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REVIEW ARTICLE

What are the risk factors for post-operative infection after hip hemiarthroplasty? Systematic review of literature

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Abstract
Background Femoral neck fractures are frequent in the elderly population and lead to high morbidity and mortality. Hemiarthroplasty is an established surgical procedure for displaced intracapsular femoral neck fractures. Post-operative infection is frequent and is potentially devastating for the patient and the healthcare services. The goal of this study was to identify the risk factors of infection after hemiarthroplasty and help adapt our surgical practice.
Methods A systematic review of the literature was performed in July 2015 by two authors using the MedLine, PubMed and Cochrane databases. We used the MeSH keywords "hip hemiarthroplasty" AND "infection" to identify risk factors and methods of prevention for surgical site infection after hemiarthroplasty. Following the search, two authors independently performed the first stage based on titles and abstracts.
Results Thirty-seven articles were selected. Review and analysis of the references was performed to find other articles of interest. Thirteen articles were selected to analyse. According to literature, the surgical site infection (SSI) rate after hip hemiarthroplasty (HHA) is between 1.7 and 7.3 %. Pre-operative comorbidities (obesity, liver disease, advanced age), operative conditions (junior surgeon, uncemented stems, time of surgery) and post-operative management (length of hospitalisation, haematoma, prolonged wound drainage and two urinary catheterisations) were identified as risk factors of surgical site infection. Authors describe conditions to decrease the incidence of these complications and underline the importance of "a specialised hip team" that provides fast care and helps decrease the duration of hospitalisation.
Conclusions Careful patient management for hemiarthroplasty is vital and may decrease the incidence of surgical site infection, which is associated with high morbidity and high procedure cost. Our review suggests that there are specific correctable risk factors for SSIs after HHA. Being able to identify these risk factors leads to better care because of SSI prevention in patients undergoing HHAs after femoral neck fractures. To improve the outcomes, some methods of prevention of surgical site infection are available: before, during and after the operation.
Study design Review of literature. Level of evidence: IV

Keywords Hip hemiarthroplasty · Post-operative infection · Risk factors · Femoral neck fracture · Post-operative complications · Prevention of surgical site infection

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Introduction

The incidence of intracapsular femoral neck fractures has increased with improvement in life expectancy and is expected to double in the next 20 years and triple by 2050 [1]. It is a challenge to the orthopaedic surgeon especially in elderly patients with medical comorbidities [2]. One-year mortality is 25 % [3] to 40 % [4]. The primary goal of treatment is to return the patient to pre-fracture functional status and avoiding the hazards of prolonged incumbency. There are multiple internal

fixation methods in addition to hemiarthroplasty or total hip arthroplasty (THA) but internal fixation has been shown to have a higher rate of revision [5]. Hip hemiarthroplasty (HHA) is an established treatment for femoral neck fractures of the elderly [6–9]. The prosthesis-related complications of HHA include: periprosthetic fractures, dislocation, infection, aseptic loosening and acetabular wear [10–15]. Studies have identified revision rates of 4-24 % following hemiarthroplasty [16, 17]. These complications can lead to increase morbidity, mortality and cost.

Patients developing deep infection after HHA have been shown to have up to 50 % 1-year mortality rates [18, 19]. Known risk factors for infection after THA include post-traumatic osteoarthritis, previous surgery, liver disease, corticoid therapy and long surgical time. No risk factors for infection after HHA have been established [20]. Understanding the risk factors associated with surgical site infection (SSI) is important for meaningful comparisons of rates and therefore allow proper prevention [21]. SSIs are divided into superficial incisional, deep incisional and joint infections [22]. In the literature, we did not find any publications discussing risk factors of infection after hemiarthroplasty. The knowledge of these risk factors, pre-operatively, intra-operatively and post-operatively allows surgical practice adaptation to decrease post-operative morbidity/mortality and cost of a prolonged hospitalisation. We performed a systematic review of the literature and a meta-analysis of articles published after January 2005 to identify the risk factors of infection and measures of prevention after HHA.

