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The importance of clinical and radiological evaluation in the diagnosis and treatment of periprosthetic joint infection following hip arthroplasty

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Introduction Infection after total joint replacement is a severe complication that accounts for 40 % with reoperations. An in-depth study from a European country measured the direct costs due to revision of infected hip prosthesis and calculated these at just over €32000 per patient. This represents a substantial need for the timely diagnosis of infection. **Material and methods** Clinical and radiological assessments were performed for 73 patients with periprosthetic joint infection after total hip replacement. Of them, 43 (59 %) patients underwent two-stage revision hip joint arthroplasty using preformed spacer and 30 (41 %) patients had resection arthroplasty with application of the Ilizarov external fixator. **Results** Clinical and radiographic findings used as the basic diagnostic tool for prosthetic joint infection and the choice of the most reliable surgical treatment could provide remission of purulent inflammatory process in 85 to 89 % of the cases and improve functional condition of the limb by at least 24 %. **Discussion** Patients with periprosthetic joint infection after hip arthroplasty constitute a challenging clinical group with the need of comprehensive clinical and instrumental examination with clinical and radiological assessments being an integral part in the diagnosis of prosthetic joint infection. Radiographs and fistulograms are practical in evaluating a clinical situation, identifying periprosthetic joint infection to make careful preoperative assessment and planning. At the same time, the use of the W.G. Paprosky femoral deficiency classification is useful in determining a volume of surgical debridement, choosing an optimal treatment of periprosthetic joint infection and hardware for the performance.

Keywords: periprosthetic joint infection, diagnosis, hip joint

INTRODUCTION

Total joint arthroplasty has become the gold standard to manage the pain and disability associated with end-stage osteoarthritis [1, 2]. Infection after total joint replacement is a severe complication that accounts for 40 % with reoperations. [3]. An in-depth study from a European country measured the direct costs due to revision of infected hip prosthesis and calculated these at just over €32000 per patient. [4].

This represents a substantial need for the timely diagnosis of infection. Major examinations used to diagnose periprosthetic joint infection include clinical, haematological (white blood cell (WBC) count, erythrocyte sedimentation rate (ESR), C-reactive protein (CRP) concentration and B-cell stimulatory factor 2), imaging (radiography, fistulography, scintigraphy, CT, PET), microbiological, morphological, cytological (WBC, neutrophil percentage and leucocyte esterase) screening [5–14].

Radiography is a well-established method to diagnose periprosthetic joint infection. Radiological manifestations that are typical for the condition include migration of an implant components or osteolysis at the bone-implant boundary during 5 years following the surgery, periosteal or endosteal reaction and transcortical sinuses [15].

MATERIAL AND METHODS

A radiological review of 73 patients with periprosthetic joint infection of the hip who received treatment at the RISC RTO from 2004 to 2014 was made. Mean age of the patients was 48.53 ± 12.51 (range, 22 to 82) years, among them 46 (63 %) males.

On admission sinuses were observed in 65 (89 %) patients, 2 (3 %) patients had wounds, and

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6 (8 %) presented with edema and hyperemia of the postoperative suture.

According to classification offered by D.T. Tsukayama (1996) first clinical signs of infection following THR were observed in 27 (37 %) patients within 1 month, in 9 (12 %) patients, from one month to one year, and 23 (32 %) developed infection at the period of more than a year. Intraoperative cultures were positive in 14 (19 %) patients. However, the time of infection manifestation was more than 4 weeks in all the patients on admission that was in indication to removal of the implant.

The involved bone tissue also determined orthopaedic status of the patients. Harris Hip Score calculator measured the mean physiological condition of 43.26 ± 18.66 points. Thus, functional condition of 6 (8 %) patients was evaluated as excellent and good, 5 (7 %) patients were assessed as fair and 62 (85 %) patients as poor.

Three (4%) patients were assigned the American Society of Anesthesiologists physical status (ASAPS) class 1, 41 (56 %) were assigned ASAPS class 2, 15 (21 %) had assigned ASAPS class 3, and 14 (19 %), assigned ASAPS class 4.

Prevalence of elderly patients with accompanying diseases and evident clinical manifestations of periprosthetic joint infection resulted in poor functional condition of the limb and overcomplicated the treatment.

Radiographs of the hip were made for all the patients using a standard technique of two perpendicular projections and AP view of pelvic with focal distance of 1 m was produced with RAY-MAT X-ray unit (Raymed, Switzerland, registration certificate FS № 2006/2099) and Clearscope-1000 (TOSHIBA, Japan, registration certificate FS № 2005/1757). Fistulography was performed using urografin contrast media.

Radiographs showed a type of implant fixation, stability/instability, presence/absence of bone defects, location of sinus and purulent leakage by injecting contrast media in sinus or wound. Migration (subsidence, inclination or rotation) of a component, width of osteolysis measuring more than 2 mm at the bone-implant boundary, periosteal or endosteal callosity at the implant stem were identified as radiological manifestations of instability. We differentiated between periosteal callosity generated by infection and stress-shielding with hypertrophic bone at the distal portion of the femoral component.

The research was conducted in compliance with ethical standards of the Declaration of Helsinki “Ethical principles for medical research involving human subjects” adopted by the World Medical Association, amendments of 2000 and “Regulations for clinical practice in the Russian Federation” approved by the Order of the Ministry of Health of the Russian Federation No. 266 of June 19, 2003. An informed consent for publication of the findings without identification of personal data was received from all the patients.

