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Review article

Is there a role for femoral offset restoration during total hip arthroplasty? A systematic review

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ABSTRACT

Benefits of femoral offset restoration during total hip arthroplasty should be the reduction of bearing surfaces wear, implant loosening and dislocation rates. Modular neck stems ensure offset customization but fretting corrosion and catastrophic failures are well-documented complications. Since clinical evidences are needed to substantiate the effectiveness of femoral offset restoration and promote modular neck choice, we systematically reviewed the literature to ascertain whether femoral offset itself has a proven clinical influence: (1) on bearing surfaces wear, (2) implant loosening, (3) and dislocation rates. A systematic literature screening was conducted to find papers dealing with the influence of femoral offset on wear, dislocation and loosening, including articles with conventional radiographic femoral offset assessment and with comparative design. Observational studies, case reports, instructional course lectures, cadaveric and animal studies as well as biomechanical studies, letters to the editor, surgical techniques or technical notes were all excluded. No limits about publication date were supplied but only papers in English were taken into account. Data were extracted into an anonymous spreadsheet. Offset values, dislocation rates, wear rates, follow-up and surgical approaches were all detailed. Ten manuscripts were finally selected. A statistically significant correlation between femoral offset restoration and the reduction of conventional ultrahigh-molecular-weight polyethylene wear was found in two out of three papers investigating this issue, but no correlations were found between femoral offset and dislocation rates or implant loosening. Femoral offset modification influences ultrahigh-molecular-weight polyethylene liners wear, but no correlation was found with dislocation rates or implant loosening. Advantages on wear can be counterbalanced by the use of hard bearing surfaces or highly cross-linked polyethylene liners, besides the availability of larger femoral heads improving implant stability further reduces the importance of femoral offset restoration by means of modularity. We believe that efforts in restoring femoral offset during total hip arthroplasty do not translate into tangible clinical profits and consequently, we do not advise the routinely usage of modular neck stems in total hip arthroplasty. Level of evidence: level III, systematic review of case-control studies.

1. Introduction

Hip biomechanics restoration is generally perceived as the keystone to obtain a high performing new articulation, and femoral offset (FO) plays a major role in this contest [1]. FO is defined as the perpendicular distance between the center of the femoral head and a line drawn down the femoral shaft [2,3]. FO is strictly related to the abductor muscles moment arm, which is represented by the perpendicular distance between the center of the femoral head and a line tangent to the course of the glutei muscles. The strong abductor muscles act to hold pelvis level throughout the gait cycle opposing the body weight, thus a greater FO, resulting in a greater abductor moment arm, reducing the abductors force needed for a normal gait [2,3]. Since the hip is a fulcrum between the body weight and the abductor mechanism, the results of these separate forces generate a proportional joint reaction force directed toward the hip center of rotation [4].

Conventional monoblock stems fail to adequately restore FO in about two third of the cases [5] and it cannot be otherwise, considering the large variability in native femoral offset [6–8]. Lateralized offset stems were therefore introduced [7,9], but modular neck stems represented a further evolution, accomplishing the goal of precise hip geometry reconstruction [10]. Modularity at the neck-stem junction provides undoubted facilities for the hip surgeon, allowing intraoperative offset, version and leg-length adjustment

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independently of stem size. Modular neck solutions should theoretically improve proper FO restoration, which in turns should determine lower joint reaction forces, better soft-tissue tensioning and lower risk of neck to cup impingement with subsequent implant dislocation [4,11]. Although the effective ability of modular neck prostheses to really reconstruct hip geometry in a clinical setting is still under debate [7,12–18], the theoretical advantages of a near-normal FO should be the reduction of bearing surfaces wear, implant loosening and dislocation rates. On the other hand, the introduction of an additional modular junction implies a greater risk of implant failure and several cases of modular neck failures and fretting corrosion at the neck-stem junction have been documented [19–26]. Besides, revision for fractured modular necks could be very troublesome, since the re-use of a damaged trunion should be ideally avoided, and revision of a well-fixed stem is not straightforward [26,27].

We clearly recognize the biomechanical advantages of FO restoration [28–33] and modular neck stems represent an appropriate system to reach accurate FO customization during Total Hip Arthroplasty (THA), nonetheless we hypothesize that data confirming the purported clinical benefits of FO restoration during THA are lacking to date. Since clinical evidences are needed to substantiate the effectiveness of FO restoration and promote modular neck choice, we systematically reviewed the literature to ascertain whether femoral offset itself has a proven clinical influence on: (1) bearing surfaces wear, (2) implant loosening, (3) and dislocation rates.

