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Review article

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Total hip arthroplasty in patients with acetabular fractures

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Abstract

Introduction Total hip replacement is the most effective technique for the consequences of acetabular fractures. The study includes the literature review on the outcomes of total hip replacement (THR) in patients with post-traumatic coxarthrosis. **Material and methods** The search was performed via databases of PUBMED, SCOPUS, Google Scholar, Cochrane library, E-library and publications using the keywords "acetabulum", "fracture", "total hip arthroplasty" and "post-traumatic arthritis" published between 1995 and 2020. The exclusion criteria were a series of less than 10 patients, a follow-up period of less than 12 months. Abstracts of the meetings and review articles published either in Russian or in English were included in the study. Patients' demographic data, surgical characteristics and outcomes were reviewed. **Results** Total 1,843 publications were reviewed and the analysis included data from 20 studies with the total number of 1,184 cases reviewed. Surgical treatments of the patients were performed between 1984 and 2018. The follow–up period averaged to 5.5 ± 1.19 years (range, 2 to 18 years). The mean age of the patients was 56.4 ± 12.7 years. The mean interval from an injury to total hip arthroplasty was 8 ± 2.7 years. The mean Harris Hip Score was 39.4 ± 11 prior to surgery and 86.2 ± 22 postoperatively. The most common postoperative complications were heterotopic ossification (28.9 ± 10 %), aseptic loosening (8.15 ± 1.82 %) and periprosthetic joint infection (7.89+1.86 %). Complications that required revision surgery were noted in 13.47 ± 2.91 % cases. **Conclusion** THR in patients who sustained acetabular fractures is challenging, and bone grafts or acetabular augments would be needed to address an acetabular defect of any localization.

Keywords: acetabulum, fracture, total hip arthroplasty, post-traumatic arthritis

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INTRODUCTION

Acetabular fractures account for 7 to 22 % of the total number of pelvic injuries [1]. Acetabular fractures primarily occur in young people who are involved in high-velocity trauma [2]. The consequences of such injuries significantly reduce the quality of life and cause permanent disability [3–6]. Total hip replacement (THR) is the preferred method of treatment, for elderly patients, in particular [7–9]. Despite the widespread use of the technique, the results of treatment of post-traumatic coxarthrosis are worse than those from the treatment of idiopathic coxarthrosis [10–12]. THR in patients with acetabulum injuries is associated with difficulties including acetabular defects that prevent achieving a strong primary fixation of standard acetabular components, disturbed anatomical relationships in the joint, pronounced soft tissue scars, the presence of metal constructs, an increased risk of implant related infection, avascular necrosis of the femoral head with limited possibilities for bone autografts [13, 14]. The choice of surgical treatment would depend on the size of bone defect, quality of bone tissue, integrity of the acetabular columns and the pelvic ring to ensure reliable fixation and sufficient contact area with viable bone [15]. A classification is needed for identification of the parameters, clear visualization of the defect and preoperative planning. Although the Judet and Letournel (AO) classification showed the effectiveness in identifying the type of injury to the acetabulum [16], and classifications offered by W.G. Paprosky and K.J. Saleh were useful for describing post-implantation defects and determining the strategy of revision arthroplasty [17, 18], there has been no generally accepted classification for post-traumatic acetabular defects and deformaties. The AAOS acetabular classification being common in the USA [19] allows to accurately localize the defect of any etiology (both post-traumatic and post-implantation) and represent its nature, but the classification fails to reflect the severity of the changes and determine the strategy of defect reconstruction and implantation technique of the acetabular component [20, 21].

There is a limited number of prospective multicenter studies in the modern literature to include a large sample population, long follow-up periods and analysis of the results of treatment in patients with post-traumatic coxarthrosis [22]. The **purpose** of this study was to analyze the literature on the outcomes of total hip replacement (THR) in patients with acetabular fractures.

MATERIAL AND METHODS

To solve this problem, an analysis of publications in foreign and domestic press with a search depth of 25 years was carried out – from 1995 to 2020. The analysis included studies on total hip replacement in patients over 18 years of age with the consequence of acetabulum injuries. Studies on emergency and urgent arthroplasty for acetabulum fractures were not considered. The search was carried out in such databases as PUBMED, SCOPUS, Google Scholar, Cochrane library, E-library.

