REVIEW

Results of the acetabular custom-made implants usage in extensive acetabular deficiency. Literature review

Wyniki zastosowania implantów panewkowych typu custom-made w rozległych ubytkach kostnych panewki stawu biodrowego. Przegląd literatury

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Abstract

The treatment of massive acetabular deficiency is a challenging problem even for the most experienced orthopaedic surgeons and the acetabular custom-made implants are a relatively promising treatment option for severe bone defects. The aim of this study is to summarize and evaluate outcomes of using acetabular custom-made implants. This review material consists of the results of the selective literary research into custom-made acetabular implants, conducted in Medline through PubMed databases. According to the literature, satisfactory outcomes of using acetabular custom-made implants have been reported with a survival rate of more than 90%. The acetabular custom-made implants are a promising option for massive and complex acetabular bone defects, especially Paprosky type IIIA-B, AAOS type III–IV where the defect cannot be fixed with standard implants.

Key words: total hip arthroplasty, acetabulum, acetabular deficiency, acetabular custom-made implants, custom implant, revision, revision hip arthroplasty, aseptic loosening, pelvic defectss

Streszczenie

Leczenie rozległych ubytków panewki stanowi wyzwanie nawet dla najbardziej doświadczonych specjalistów ortopedii i traumatologii narządu ruchu. Stosunkowo obiecującą opcją leczenia w przypadku poważnych ubytków kostnych jest użycie panewkowych implantów typu „custom-made” . Celem pracy jest podsumowanie i ocena wyników stosowania panewkowych implantów typu „custom-made”. Materiał przedstawia wyniki wybiórczego przeglądu dostępnej literatury dotyczącej panewkowych implantów typu „custom-made” przeprowadzonego w Medline za pośrednictwem bazy danych PubMed. Literatura przedstawia satysfakcjonujące wyniki użycia tego typu panewkowych implantów ze wskaźnikiem przeżywalności powyżej 90%. Panewkowe implanty custom-made są więc obiecującą opcją leczenia masywnych i złożonych ubytków tkanki kostnej, zwłaszcza w przypadku ubytków Paprosky typu IIIA-B oraz AAOS typu III – IV, gdzie ubytek kostny jest na tyle rozległy, że nie może być leczony przy użyciu standardowych implantów panewkowych.

Słowa kluczowe: całkowita endoprotezoplastyka stawu biodrowego, panewka, ubytki kostne panewki, implanty panewkowe custom-made, implant dedykowany, rewizja, rewiizyjna endoprotezoplastyka stawu biodrowego, obłuzowanie aseptyczne, ubytki miednicy

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Introduction

Total Hip Arthroplasty, which results in extensive bone loss and severe acetabular defects is challenging even for the most experienced orthopedic surgeons and the use of standard implants is often found inadequate. The goal of the acetabular reconstruction is to reconstitute bone stock, ilium and ischium continuity, achieve stable pelvic fixation with implant stability, pain-free and functional hip by restoring the biomechanics of hip and hip center of rotation [1]. The challenge of reconstituting the acetabulum depends on the degree and type of bone loss [2,3]. The most challenging are pelvic discontinuity classified as Paprosky Type IIIA-B [2] or type III–IV according to American Academy of Orthopaedic Surgeons [3]. The literature describes multiple options of managing the large periacetabular defects and restoring the acetabular deformity, which indicate considerable difficulties in treatment of this type of pelvic discontinuity among orthopaedic surgeons. The options of treatment are varied but they are not always suitable for treating large structural bone defects. The described complications of using these methods in patients with massive periacetabular bone loss included instability of the hip, loss of fixation, component fracture and failure in restoring functional hip biomechanics [8]. A custom-made acetabular component is a relatively promising option to limit the shortcomings. In recent years, the number of publications on individual replacement of the pelvis have increased which indirectly proves the increasing popularity of the use of acetabular custom-made implants.

The Aim

The aim of this study is to summarize and evaluate outcomes of using acetabular custom-made implants to reconstruct massive acetabular defects.