2. Materials and methods

2.1. Search strategy

A systematic search was conducted screening the available literature to find papers dealing with the influence of FO on wear, dislocation and loosening. The keyword “femoral offset” was therefore combined with “hip prosthesis”, “total hip replacement”, “revision hip replacement”, “dislocation”, “wear”, “loosening”, “complications”, “failure” and “outcomes”. Grey literature was not included in this study. No limits about publication date were supplied but only papers in English were taken into account.

PubMed (http://www.ncbi.nlm.nih.gov/sites/entrez/), Ovid (http://www.ovid.com/), Cochrane Reviews (http://www.cochrane.org/reviews/) and Google Scholar were all accessed on March 1, 2016. This search strategy produced a total number of 1086 articles, all entered onto the Zotero™ reference manager. After elimination of duplicates, two authors (M.R. and A.T.) independently assess abstracts whereas title page or the full text versions were used when the abstract was missing. Papers deserved to be included in the review if conventional radiographic assessment of FO on standard Anteroposterior (AP) pelvis radiographs was available and if they had a comparative design (i.e. case control studies, cohort studies, prospective comparative studies and randomized controlled trials). Observational studies, case reports, instructional course lectures, cadaveric and animal studies as well as biomechanical studies, letters to the editor, surgical techniques or technical notes were all excluded. If there was any doubt about inclusion, the senior author (S.Z.) solved the question.

From the total initial number of 1086 retrieved articles, after elimination of duplicates and abstract/title evaluation, 1038 articles failed to meet the inclusion criteria. After selection 48 were remaining. The full text of these 48 selected was obtained and cross-referencing these manuscripts no further articles regarding the subject of the research were included. Assessing the contents of these 48 records, 38 papers were additionally excluded. Reason for exclusion was the lack of a case control design, the inconsistent FO radiographic measurement or the investigation of the relationship between FO and abductor strength, which is beyond the scope of this review. The remaining 10 articles were included in the review [12,14,34–41]. The search process was resumed in Fig. 1.

2.2. Data extraction

Data were extracted into an anonymous spreadsheet by one of us (A.T.). FO values, dislocation rates, wear rates, follow-up and surgical approaches were all detailed. The retained articles were published from 1999 to 2015. All but one [34] were characterized by a retrospective design. There were 8 level III [12,14,35,36,38–41], one level II [34] and one level IV studies [37], assessing the outcomes of 2885 THAs. Baseline comparability between populations under investigation was adequate in all but one [40] studies. The relationship between FO and dislocation rate was the most frequently investigated topic (Table 1). Since none of the retrieved article was a randomized controlled trial, methodological quality was scored using the Newcastle-Ottawa Scale (see http://www.ohri.ca/programs/clinical_epidemiology/oxford.asp) (Table 2) and methodological features of the retrieved articles were reported in Table 3. The methodological evaluation was independently performed by two of us (A.B. and M.N.). Power analysis was present just in one article [34] and, although sample size calculation was theoretically performed in the paper by Hartman and Garvin [39], authors did not report the exact sample size, simply affirming that the required population was not reached.

2.3. Statistical assessment

The wide variability among the extracted data allowed just a qualitative analysis. In fact, data aggregation and statistical assessment were precluded due to the heterogeneity of subgroups and the variability of the assessed parameters across the studies.

3. Results

In three papers, FO assessment was performed by means of a digital software whereas traditional assessment on AP pelvis X ray was the method used in six. More than one assessor was present just in three papers [14,34,39] (Table 3).

3.1. Femoral offset and wear

The relationship between FO and polyethylene wear was investigated in three articles [34–36] (Table 2). A total number of 218 hips were enrolled. In the paper by Little et al. [34], study groups were created considering the ability of THA to restore FO within 5 mm of the native contralateral FO, founding no significant differences in liner and volumetric wear rates. Although the authors reported a trend toward lower polyethylene wear in the hips with an adequately restored FO, this difference did not reach significance probably due to the small sample size. Sakalkale et al. [35] evaluated 17 staged bilateral THAs using standard offset stems on one side and lateralized offset stems on the contralateral side. Under-restoration of FO determined a significantly increased wear in this paper. Even in the paper by Devane and Horne [36], under-restoration of FO with respect to preoperative values led to a threefold increase in mean volumetric wear. Follow-up seems to be adequate in all studies (Table 4).

3.2. Femoral offset and dislocation

The influence of FO on dislocation rate was resumed in Table 4. A total number of 1830 hips were assessed. In three studies, a population of dislocated hips was compared to the non-dislocated