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ORIGINAL ARTICLE

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Patient outcome following revision total knee arthroplasty: a meta-analysis

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Abstract The purpose of this study was to summarize the literature describing patient outcome following revision total knee arthroplasty. Original studies were included if they were published between 1990 and 2002, enrolled ten or more patients, and measured patient outcome using a global knee rating scale. We found 33 studies with a total number of 1,356 patients. There were 429 men and 611 women with a mean age of 67 (45–90) years. The weighted mean follow-up time was 57 (6–108) months. The main indication of revision was loosening. The weighted mean preoperative and postoperative knee scores were 49 (15–82) and 84 (58–109) respectively. There were significant differences between preoperative and postoperative knee and function scores and motion (knee: t=12.507 p<0.001, function: t=4.704 p<0.001, motion: t=5.346 p<0.001). Loosening was also the main complication after revision surgery. In this analysis, revision total knee arthroplasty was a safe and effective procedure.

Résumé Le but de cette étude était de résumer la littérature qui décrit les résultats après reprise d'arthroplastie totale du genou. Les études originales ont été incluses si elles avaient été publiés entre 1990 et 2002, avec dix malades au moins et l'utilisation d'une échelle d'appréciation globale du genou. Nous avons trouvé 33 études avec un nombre total de 1356 malades. Il y avait 429 hommes et 611 femmes avec un âge moyen de 67 (45–90) années. La moyenne pondéré de suivi était 57 (6–108) mois. La principale indication pour la révision était le descellement. Les scores moyens pondérés préopératoires et les scores postopératoires étaient 49 (15–82) et 84 (58–109) respectivement. Il y avait des différences significatives entre les scores du genou pré - et postopératoires, les scores fonctionnels et les scores d'amplitude (score du Genou: t=12.507 p<0.001, scores fonctionnels: t=4.704 p<0.001, scores d'amplitude: t=5.346 p<0.001). Le descellement était aussi la principale complication après la chirurgie de révision. La révision de l'arthroplastie totale du genou était une procédure sûre et efficace dans ces études.

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Introduction

The aim of this study was to perform a systematic literature review to describe patient outcomes following revision total knee arthroplasty. The study investigators agreed a priori on four questions of patient prognosis to be addressed in this review: (1) Is there significant difference between preoperative and postoperative knee and function scores and motion? (2) What is the revision's main indication? (3) What is the main complication after revision surgery? (4) Are there significant differences between various implants?

Materials and methods

Literature search

We performed a computerized literature search using MEDLINE to identify all citations concerning revision total knee surgery published from 1 January 1990 through 31 August 2002 using the MeSH terms knee, prosthesis, arthroplasty, and revision. We obtained a copy of the original article for each identified English-

language citation. We then examined the reference lists of all retrieved review articles published from 1990 through 2002.

We used a multistaged assessment to determine which articles contained data that could address our study questions. In the first stage, the study investigators determined the number of patients enrolled and whether the article reported on any postoperative outcomes. We excluded from further review any article that enrolled fewer than ten subjects or failed to report any postoperative outcome and were published before 1990. We performed a second-stage assessment to exclude any article that reported on procedures other than revision total knee replacement and did not report on relevant postoperative outcomes. At the third stage, we excluded any study that did not use a global knee-rating scale to describe patient outcomes. A global knee-rating scale was defined as an instrument that measured patient outcomes in the domains of pain, function, and range of motion and combined these domains in a summary scale. This third filter on the identified literature was necessary to allow comparison of global outcomes across studies.

Data abstraction

One investigator, who had been educated in the data abstraction requirements, completed the data abstraction. Difficulties in abstracting data primarily resulted from two types of missing data. First, when an author did not mention the variable of interest, the data abstracter could not ascertain whether the characteristic was absent or simply not reported. The second type of missing data occurred when the variable of interest was mentioned as applying to a subset of enrolled patients, but these patients were not identified in number or stratified in the results.

Examples of variables that we were unable to include in this study because they were inconsistently reported include patient race, prosthetic design factors, previous surgical procedures on the index knee, and postoperative rehabilitation.

In addition to missing data, we encountered two problems with reporting style. The first concerned whether the author reported data using the patient or the knee as the unit of analysis. To correct for this difficulty, we determined for each abstracted variable the mean proportion of enrolled knees to enrolled patients based on studies that reported both, and then we converted all data to "patients" as the unit of analysis. The exception to this process was for complications, because the majority of studies used the knee as the unit of analysis to report postoperative complications. For complications, we converted "patients" to "knees" when the data were reported only as patients. The second problem was the author's choice of a global knee-rating system. To allow a comparison of patient outcomes across studies, we recorded for each study the mean preoperative and postoperative global knee-rating scale score using a 100-point scale, the Knee Society's scoring system, the Hospital for Special Surgery knee-rating scale system, and the Bristol scale system for all studies. All different scoring systems were analyzed independently and separately.