Methods

The structure of this review followed previously recommended guidelines [23] and was written in accordance with the PRISMA checklist for systematic reviews and meta-analyses [24].

Selection criteria

Initial inclusion criteria were all articles which report medical and surgical management of infection of HHA and which describe risk factors and prevention of SSI, including epidemiological articles. Studies considered for review had the following inclusion criteria: (1) all patients over 18 years of age; (2) femoral neck fracture as the primary indication for surgery; (3) HHA as a primary procedure; (4) final post-operative follow-up of at least one year; (5) recorded SSI data. These studies were restricted according to the following report characteristics: (1) published after January 2005, (2) English or French languages, (3) with an abstract available. The search period was restricted to be more representative of modern operative procedures. The major reasons for exclusion from the study were: case series without description of the SSI, technical notes, letters to the authors, biomechanical studies, articles with less than one year minimal follow-up and articles with a poor methodology. Inconsistencies were resolved by reaching a consensus between all authors after discussion.

Search strategy

A systematic review of the literature was performed in July 2015 by two authors on the MedLine, PubMed and Cochrane databases. We used the following MeSH keywords: “hip hemiarthroplasty” AND “infection”. An additional manual search of OVID (MEDLINE) and EBSCO host (EMBASE) databases, as well as reference lists of each included study, was conducted to identify studies not covered by the initial MeSH Keyword search.

Study selection and quality assessment

Following the search, two authors independently performed the first stage, based on titles and abstracts. Studies were excluded if they did not meet eligibility criteria. If the information required determining eligibility was not in the abstract, a second-stage screen was performed after data extraction. Consensus for studies to be included was achieved by discussion between the two reviewers. Reviewers were not blinded to any study characteristics including journal, authors and study institution. Study quality was first assessed using sample size, study design, follow-up consistency and variability of results. Overall level of evidence applicable to orthopaedic surgery was also assessed [25].

Results

A total of 171 references was found and 37 articles were selected based on title and abstract analysis performed by two of the authors. For all of the 37 articles selected, the reading was completed together with a detailed analysis of the references. The result of the selection is summarised in Fig. 1. Thirteen articles were finally selected.

Study characteristics Five articles with description of national health registers [12, 22, 26–28], four retrospectives studies [20, 29–31], three studies with prospective data [32–34] and one randomised controlled trial [4] were included.

Generality HHA as surgical procedure for femoral neck fracture was associated with an increased rate of surgical site infections following implant surgery for hip fractures [32, 34]. SSI rates after HHA (Table 1) was between 1.7 % [30] and 7.3 % [26]. The two main causative micro-organisms were methicillin-resistant *Staphylococcus aureus* [22] and *Pseudomonas aeruginosa* [29].