Materials and Methods

This material represents the results of the selective literature review on custom-made acetabular implants conducted in Medline through PubMed databases. Potentially relevant papers were selected based on abstracts and then full text versions were obtained and evaluated.

Results

It is difficult to make a reliable comparison of the clinical results in the literature due to differences in classification, types of acetabular bone defect, implant features, numbers of patients, number of previous surgeries and revisions and various indications for surgery. Clinical results were summarized by Chiarlone [4] in a review in which 18 publications [6-23] were taken into account and included 627 patients in total (634 hips). The studies showed good clinical and radiological outcomes of custom-made acetabular implants with 94.0±5.0% survival rate. The mean number of complications was 29.0±16.0% . The mean rate of custom acetabular aseptic loosening was 2.6±4.0% and the incidence of periprosthetic joint infection was 4.0±3.9%. The estimated rate of re-operations and re-revisions was 19.3±17.3% and 5.2±4.7%, respectively. Dislocation was the main indication for re-operation (11.5±10.7%). In all studies [6-23] clinical evaluation using Harris Hip Score was performed and the mean was 76.1±8.6. In 17 out of 18 studies analyzed by Chiarlone [4] pre-operative bone defects were classified according Paprosky or AAOS system and in the most cases the grade of bone loss was classified as type IIIA–IIIB or AAOS III–IV. In one case the bone defects were minor classified as IIA–IIIB [22]. One study did not mention any classification or grade of bone loss [23].

Discussion

The treatment of a massive acetabular deficiency classified in publications as Paprosky Type IIIA-B or type III–IV according to American Academy of Orthopaedic Surgeons [6-22] is a complex problem. The acetabular custom-made implants seem to open up new opportunities. First attempts to reconstruct acetabular deficiency using endoprosthesis began in the early 1970s when Scales and Rodney designed and implanted a steel prosthesis in the shape of a resected iliac bone, but it failed due to the infection [24]. The first case of endoprosthetic reconstruction after pelvic tumor (chondrosarcoma) was reported in the literature in 1974 [24]. The preoperative plan was determined by X-ray. Nowadays, the implant is created based on a preoperative CT scans to estimate the extent of the bone defects [25]. Acetabular implant is designed based on the ideal center of rotation and primarily aimed at bone preservation. A unique bone quality map is created and determines the ideal screw positioning. When the project is ready, the implant is made in 3D printing technology from biocompatible materials. The finished product is sterilized and delivered to the client in a sterile form, which saves time during preparation for surgery [25]. Initially, acetabular custom-made implants were created mainly for oncological patients, but over time they were used in revisional total hip arthroplasty [24]. In summarized clinical results the main indication for rTHA with acetabular custom-made implant was acetabular aseptic loosening [4]. The other indications were: implant failure, osteolysis, periprosthetic joint infection, multiple dislocations, instability, metallosis, dysplasia, acetabular fractures and peri-prosthetic femoral fractures [4]. The usage of acetabular custom-made implants has a lot of advantages. Perfectly matched shape of
the custom-made implants to the patient's anatomy addresses the functional and physiological needs.

The perfectly matched custom acetabular component is created from a CT scan of the pelvis, and designed with a central dome that fits into the central acetabular defect [8].

This method allows to achieve stable pelvic and restore biomechanics of hip and hip center of rotation [1,4]. Despite all the advantages, it should be mentioned that the custom-made implants have few flaws.[25]. The designing process takes several weeks and within this time the bony defect may worsen. The other negative aspect is that the overall costs of the procedure are high, usually over 10,000 euro [5, 8, 9, 10].

Conclusions

In the literature satisfactory outcomes of using acetabular custom-made implants have been reported with a survival rate of more than 90%. The acetabular custom-made implants are a promising option for massive and complex acetabular bone defects especially Paprosky type III-B, AAOS type III–IV where the feature of the defect cannot be handled with standard implants. This method allows to adjust the implant to suit the patient's anatomy, achieve stable pelvic fixation and reconstruct the centre of rotation of the hip. However the costs of these implants are high and planning is time consuming.

References