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Survival Rate of Short-Stem Hip Prostheses: A Comparative Analysis of Clinical Studies and National Arthroplasty Registers

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ABSTRACT

Background: The primary aim was to evaluate the outcome of short-stem hip prostheses in terms of overall revision rates. Data were taken from published literature and national arthroplasty registers. The second study aim was to evaluate a potentially superior outcome of dependent compared to independent clinical studies.
Methods: All clinical studies on short-stem hip prostheses between 2006 and 2016 were reviewed and evaluated with a special interest on revision rates. Revision rate was calculated as “revision per 100 component years.” Short stems were divided into femoral neck retaining (NR), neck sparing (NS), and neck harming (NH) prostheses. Published literature was further classified into dependent and independent studies, and data were compared to the Australian National Arthroplasty Register.
Results: Fifty-two studies with 56 cohorts met the inclusion criteria and were therefore included in our study. All clinical studies showed a median revision rate of 4.8% after 10 years. NS and NH stems performed equally, whereas neck retaining prostheses were significantly inferior. Independent showed higher revision rates compared to dependent data without being statistically significant. The Australian register revealed a revision rate of 6.6% after one decade.
Conclusion: Similar low revision rates for NS and NH short-stem prostheses were found in the included data. Dependent studies seem not to be biased with regard to the longevity of short-stem hip replacement. Longer follow-up periods in clinical studies and more detailed information in arthroplasty registers would be desirable for future studies.

Total hip arthroplasty (THA) developed from a geriatric surgery to a lifestyle surgery during the last decades [1]. One suggested reason is a long-term survivorship of more than 95% after 15 years, which has led to an increased number of performed THAs in the younger and more active population [2,3]. Owing to the younger age at primary THA, this patient group is more likely to have revision surgery. This is why it has become a major issue to optimize the outcome of THA for young patients.

Short-stem prostheses for hip arthroplasty were introduced in the 1990s to preserve proximal bone stock for future revisions and to better reconstruct biomechanical proportions [4–7]. It has been postulated that conventional stems with diaphyseal or metadiaphyseal anchorage may lead to stress shielding and potential bone loss and may not retain enough intact bone for revision surgery [8]. In addition, a correct biomechanical reconstruction affects the survival rate of the implant. Another positive aspect of short-stem hip prostheses is the fact that a smaller prosthesis design makes it easier to allow tissue-sparing minimally invasive approaches [9].

Although no uniform classification is available for short-stem prostheses, depending on the femoral neck resection, they can be divided into femoral neck retaining (NR), femoral neck sparing (NS), and femoral neck harming (NH) short-stem prostheses as illustrated in Figure 1 [1]. Life expectancy of prostheses and their revision rates are of fundamental importance for surgeons, patient's satisfaction, and for economic reasons [10–12], and 2 major data sets are available for final evaluation: sample-based clinical studies and national arthroplasty registers. Studies try to extrapolate the results of a sample to the patient population [13].

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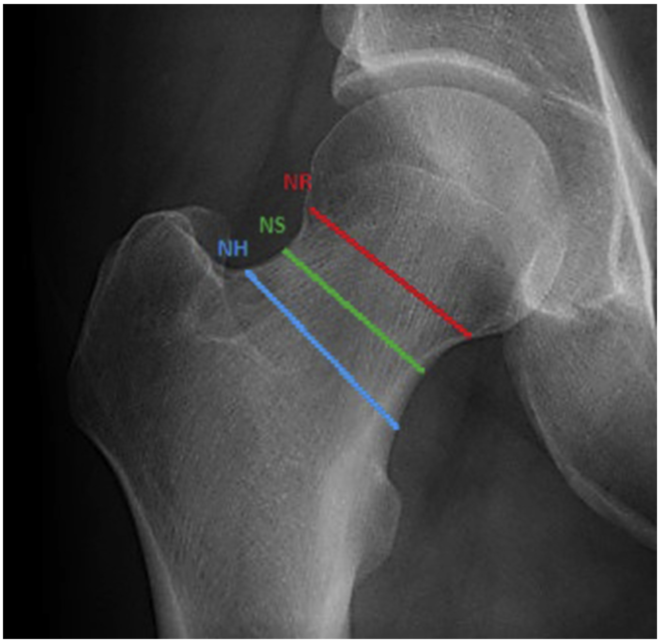

Fig. 1. Classification of short-stem hip prostheses depending on the femoral neck resection. NH, neck harming; NR, neck retaining; NS, neck sparing.

