

**APPENDIX C.6 HIP AND KNEE REPLACEMENT
LITERATURE REVIEW**

Western Canada Waiting List Project

Literature Review – Hip and Knee Joint Replacement

By

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1. Introduction

This literature review summarizes recent study-based data concerning the outcomes of hip and knee replacement. This review was conducted under the auspices of the Western Canada Waiting List Project for use by the hip and knee surgery panelists while developing priority criteria and associated criteria weights. Panelists will be asked to assess the extent to which the review provided meaningful assistance in this regard.

The information contained in this report will also be used to help develop a method for comparing the severity of patients' suffering and disability across different domains, e.g., poor vision due to cataracts versus pain and stiffness due to hip arthritis. (This process is separate and distinct from the hip and knee panel's mandate, which is to develop criteria specifically for hip and knee replacement.) It is for this reason that pre-operative severity is described at rather more length than usual and why standardized scaling formats are used for summarizing the results depicted by study questionnaires.

This report focuses on three major questions: (1) severity of suffering and disability pre-operatively, (2) the degree to which hip and knee replacement surgery alleviated suffering and disability and (3) which pre-operative indicators were indicative or predictive of the degree of benefit experienced by patients following hip and knee replacement. These are the issues most directly relevant to the task of developing criteria and for purposes of cross-treatment comparisons.

2. Search Strategy

The PubMed search service was used to search the Medline database, a system maintained by the National Library of medicine (NLM). Searches were limited to articles published between 1989 and 1999, either written in English or that had an English abstract. Articles were retrieved by combining medical search headings (MeSH) within the topics of arthroplasty, replacement, knee or hip prosthesis. (See Appendix A for search terms). References from selected articles were also checked to locate additional relevant studies.

Articles were considered with respect to the three research questions listed in the Introduction, and relevant information recorded on "Article Coding Templates" or ACTs (Appendix B). This information was then used to create a database that also holds all reference information, as well as other data used for this report.

Records returned from these primary searches were screened by a Medical Librarian Specialist to eliminate any items that were not likely to have relevant information (referred to as the "false drop filter"). Abstracts for 245 remaining articles were then reviewed, and added to a custom reference database. If an abstract pertained to any of the research questions, the article was fully reviewed, and an ACT was completed. A total of 59 articles were used in preparing this report.

3. Condition and Treatment Description

Hip and knee replacements are two of the most common types of elective surgery. In most cases the indication for surgery is osteoarthritis (OA). Other indications include, but are not limited to, rheumatoid arthritis (RA), avascular necrosis, traumatic arthritis, certain hip fractures, benign

and malignant bone tumors, arthritis associated with Paget's disease, ankylosing spondylitis, and juvenile rheumatoid arthritis. Prospective patients have radiographic evidence of joint damage and moderate-to-severe, persistent pain and/or disability, which is not manageable with extended nonsurgical methods.[1]

Damage to the cartilage is caused most frequently by OA, RA, or trauma, which injures the surface of the joint, ligaments, or menisci. In cases of osteoarthritis, the underlying bone becomes compressed and irregular. Bony outgrowths called spurs may form. Instead of gliding smoothly, joint surfaces rub against each other. The result is stiffness and pain. This type of damage is irreversible.[2, 3]

Rheumatoid arthritis is caused by an immune disorder. Its symptoms are more generalized than OA and are usually more severe. The disease typically strikes the hands, feet and other joints, and causes painful swelling, inflammation, and sometimes deformity. In RA, white blood cells enter the synovium, the membrane which lines each of the joints. There, the blood cells appear to cause inflammation of the synovial membrane. This inflammation causes the release of chemicals that, over months or years, result in the thickening of the synovium. These chemicals also damage cartilage, bone, tendons and ligaments in the joint. Gradually, the joint loses its shape and alignment. Eventually, it may be destroyed. The most common signs and symptoms of RA are joint swelling, stiffness, and pain. Affected joints may feel warm to the touch, and the skin covering them may appear reddish. Other symptoms may include fatigue, loss of appetite, fever, sweats, and difficulty sleeping. About one-fifth of people with rheumatoid arthritis also develop rheumatoid nodules—lumps of tissue under the skin, often over the bones in the affected areas.[4]