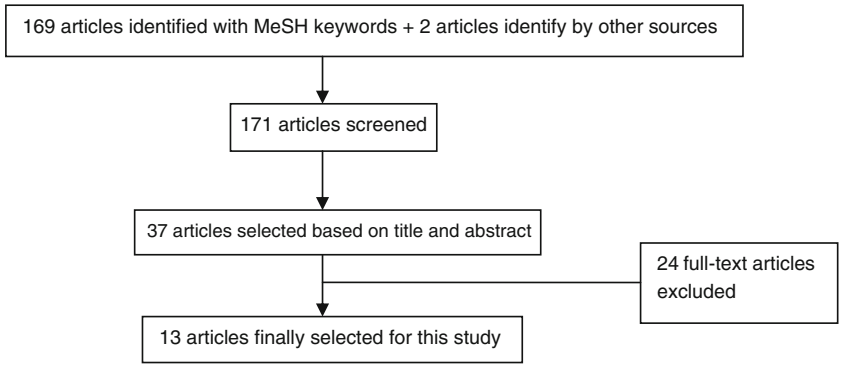

Fig. 1 Flow chart demonstrating selection of studies for inclusion

Pre-operative risk factors Patients who waited for more than one week for surgery and patients with increased length of hospital stay had a statistically and significantly higher risk of SSI [22, 29]. The management of the surgical procedure by a specialist hip fracture surgeon together with a short duration of anaesthesia, significantly decreased the risk of deep infections [34, 35]. Ridgeway et al. [22], Cordero-Ampuero et al. [20] and Acklin et al. [32] showed the importance of surgical time reduction in the prevention of SSIs. For Dale et al. [26], an age of more than 60 years and a long duration of surgery were risk factors of revision due to infection. Acklin et al. [32] concluded that the presence of two operating room staff members is a risk factor for SSI.

A minimum follow-up of 12 months, female gender, previous surgery, obesity, corticoid and immunosuppressant treatments, and inadequate antibiotic prophylaxis were more frequent in late-infected HHAs according to Cordero-Ampuero et al. [20]. Dementia, diabetes and *Staphylococcus aureus* infections are independent predictors of mortality following deep infection [33].

Post-operative risk factors Prolonged wound drainage, haematoma, dislocation [20] and two urinary catheterisations [30] were associated with a higher risk of SSIs [20].

Prevention In the national analysis of Jameson et al. [27], midterm revision and peri-operative infections were significantly higher in the cementless group. Leonardsson et al. [28] and Gjertsen et al. [12] found that the risk of re-operation was higher for uncemented stems because of infection with a hazard ratio of 1.3 and 4.6 respectively. Adoption of a care bundle approach led to a reduction of SSI rates after 1,830 surgical procedures for HHA in the study performed by Johnson et al. [31]. This effective care bundle included double skin preparation with chlorhexidine, a single dose of intravenous co-amoxiclav and gentamicin at induction, and implanted gentamicin-impregnated equine collagen at wound closure.

Discussion

Several risk factors for postoperative infection after HHA are clearly identified in the literature [20]. Careful patient management in cases undergoing hemiarthroplasty may decrease the incidence of SSI, which is associated with high morbidity and high procedure cost. Some methods of prevention of SSI are available: before, during and after the operation.

Treatment of displaced femoral neck fractures includes internal fixation and arthroplasty. The risk of re-operation in the fragile elderly population should not be forgotten when choosing the initial surgery (internal fixation vs HHA) and should be based on the detailed analysis of the initial femoral neck fracture stability [36]. Compared with internal fixation, arthroplasty reduces the risk of the major complications and the incidence of re-operations but does not reduce mortality [5]. As HHAs are considered unique surgical procedures reserved mainly for the elderly population, they cannot be

Table 1 Surgical site infection rates in the selected studies

	Surgical site infection rates after HHA	Number of cases
Sprowson et al. [4]	4.68 %	848
Harrison et al. [34]	4.9 %	6,905
Acklin et al. [32]	6.9 %	217
Cumming et al. [30]	1.7 %	949
Lau et al. [29]	4.3 %	1,320
Dale et al. [26]	7.3 %	1,416
Ridgeway et al. [22]	4.97 %	5,769

compared to THAs. They have different characteristics, aetiologies and prognosis [26, 37, 38]. Late infection is the second most frequent early complication after THA and the most frequent after hemiarthroplasty [20]. The 30-day mortality rate in patients diagnosed with deep infection following hip fracture surgery is higher than those without infection [33]. There are specific risk factors for infection in HHA [20]. The goal of this systematic review was to identify the risk factors of SSI after HHA, therefore aiding in their occurrence.

To avoid SSI, the pre-operative conditions are important [39]. The preoperative management must be multidisciplinary to treat medical comorbidities (chronic renal and liver disease), to stop medications (corticoid and immunosuppressant treatments) and to use the adequate antibiotic prophylaxis [20, 40]. This management must be efficient to decrease the length of time until surgery [29]. Number of days from admission to surgery is an important risk factor of SSI. Steps should be taken to prevent unnecessary delay of surgery in elderly patients requiring HHA. Moreover, use of recommended specific antiseptic agents for patient pre-operative skin preparations is known to be beneficial in decreasing SSIs [41].