A literature review assessing Russian and foreign studies on outcomes of THR performed for patients over 18 years of age with acetabular injuries was produced between 1995 and 2020 with a search depth of 25 years. A search was conducted using bibliographic databases of PUBMED, SCOPUS, Google Scholar, Cochrane library, E-library. Search terms included 'acetabular', 'fracture', 'arthroplasty', 'post traumatic arthritis'. Studies on emergency and urgent arthroplasty for acetabular fractures were not reviewed. Case reports, studies reporting less than 10 cases with the follow-up period of less than 12 months were not included in the review. The exclusion criteria were reference papers and publications with unavailable full texts (theses, abstracts). The observation periods were regarded as inclusion criteria, since the period reported reported was reliable for THR cases [4, 22]. The percentage of patients with long-term follow-up was another exclusion criterion. Studies that analyzed the results of treatment in less than 70 % of the total number of cases were not reviewed [23].

Demographic characteristics of patients (number of cases, age), an interval between injury and THR, acetabular defect pattern, description of surgical intervention (surgical approach, type of implant fixation, the use of graft, operating time, blood loss), clinical and functional results of treatment were investigated in the cases. The timing, the number, characteristics and causes of complications, the percentage and timing of revision interventions, implant survival were analyzed at a long term.

The literature search in the databases was performed by two authors, 1843 titles were found, 1022 titles were excluded due to repetition. 821 publications were independently reviewed by two authors who selected the papers for inclusion and exclusion criteria.Total 47 full-text publications were selected for research analysis. Several publications were excluded after a thorough review of full-text versions with 7 papers being neither in Russian nor English [24–30]. Eight publications discussed emergency or urgent joint replacement [31–38]. Eleven contributions discussed either case reports or included less than 10 cases [39–49]. One paper reported the follow-up period of less than 12 months [50]. A PRISMA flowchart was compiled with the contributions reviewed for the inclusion and exclusion criteria [51] (Fig. 1).