RESULTS AND DISCUSSION

Radiological evaluation revealed 40 (55 %) cementless implants, 9 (12 %) hybrids, 15 (21 %) cemented implants and reinforcing (antiprotrusion) constructs applied for 9 (12 %) (**Table 1**).

Radiological signs of instability were observed in 42 (57 %) patients, of them (of the total number of patients) 20 (27 %) patients had unstable pelvic component, 6 (8 %) cases had unstable femoral component and both components were unstable in 16 (22 %) cases. Stable implants were recorded in 31 (43 %) cases.

Fistulography showed localisation of sinuses and purulent leakages (**Table 2**).

Purulent leakages localised at the boundary of pelvic and femoral components were observed in more than half of the patients. Femoral involvement was noted in 22 (30 %) patients, and pelvis was involved in 3 (4 %) cases. Fistulography was not performed for 6 (8 %) patients due to absence of wounds and sinuses.

The above radiological findings allow for objective assessment of clinical situation, absence/presence of periprosthetic joint infection and accurate preoperative planning of appropriate reconstructive option.

The most widely used Paprosky Classification for femoral and acetabular defects was employed to establish bone condition (**Table 3**).

Table 1

Type of implant fixation and stability

Type of implant fixation	Stable/unstable implant				Total
	unstable			stable	
	stem	cup	both components		
cemented	2	2	8	1	13
hybrid	1	4	–	5	10
cementless	3	12	5	21	41
reinforcing constructs	–	2	3	4	9
Total	6	20	16	31	73

Table 2

Location of purulent leakage

Location of infection	Number of observations	% of the total number of cases
Involved pelvic component	3	4
Involved femoral component	22	30
Both components involved	42	58
No fistulography performed	6	8
Total	73	100

Table 3

Condition of bone tissue following THR

Type of acetabular and femoral defects according to the W.G. Paprosky classification (1994)	Absolute number	% of the total number of patients
1) acetabulum		
– type 1	26	36
– type 2 A	15	21
– type 2 B	10	13
– тип 2 C	15	21
– type 3 A	2	3
– type 3 B	5	6
Total	73	100
2) femoral bone		
– type 1	28	38
– type 2	24	33
– type 3 A	8	11
– type 3 B	10	14
– type 4	3	4
total	73	100

Type I femoral bone loss was observed in 28 (38 %) patients with intact cortical and cancellous bones of the proximal femur. Considerable loss of cancellous bone at the femoral metaepiphysis was noted in 24 (33 %) cases with assigned type II. Type III A was recorded in 8 (11 %) cases with compromised cortical and cancellous bones in the femoral metaepiphysis and diaphysis and 4 cm of intact bone maintained at isthmus. Compromised cortical and cancellous bones in the femoral metaepiphysis and diaphysis and 4 cm of intact bone maintained at isthmus were observed in 10 (14 %) patients. Extensively compromised metaphysis and diaphysis, malalignment and widened femoral canal like in type IV were seen in 3 (4 %) cases.

Type I acetabular defects were observed in 26 (36 %) patients and were characterised by minimal injury to bone tissue similar to primary arthroplasty. Type II acetabular defects predominated in 40 (55 %) patients. This type involves migration of pelvic component, distorted hemisphere and/or its internal wall with intact and supportive anterior and posterior columns. Only 7 (9 %) type III patients showed radiological signs of marked bone loss of acetabular rim with no support to the implant.

The usage of the above classification was practical in establishing bone defect type, size, and

localization in order to allow selection of appropriate reconstructive option for a given bone loss pattern. We base our clinical decisions on this classification system.

Two-stage revision arthroplasty using preformed spacer was performed for 43 (59 %) patients, and 30 (41 %) patients underwent resection revision arthroplasty of the hip with the Ilizarov external fixation. A combination of chronic periprosthetic joint infection and Paprosky types III and IV femoral defects and types II and III acetabular defects, the previous three and more articular interventions, presence of polymicrobial infection or diabetes mellitus (prediabetes condition), severe immunodeficiency were indications for resection arthroplasty. Two-stage revision arthroplasty was produced in the rest of the cases.

Two major criteria including the Delphi method (2012) to evaluate an extent of purulent infection suppression and the HHS to assess functional condition of the limb were used for the treatment outcomes of periprosthetic joint infection. Remission of the purulent infection process was observed in 85 % of the cases at the first year of observation and in 89 % (n = 18) patients at five years and over of the follow-up. Overall, an average HHS score was shown to increase by 23.76 points reaching 67.02 in both groups of patients. An average HHS measured 81.41 ± 9.0 points in patients who underwent two-stage revision arthroplasty, and 52.63 ± 11.78 points in the group of revision arthroplasty.

CONCLUSION

Patients with periprosthetic joint infection after hip arthroplasty constitute a challenging clinical group with the need of comprehensive clinical and instrumental examination with clinical and radiological assessments being an integral part in the diagnosis of periprosthetic joint infection. Radiographs and fistulograms are practical in evaluating a clinical situation, identifying periprosthetic joint infection to make careful preoperative assessment and planning. At the same time, the use of the W.G. Paprosky femoral deficiency classification is useful in determining a volume of surgical debridement, choosing an optimal treatment of periprosthetic joint infection and hardware for the performance.

The usage of clinical and radiological findings as the basis for diagnosis of periprosthetic joint infection and selection of appropriate reconstructive option can provide remission of the purulent infection process in 85-89 % of the cases improving functional condition of the limb at least by 24 %.

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