Authors also showed variability in reporting style of complications. Some studies did not report complications that were minor, transient, or not directly related to the prosthesis. To provide some consistency across studies in reported complication rate, we did not include in the complication rate patients with reported complications such as delayed wound healing, hematomas, knee effusions, pressure sores, etc.

Because of the number of different prostheses reported in the literature and the variable number of studies per prosthesis, we used two classification schemes to compare groups of prostheses. First, we classified them by the manner in which the cruciate and collateral ligaments were treated, either as PCL sparing, PCL sacrificing without PCL substitution, and PCL sacrificing with PCL substitution. In another method, we classed implants just by their trademark. When an article reported data across more than one classification and stratified patient characteristic and outcomes by classification, we regarded these data as two separate articles. When an article reported data across more than one classification but did not stratify outcomes by classification, we regarded the article as a single study and the outcomes as a mixed group.

Data analyses

One investigator, who is a professional statistician, completed the data analysis independently. We performed a multivariate analysis using the mean postoperative global rating scale knee and function score and motion degree as the dependent variable. Because individual studies varied in the number of enrolled patients, each mean was weighted by the number of enrolled patients. We included as independent variables only those with significant bivariate relationships ($p<0.05$).

Results

Literature description

A total of 605 articles were identified in the literature search. Of these studies that passed through all three filters, 33 reported on patient outcomes following revision total knee arthroplasty(Table 1). These 33 articles were published from 1990 through 2002. The articles were mainly published in two different journals: 42.4% appeared in *Clinical Orthopaedics* and 36.4% in *Journal of Arthroplasty*. Four studies reported stratified results across two different prosthetic classifications and one across three different prosthetic classifications for a total of 33 patient cohorts. The Knee Society score system was used in 70% of the studies.

Patient characteristics

The total number of patients summed across the 33 studies was 1,356. Because some articles lacked the number of patients' gender [1, 3, 5, 6, 7, 8, 9], there were 429 men and 611 women with the weighted mean age of 67 (range 45–90) years. The studies reported outcomes on a mean of 41 (median 34) patients. The weighted mean patient follow-up time was 57 (median 48 months, range 6–1080 months.

Study outcomes

Weighted mean preoperative and postoperative global rating scale knee scores were 49 (range 15–82) and 84 (range 58–109). Weighted mean preoperative motion and postoperative motion were 83 (range 32–134) and 95 (range51–139). Mean preoperative and postoperative function scores were 36 (range 0–75) and 59 (range 19–100). After meta-analysis, the results show that there were observably significant differences between preoperative and postoperative knee and function scores and motion (knee: $t=12.507$ $p<0.001$, function: $t=4.704$ $p<0.001$, motion: $t=5.346$ $p<0.001$).

Table 1 List of enrolled articles on which the meta-analysis was based. *KSS* Knee Society clinical rating system, *HSS* Hospital for Special Surgery knee rating scale

Author	Origin	Number of revisions (knee)	Scoring system
McAuley JP	Clin Orthop (2001) 392:279–282	32	KSS
Bradley GW	Clin Orthop (2000) 371:113–118	21	KSS
Fehring TK	Clin Orthop (1998) 356:34–38	63	HSS
Whiteside LA	Clin Orthop (1998) 357:149–156	63	KSS
Gill T	Clin Orthop (1995) 321:10–18	30	KSS
Tsahakis PJ	Clin Orthop (1994) 303:86–94	19	KSS
Mow CS	Clin Orthop (1994) 309:110–115	17	KSS
Murray PB	Clin Orthop (1994) 309:116–123	40	KSS
Takahashi Y	Clin Orthop (1994) 309:156–162	39	KSS
Berry DJ	Clin Orthop (1993) 286:110–115	42	KSS
Elia EA	Clin Orthop (1991) 271:114–121	40	KSS
Padgett DE	J Bone Joint Surg [Am](1991) 73(2):186–190	21	HSS
Karbowski A	Arch Orthop Trauma Surg (1998) 117:256–258	36	HSS
Hohl WM	Clin Orthop (1991) 273:91–97	29	KSS
Rosenberg AG	Clin Orthop (1991) 273:83–90	36	HSS
Christensen CP	J Arthroplasty (2002) 17 (4):409–415	11	KSS
Bugbee WD	J Arthroplasty (2001) 16 (5):581–585	139	KSS
Bohm I	J Arthroplasty (2000) 15(8):982–989	35	HSS
Haas SB	J Bone Joint Surg [Am] (1995)77(11):1700–1707	76	HSS
Benjamin J	Clin Orthop (2001) 392:62–67	46	KSS
Barrack RL	J Arthroplasty (2000) 15(4):413–417	73	KSS
Barrack RL	J Arthroplasty (2000) 15(7):858–866	103	KSS
Hartford JN	J Arthroplasty (1998) 13(4):380–387	16	KSS
Mow CS	J Arthroplasty (1998) 13(6):681–686	36	HSS
Chakrabarty G	J Arthroplasty (1998) 13(2):191–196	73	Bristol
Peters CL	J Arthroplasty (1997) 12(8):896–903	57	HSS
Otte KS	J Arthroplasty (1997) 12(1):55–59	29	HSS
Mow CS	J Arthroplasty (1996) 11(3):235–241	16	HSS
Knight JL	J Arthroplasty (1995) 10(6):748–757	18	HSS
Babis GC	J Bone Joint Surg [Am] (2002) 84(1):64–68	56	KSS
Clatworthy MG	J Bone Joint Surg [Am] (2001) 83(3):404–411	52	HSS
Ikezawa Y	J Orthop Sci (1999) 4:83–88	23	KSS
Ghazavi MT	J Bone Joint Surg [Am] (1997) 79(1):17–25	30	HSS