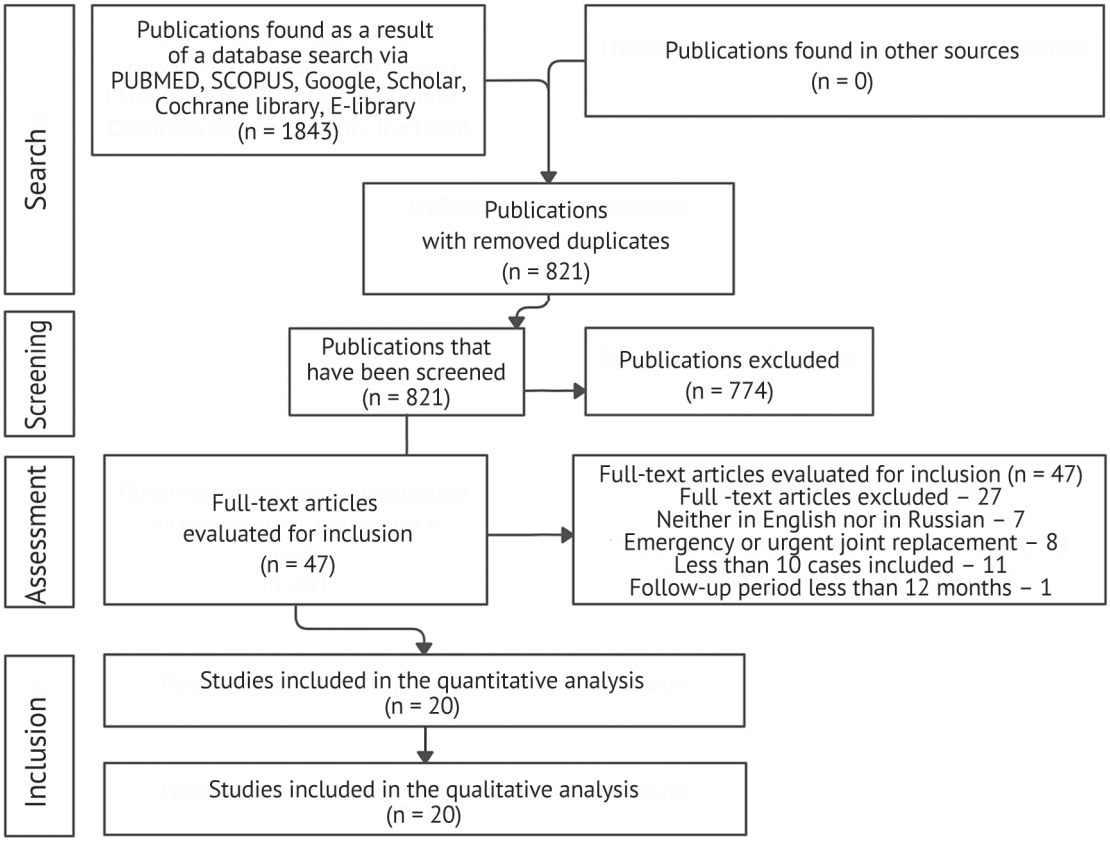

Fig. 1 Flow chart of the review

RESULTS

Twenty publications were included in the study after screening and evaluation of contributions (Table 1).

The total number of clinical observations was 1,184 patients ranging from 12 to 221. Surgical treatment of patients was performed between 1984 and 2018. Patients were followed up for 5.5 ± 1.19 years (2 to 18 years). The mean age of patients was 56.4 ± 12.7 years (19 to 90 years, the median was 51 years). Eleven studies reported the gender composition with the ratio of males and females averaging to 66.2 % of males and 43.8 % females. Ten studies reported an interval between the injury and total arthroplasty with the mean period of 8 ± 2.7 years ranging from 3.1 to 20 years with the median of 6.7 years. Eight studies reported the mean operating time measuring 109 ± 24.2 minutes ranging from 81 to 179 minutes with the median of 93 minutes. The volume of blood loss was reported in 7 studies with the mean intraoperative blood loss of 820 ± 316 mL ranging from 314 to 1100 mL with the median of 898 mL.

The parameter was analyzed as an operational approach. Operational approach was described in 13 publications. Different types of posterior approaches were described in 6 publications (345 cases). A modified anterolateral Harding approach was used in 6 series (440 cases), and the original modified anterior approach was employed for surgical intervention in 21 patients [51]. The Harris Hip Score (HHS) scale was used to assess functional results in most contributions (15 out of 20 papers). Preoperative and postoperative measurements of joint function was reported in 10 papers, and 5 reported postoperative HHS score only. The mean preoperative HHS scored 39.4 ± 11 with the minimum of 28 points [17] and the maximum of 49 points [52, 53]. The median scored 38 points. The mean postoperative HHS scored 86.2 ± 22 points with the minimum of 77 and 78 points [54, 55] and the maximum of 93 points [55, 57]. The median scored 88 points. Postoperative complications required associated revision procedure in 13.47 ± 2.91 % of cases ranging from 1.7 % [55] to 26 % [58] with the median of 13.75 % (Table 2). Neuropathies of different portions of the sciatic and femoral nerves and heterotopic ossification at the site of the totally replaced joint were most common among postoperative complications (Table 3).

Table 1

Studies included in the review

Author	Year	Mean age of patients	Number of cases	Years of study	Period of observation, years
Chiu FY	2015	51	56	1996–2010	10
Khurana S	2015	58	22	2005–2013	4.4
Morison Z	2016	51	74	1987–2011	2
Lizaur-Utrilla A	2012	56.4	24	1992–2005	8
Zhang L	2011	46.6	53	1998–2007	5.3
Ranawat A	2009	52	32	1995–2003	4.7
Berry DJ	2002	49.7	33	1984–1990	10
Bellabarba C	2001	51	30	1984–1995	5.2
Huo MH	1999	52	21	1985–1993	5.4
Weber M	1998	52	63	1970–1993	9.6
Clarke-Jenssen J	2017	54	52	1995–2014	8
Schreurs BW	2005	53	20	1980–2005	9.5
Sermon A	2008	53	121	1983–2003	2.6
Lai O	2011	51	31	2000–2003	6.3
Goodz A.I.	2017	45.7	150	2004–2016	2
Shesternya N.A.	2016		96	2011–2016	5
Pronskikh A.A.	2019	46.1	221	2012–2018	2
Grischuk A.N.	2015	42	12	2009–2014	5
Garkavy N.G.	2017	42	17	2012–2016	1
Tikhilov R.M.	2005	42	56	1996–2004	4