Operations by a specialist hip fracture surgeon half the rate of deep infection compared with junior surgeons [34]. Given that information, a special surgical "hip team" is recommended [34]. The shorter duration of surgery is also associated with a lower rate of SSI after HHA [22, 42]. Besides being faster, a specialised hip surgeon could decrease the rate of haematoma and dislocations which are associated with a higher risk of surgical site infection [20]. This conclusion is shared by other publications [43, 44]. According to Parker et al. [44] the most significant benefit of the special "hip" team was in reducing the incidence of surgical site infection following the operative management of displaced intra-capsular femoral neck fractures. Therefore, assigning hip fracture surgery to a designated team will result in a significant reduction in morbidity [44].

A higher risk of SSIs is significantly associated with the presence of two or more operating room staff members, which is a frequent situation in university hospitals [32]. There are significant variations between hospitals in the rates of SSIs and many hospitals have developed local audit systems to focus on its prevention [45]. The results obtained from the randomised controlled trial of Sprowson et al. [4] lead to the recommendations for antibiotic-impregnated cement in the management of patients with fractured neck of femur undergoing a hip arthroplasty.

Furthermore, the risk of re-operation is higher in uncemented stems because of infection [12]. The national guidelines of Jameson et al. [27] support cement fixation of hemiarthroplasty. Cemented stems (with antibiotic-impregnated cement) in the management of patients with fractured neck of femur could be recommended [4, 28].

Post-operative conditions that help prevent SSI are: a shorter wound drainage time, prevention of haematoma and dislocation [20], avoidance of two urinary catheterisations or long-term catheter [30] and decreased length of hospital stay [29]. Burgers et al. [14] showed the importance of implementing a clinical pathway for hip fractures to reduce the hospital length of stay and improves the quality of care.

The management of SSI after HHA depends on time between implantation and beginning of septic symptoms. The management of early post-operative infection (less than 3 weeks after) is a surgical and medical emergency with a multidisciplinary strategy to permit retention of implant [46]. An open approach with surgical debridement, lavage and implant retention with exchange of head and bipolar components followed by aggressive antibiotics may be considered in patients with infections occurring acutely within three weeks of implantation. Diagnostics after three weeks has a success rate of prosthesis retention of less than 10 % [47, 48]. A higher success rate with implant retention may be expected in patients with a short duration of symptoms [49]. Bacteriological analysis during surgery and before antibiotics can identify an infective microorganism and permit medical therapy to be adopted.

The conversion from a HHA to a cemented THA is not clearly established in the literature for early infection, while acetabular components are systematically implanted during revision for chronic infection of HHA [22]. For chronic infection of HHA (more than 3 weeks after implantation), one-stage revision or direct exchange arthroplasty is performed with new implantation of cemented femoral stem in association with large debridement, removal of all old cement mantle and lavage. The authors suggested that using cementless implants or bone graft might be a contraindication for the technique [50]. One-stage revision has obvious advantages and is actually preferable to two-stage revision [51]. With one major procedure, the patient is exposed to less cumulative perioperative risk [52]. A functional revision is completed without exposure to the complications associated with spacers in this fragile population [53]. The duration of the antibiotic treatment is determined after multidisciplinary (medical and surgical) decision and depends on the identified microbe but there is no consensus.

SSIs after HHAs increase morbidity and mortality in the elderly [31]. It is important to identify risk factors and prevention methods to manage the patient requiring HHA. This will ultimately lead to better clinical and functional outcomes. Our data suggest that there are specific correctable risk factors for SSIs after HHA. Being able to identify these risk factors leads to better care because of SSI prevention in patients undergoing HHAs after femoral neck fractures.

Compliance with ethical standards

Conflict of interest None.

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