Prosthesis characteristics

There were many different prostheses in the enrolled literature; we constructed two graphs to display the total cases of each type of prostheses classed by implant brand or anatomic classification. In the classed by brand group, the Insall-Burstein (Zimmer, 18%), TC III (Zimmer and J&J, 17%), Coordinate (Depuy, 16%), PCA (Howmedica, 16%), and PFC (J&J, 14%) were in more common use than other implants. In the classed by anatomic classification group, PCL sacrificing with PCL substitution (52%) and PCL sparing (42%) were often chosen. Because there were many studies with mixed implants, we could not separate them clearly. The results showed that no clear significant differences between various implants were found due to the small number of valid and exclusive observations.

Indication for revision

The results show that loosening (55%) was the main reason for revision total knee arthroplasty, and other reasons include polyethylene wear (11%), instability (10%), infection (7%), and progression of disease (4%).

Complications after revision surgery

Common complications were loosening (18%), instability (16%), and infection (16%). Other complications were patellar failure (15%), pain of unknown origin (13%), fracture (9%), manipulation (7%) and stiffness (6%). Patellar failure included subluxation, dislocation, tendon avulsion, patellofemoral pain, and clunk.

Discussion

The study summarizes results of a systematic literature review reporting on patient outcomes following revision total knee arthroplasty. The goals of this meta-analysis were to provide precise estimates of patient outcomes and to identify clinical questions concerning revision total knee arthroplasty that are not readily answered by the current literature. Meta-analysis is particularly useful when the extant literature concerning an intervention is composed of numerous small studies that report conflicting results [10, 11].

Mean knee scores improved from 52 points preoperative to 92 postoperative. Mean knee motion was 85 preoperative to 97 postoperative. Knee function scores were 29 preoperative to 54 postoperative. There were observably significant difference between preoperative

and postoperative knee and function scores and motion. We also found a temporal trend that more recently published studies reported higher mean postoperative global rating scale scores [1, 2, 4]. This temporal relationship may represent technology improvement in prosthetic design, surgical techniques, patient selection, or postoperative management. Clearly, knee revision was an effective procedure in the majority of patients reported in the analyzed literature.

Because few studies reported outcomes just for one type of prosthesis, it was difficult to separate them clearly; results show that no clear significant differences between various implants are found due to the small number of valid and exclusive observations. We found that surgeons mainly selected the PCL-sacrificing with PCL-substitution prosthesis and PCL-sparing prosthesis for revision total knee arthroplasty, and the choices of hinged prosthesis were few.

From the studies, the results show that loosening was the main reason for revision total knee arthroplasty. The loosening rate for patients in these studies was 55%. Other reasons included polyethylene wear (11%), instability (10%), infection (7%), progression of disease (4%), osteolysis (4%), bone fracture (4%), component failure (3%), stiffness (1%), and pain of unknown origin (1%). Component failures included breakage and malposition. This shows that preventing implant loosening is the most important goal in primary total knee arthroplasty.

The overall effectiveness of revision total knee arthroplasty must be considered in light of its complication rate and the seriousness of these complications. In this study, the mean complication rate was relatively high (19%). The most common complications were loosening (18%), instability (16%), infection (16%), and patellar failure (15%). Patellar failure included subluxation, dislocation, tendon avulsion, patellofemoral pain, and clunk. This indicates that revision total knee arthroplasty presents a higher degree of technical challenge and is associated with more risk compared with primary total knee arthroplasty.

This meta-analysis had several limitations. Although meta-analytic techniques can help to provide more precise estimates for patient prognosis, none of the filtering or pooling procedures performed in this study could correct for missing data, biases, or methodological flaws present in the original studies. Publication bias or underreporting of studies with negative outcomes could also artificially inflate pooled estimates of an intervention's impact.

From this study, it is shown that revision total knee arthroplasty is a safe and effective procedure for patients, although the mean complication rate is high.

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