Table 2

Distribution of complications that required revision arthroplasties

Complication	Recurrent dislocation	Aseptic loosening of the components	Periprosthetic joint infection
The mean	7.29 ± 1.63 %	8.15 ± 1.82 %	7.89 ± 1.86 %
The median	6.00 %	5.50 %	5.90 %

Table 3

Distribution of most common complications

Complication	Neuropathy	Heterotopic ossification
The mean	5.99 ± 2.26 %	28.9 ± 10 %
The median	5.70 %	34 %

DISCUSSION

Acetabular fractures and the consequences are one of the common issues discussed by trauma and orthopaedic surgeons. With introduction of open reduction followed by stable internal fixation [59], the techniques and algorithms have been constantly evolving [60]. Modern studies have shown that, post-traumatic arthrosis of the hip joint can progress after acetabular injury in majority of cases, regardless of whether the anatomy of the joint has been restored or not [6]. Many authors report that the pathological changes developing in the hip joint after injury can be polyethological in nature. Z. Morrison et al. suggested that the development of arthrosis of the hip can result from incongruent articular surfaces and also from contusion injury to articular cartilage at the time of injury [61].

Functional results reported showed the effectiveness of surgical intervention that allowed to restore the joint function in the postoperative period and improve the quality of life of patients. M. Weber et al. (1998) [56], B.W. Schreurs et al. (2005) [57], M.H. Huo et al. (1999) [62] reported improvement of joint function that scored 93, 93 and 90 points on the HHS scale, respectively. The studies were conducted in 1970 (M. Weber et al.), 1980 (Schreurs et al.) and 1985 (Huo et al.). Recent studies reporting outcomes of patients treated between 2010 and 2020 [63–65] demosntrated good postoperative HHS score and the results reported were rated as good and excellent. Revision interventions reported in different series ranged from 1.7 to 32 %. The highest revision rate was 30 % and 32 % reported, respectively, by Z. Morison [61] and D.J. Berry et al. [67]. Aseptic loosening of the components in the postoperative period was the main reason of revision surgeries. The above authors concluded that a greater number of revision surgeries occurred in relatively young patients (51 and 49.7 years), in sclerotic cases, in the presence of acetabular defects and pronounced anatomical changes and construct related complications. Analysis of complications and long-term functional results showed no statistically significant differences in use of different approaches that is in line with the findings reported by other authors [68, 69].

Z. Morison [62] and D.J. Berry et al. [67] reported cementless implantation in 96 % of clinical cases. As compared to the findings reported by M. Weber [56] and J. Clarke-Jenssen [70] with cement fixation of the acetabular components in most cases (63.4 % and 64.3 %, respectively), cement-free fixation of the components demonstrated higher survival rate at a long term. Cement fixation of the acetabular components was reported by DW Romness and D.G. Lewallen in earlier studies with the survival rate of implants of 50 % only at a 10-year follow-up [71].

Z. Morison and D.J. Berry reported the polyethylene liner wear, subsequent osteolysis and loosening of components in young patients with involvement of one joint due to a high activity level and the use of thick inserts. D.J. Berry et al. suggested that the use of cement-free acetabular cups of the first and second generations also led to greater polyethylene wear and to revision surgery at earlier periods [61, 67]. F.Y.Chiu et al. and L. Zhang et al. reported a revision rate of 5 and 2 %, respectively and suggested that the choice of the cup and liner material affected the implant survival rate [53, 72]. F.Y. Chiu et al. reported the use of trabecular metal acetabular components with no case of loosening detected [72]. L. Zhang et al. reported use of a ceramic-ceramic friction pair in more than 50 % of cases avoiding a high rate of osteolysis of periprosthetic bone tissue and suggested greater survival of implant components with use of trabecular metal acetabular components and ceramic-ceramic friction pairs [53].

