision endoprosthetics with the CATC is usually standard, characterized by: more broadly exposed bones which make the acetabulum, for comfort view of a defect and surfaces used for adjustment. After the standard removal of the non-stable primary graft and clearing the bone bed from the scars, CTAC is positioned. The place for the individual acetabular components pubic and ischial flange is prepared by cautious subperiosteal shedding of soft tissues. The vascular and nervous structures must not be damaged. The expressed bone defects need for the bone plastics. After the CATC is positioned, it is attached, the procedure starts with the ischial flange and needs 9-15 screws. Eccentric, lateralized and combined CATC versions may be used to reach the required soft tissue tension and provide for the endoprosthesis components' stable position.

Hourscht C. announced their results after the average period of 4.5 years, after having performed 26 triflange reconstructions, which included three disintegrated pelvic ring cases (AAOS Type-IV)[27]. Two of these three hip joints with the disintegrated pelvic ring were characterized by loose ischial screws, with lost ischial flange adjustment. The screws were not broken. In the Berasi C.C. type, one patient with such faulty ischial flange adjustment wore a stable graft for 11 years [23].

So, during the arrangement of the CTAC, special attention is paid to the ischial flange attachment. To prevent the screws from loosening, which may result from the bone tissue quality deterioration, the screws are primarily twisted in the ischial bone, which provides to pull the CTAC downwards and provide contact of the flange with a bone tissue. An alternative to the screw attachment improvement is filling the ischium bone defect with cement before the screws are introduced. Some authors consider the option of improving attachment by using blocking screws [6,28, 29].

EFFECTIVENESS

Application of the CTAC has shown its high effectiveness in early postoperative period. In studies of numerous researchers, by the Harris scale, the difference in values before the operation and in a year after it ranges within: 36-46 till 75-80 points [30-32].

The frequency of revisions after the CTAC use related to massive defects of the acetabulum (3B type Paprovsky), according to various authors, ranges from 7 to 13.5 %. An increase in revisions, shown in the study of Barlow B.T. et al. was related to the mistakes during locating endoprosthesis (shifting the rotation center for over 2 cm) [20, 21, 27, 29, 33-36].

Different statistical data have been revealed using the CTAC for the pelvic ring dislocation. Thus, in the studies by De Boer D.K. et al. and Taunton M.J. et al., the frequency of revisions was 30 and 35 % [22,28], in the period (123 months and 76 months respectively) after the operation.

A potential advantage of the CTAC is possibility of precise positioning and attachment of the endoprosthesis acetabular component. The results of this method vary with different researchers.

C.C. Berasi et al. have stated only 4 (14.3 %) repeated revisions out of 28 cases of the CTAC use, in patients with the acetabular defects type 3 B by Paprovsky, observed during the period of 4.5 years. The repeated revisions were caused by: two cases of periprosthesis infection and one case of the acetabular component loosening. Here the authors suggest, that the CTAC used with the augments or anti-protrusion cages, for the severe acetabular defects, with disintegrated pelvic ring, will be more effective [23].

The authors of another analysis defined that compared to the alternative treatment options (anti-protrusion constructions with or without bone plastic, trabecular metal constructions), revisions incidence increases twice with the CTAC [34].

The scientists think that the causes of relatively high frequency of revisions, associated with the CTAC, may be explained as follows:

1. Surgeons use the CTAC in cases of impossible reconstruction with a simple graft, which usually is not complicated cases.
2. The CTAC effectiveness estimation in a long-term perspective includes the first individual grafts generation, in which biointegration ability of lower than in the modern constructions, made from the trabecular metal.
3. Using the available data, it is hard to compare the treatment outcomes, which are connected with non-homogenous bone defects in various studies and their imperfect classification. The authors suggest estimating the treatment results of the pelvic ring disintegration and the 3B defects in separate groups.
4. Considering that all the researchers have observed a dozen or more patients, we could assume that the CTAC is the first experience of surgeons, and so, the complications percentage is connected with the introduction of new grafts and different techniques of their adjustment [10, 35].

According to the newly published metaanalysis, the average frequency of revisions observed with treatment of the huge acetabular defects, with the CTAC was 3.8-30.3%. The analysis includes data from 193 patients and 5 studies of the significance level IV [6,8, 28, 32], with the average of revisions, equaling 7.8 %, and the complications percentage - 22 % during 5 years [27, 31]. Nonetheless these values increased to 30 and 35% respectively in studies older than 10 years [28, 29].

POSTOPERATIVE COMPLICATIONS

The most frequent complication which did not require revision, according to the publications, is represented with dislocations. The percentage of dislocations differs between different authors, from 0 to 6.4% [27, 28, 29] to 33 % [36]. M. Citak et al. related a large proportion of postoperative dislocations to the hip joint repeated operative interventions and bone tissue deficiency in the ischiac muscle attachment region, accompanied by muscle misbalance. [36]. The greater trochanter dislocation after the periprosthesis fracture, following the osteolysis or injury, according to MJ. Taunton et al., may be a risk factor for the recurrent endoprosthesis head dislocations when using CTAC. A precise inclination and anteversion as well as the cup design minimize the dislocation risk after attaching the CTAC [22].

As BT. Barlow et al. suggest that extreme verticalization of the endoprosthesis acetabular components is a typical mistake in restoring the acetabulum with segmental defects, which soon leads to the recurrent dislocations [21]. The choice method for recurrent dislocations is using the head with double mobility [8], and use of connected inlays without the acetabular component biointegration increases risk of loosening the acetabular construction.

The next complication is represented with the nerve damage, which represents the minor complications with the incidence of 4 - 8 % [27, 29, 31, 37].

ECONOMIC JUSTIFICATION OF THE CTAC USE

Upon the review of available literature sources, the authors have found a small portion of publications dedicated to the economic effectiveness of the CTAC use. The CTAC advantages include small operation time and, appropriately, decrease in the postoperative complications incidence. The final cost of computer tomography, modeling and producing the CTAC, according to De Boer D.K., may exceed the cost of operation itself. The price of a triflange cup in 2006 was about US $ 8500. Improved clinical results justify such a high price [28].

The CTAC price ranges from that compared to analogical alternatives to the exceeding alternative methods by 36-46%. Taunton M.J in his studies estimated the CTAC cost, including the cup, screws, polyethylene inlay and the production process as equal to $12500. At the same time, the construction made from the tantalic cup, screws, anti-protrusion cage and polyethylene inlay costs $11250. If extra two augments from porous metal were used, the construction cost $14 500 [29]. Wyatt M.C. states that the cost of individual implants MOBELIFE was £13,000, OSSIS – £11,000 and TMTCup-Cage – £7,000 [12]. One should note that the study data do not consider the effect of method on the patients' life quality. It should be emphasized that the authors have not found any studies of the "cost-effectiveness" analysis. So, it is early to make any conclusions about the economic effectiveness of the method.

CONCLUSIONS

A review of the publications dedicated to the CTAC use proved its high effectiveness in an early postoperative period, used for the treatment of the acetabular critical defects and pelvic ring discontinuity, where this method is a choice method and alternative methods are impossible to use. Other methods require maximum adaptation of constructions and allographs to the defect borders and the acetabular bed. With the CTAC use, the osseous bed adaptation is minimum. So, the use of individual constructions is indicated for the patients with significant bone mass loss, where augment adaptation is impossible.

As for the cost and economic effectiveness, the authors suppose that optimizing the production and increasing the production of constructions should affect their cost (toward lower price). The authors recommend this method for broader use in Ukraine.

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