Registers include all surgeries performed in a certain region and represent the average outcome in average patient. Therefore, data sets of high-value registers can be used as a control group when compared to sample-based studies [12].

The primary aim of this study was to compare revision rates of short-stem prostheses, as presented in the literature of the past decade and in arthroplasty registers. The respective data were analyzed with regard to a potential difference of the percentage of performed revision surgeries as described in clinical studies. The intention was to reveal the characteristics of successful short-stem hip prostheses.

The second aim of this study was to evaluate a potentially superior outcome of short-stem hip prostheses described in dependent clinical studies compared to independent studies or arthroplasty registers.

Materials and Methods

Literature Selection

In June 2017, the electronic medical database PubMed was searched for the following search terms "(arthroplasty, replacement, hip)" AND "short stem OR mini stem." In addition, an individual search on all known systems of short-stem prostheses was carried out. After completion of the search, the search output was recorded. Scientific papers with no direct reference to the topic were excluded.

Finally, we checked the reference papers from included publications for their eligibility to join our study.

Each study was evaluated separately. Included prostheses were classified as either femoral NR, femoral NS, or femoral NH prosthesis. Included publications were divided into dependent studies or independent studies. If the implant developer was listed as an author or co-author, or the developing institution was indicated for correspondence, the study was rated as dependent.

Studies have had to meet the following criteria to be included: (1) a mean follow-up time of 24 months or more, (2) revision rates were either mentioned in the text or could be calculated from the available data, (3) the used implant must have been clearly specified as a short-stem prosthesis, (4) the presented data have had to be published in a MEDLINE-listed, peer-reviewed journal and to be written in English or German language, and (5) the date of publication was between 2006 and 2016. If there were multiple reports of the same study group published in this period, the report with the longest follow-up period was included.

Reports on custom-made short-stem prostheses as well as case reports, reviews, and former meta-analyses were excluded.

All included papers were reviewed for the following information: title, year of publication, origin of the corresponding author, publishing journal, study design, name of prosthesis, type of prosthesis, number of patients lost to follow-up, follow-up in months, number of revisions for any reason, reason for revision (if available), surgical approach (if available), and Harris Hip Score preoperative and postoperative (if available).

National arthroplasty register reports were scanned for data concerning revision rate of short-stem hip prostheses. The latest annual reports were taken from the European Federation of National Associations of Orthopaedics and Traumatology Website of the Network of Orthopaedic Registries of Europe [14]. Only the Annual Report of 2016, provided by the Australian Orthopaedic Association National Joint Replacement Registry published sufficient information and long-time data for our purpose [15].

Outcome Measurement

The main indicator evaluated was "revision for any reason." This is a recognized, well-defined, and objective parameter after primary hip arthroplasty that covers a variety of possible complications. This indicator clearly determines an event of failure and is therefore well suited for comparative analyses [10,13].

As included studies differ between number of implants and follow-up periods, we used the parameter "revision per 100 observed component years (CYs)" introduced by the Australian Joint Replacement Registry. This parameter normalizes separate studies and allows to compare revision rates of different clinical studies irrespective of different follow-up periods and different number of implants. The formula for the calculation is number of cases of revision surgery for any reason divided by the number of CY observed and multiplied by 100. A value of 1 represents a 1% revision rate at 1 year and a 10% revision rate at 10 years of follow-up [13].

The principle of the calculation means that there is a potential risk of reintervention from the time a prosthesis is implanted until revision surgery or death of the patient. The individual follow-up periods of all patients included are combined, and this cumulative figure of "observed CYs at risk" is then compared to the actual number of revision operations observed [16].

Publications were rated as successful if they presented a calculated 10% or lower revision rate at 10 years of follow-up.

Statistical Analysis

With regard to the methodology, we used the same criteria as already published by other investigations [11,12,17]. Since the included studies and register data represent real-life data, we do not work with "probabilities," and therefore, no calculation of *P* values is possible [17]. Thus, a difference factor by the ratio of 3 between the outcomes of the investigated groups was considered as significant. As described in quality of literature in arthroplasty [13], a different factor up to 3 (for instance, the revision rates of a data set are 3 times as high as in the control group) between the data sets is considered to be explicable by