K.G. Makridis (2014) compared the ten-year survival rate of cemented and uncemented implant fixation in a meta-analysis. The authors found no statistically significant differences with the survival rate of uncemented acetabular components being higher (86.7 %) than that of cemented components (81 %) [4]. The authors compared the percentage of aseptic loosening between THR performed before 1995 and those performed within the last 20 years. Revision rate of surgeries performed for aseptic loosening of cups and stems was found to be significantly lower in recent studies.

The authors of the studies included in the analysis used osteoplasty to repair bone defects. Bone chips from cutters were used to repair cavitary defects and structural grafts were applied for segmental defects. Both auto- and allografts were used. Augments made of porous titanium, individual implants (acetabular components and augments) made with use of additive technologies were additionally used to replace an extensive defect and achieve stable primary biological fixation [61, 63–66, 70, 73, 74]. Periprosthetic joint infection is another complication that often requires revision surgery. The highest percentage of the complication was reported by A. Ranawat (16 %, 6 out of 32 cases) [11] and Sermon (15.7 %, 19 out of 121 cases) [7]. A. Ranawat et al. reported 3 cases with a history of a superficial wound infection not requiring removal of hardware, and 3 others developed deep infection with 2 requiring revision surgery and one of these ending in a fatal sepsis. A history of deep periprosthetic infection is clearly associated with septic complications developing due to unstable metal constructs. A. Ranawat et al. reported that out of the 8 patients that had an infection before their arthroplasty, 6 had a post-THA infection. Patients with posttraumatic and idiopathic coxarthrosis show significantly higher complications rate following THR and longer operating hours [11]. Intraoperative blood loss increases with increased operating time resulting in increased anemia that also causes an increased risk of septic complications [61–63]. Measuring inflammation blood markers and examining hip joint with biopsies are offered to be included in the standard preoperative workup to predict septic complications. Metal constructs are to be completely or partially removed from the acetabulum and there should be an interval prior to THR [64, 65].

Another common postoperative complication noted in THR patients is heterotopic ossification Z. Morison et al. reported the highest incidence of clinically significant heterotopic ossification in 43 % with almost 40 % Brooker II heterotopic ossification. D.J. Berry et al. [67] reported the frequency of heterotopic ossification ranging from 28 to 40 %. Our findings showed the incidence of the complication ranging from 5.7 to 43 %, but the occurrence of clinically significant heterotopic ossification was described in 7 out of 20 studies. C. Bellabarba et al. emphasized the effectiveness of the prevention policy reporting 20 % (2 out of 8) of patients who received prevention developed the complication in comparison with 50 % (11 out of 22) who received no preventive treatment. It was hypothesized in the study that indomethacin may play an important role in reducing the likelihood of heterotopic ossification after THR. Preoperative prophylactic radiation can also reduce the likelihood of developing the complications [73].

Treatment results were compared with controls in 9 studies. Two studies compared outcomes of THR in patients whose fracture was repaired either conservatively or surgically [52, 64]. Another 2 studies compared the results of treatment in patients with acetabular defects of various shape and size [58, 65]. A comparative analysis of the results of treatment in THR patients treated for post-traumatic and idiopathic coxarthrosis presented in 4 studies demonstrated that surgical intervention performed for an acetabular injury was more challenging for the surgeon with greater operating time and statistically significant increase in blood loss (by 360 mL on average). Postoperative complication rate was also shown to increase [54, 61, 73, 76, 77, 78, 79].

CONCLUSION

THR for patients with the acetabular injuries and associated bone defects is an important issue of modern orthopaedics. The procedure is complicated with greater blood loss, longer operating hours and increased percentage of complications as compared to routine arthroplasties. THR in patients who sustained acetabular fractures is challenging, and bone grafts or acetabular augments, tailored constructs and implants would be needed to address an acetabular defect of any localization to provide stable fixation of cups and stems. Despite a large sample of studies, there has been no generally accepted classification for post-traumatic acetabular defects and a generally accepted algorithm for surgical treatment of the condition depending on the pattern, nature and localization of the defect. The creation of such an algorithm is becoming a new task in modern traumatology and orthopaedics.

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