In the case of total knee replacement (TKR; sometimes referred to as total knee arthroplasty or TKA), injured or damaged parts of the knee joint are replaced with artificial parts. The procedure is performed by separating the muscles and ligaments around the knee to expose the knee capsule. The capsule is opened, exposing the inside of the joint. The ends of the thigh bone (femur) and the shin bone (tibia) are removed, and often the underside of the kneecap (patella) is removed. The artificial parts are then cemented into place. The new knee consists of a metal shell on the end of the femur, a metal and plastic trough on the tibia, and if needed, a plastic button in the kneecap.[5]

In total hip replacement (THR or THA), the two parts of the hip joint are removed and replaced with smooth artificial surfaces. This hip is composed of the hip socket (acetabulum, a cup-shaped bone in the pelvis) and the "ball" or head of the femur. The artificial socket is made of high-density plastic, while the artificial ball with its stem is made of a strong stainless metal. These artificial pieces are implanted into healthy portions of the pelvis and femur and affixed with a bone cement (methyl methacrylate) or through a cementless procedure in which the implant has a rough surface that the bone grows into over time.[6]

4. Baseline Health Status Measures

The primary indicator of baseline status in the studies reviewed was scores on assessment tools. In an effort to derive data that could be compared to other elective surgeries, the primary

domains of interest were considered function and pain. Scores reflecting pain and functional impairment were extracted from generic and disease-specific measurements and transferred to a table format to simplify comparisons. Other quality of life domains (such as vitality, emotions and social isolation) were extracted whenever available.

4.1 Function

The scales most often used in the studies reviewed were the generic quality of life instrument SF-36 and the disease-specific Western Ontario and McMaster University Osteoarthritis Index (WOMAC). Mobility or walking ability scores were also available for the Nottingham Health Profile, the Health Assessment Questionnaire (HAQ), the Charnley modified D'Aubigne-Postel, the Knee Society clinical rating system, an 11-point visual analog scale, and the Sickness Impact Profile (SIP). (See Appendix C for measurement descriptions.) The measurement tools differ in the range of points used in the scales, from five to 100 points, and in their direction, (e.g., ascending or descending numbers). The scores were standardized to 100 points with the worst score at zero and the best at 100 for comparison purposes. As summarized in Table 1, standardized median scores for function ranged preoperatively from 30 – 84.

Table 1: Function								
Measure	Worst /Best Score	Median (Range of Scores)*		Standardized scores 0/100 (worst/best)			n=	Reference
				Median (Range of Scores)**		Change		
		Pre-operative	Post-operative	Pre-operative	Post-operative			
SF-36	0/100	26 (19 - 34)	51 (45 - 64)	26 (19 - 34)	51 (45 - 64)	+ 25	1,303	[7-10]
WOMAC	85/17	55	32 (31 - 34)	44	78 (75 - 79)	+ 34	291	[10]
WOMAC	0/100	41 (39 - 43)	71 (71 - 77)	41 (39 - 43)	71 (71 - 77)	+ 30	709	[7, 9]
WOMAC	54/0	38 (37 - 39)	30 (25 - 35)	30 (28 - 32)	44 (35 - 54)	+ 14	63	[11]
WOMAC	10/0	6	1.0 (0.7 - 1.7)	40	90 (83 - 93)	+ 50	188	[12]
HAQ	100/0	44	12 (7 - 18)	56	88 (82 - 93)	+ 32	50	[13]
NHP	100/0	61 (55† - 67)	29 (28† - 33)	39 (33 - 45†)	71 (67 - 72†)	+ 32	80	[14, 15]
SIP	100/0	16 (9 - 22)	1 (1 - 12)	84 (78 - 91)	99 (88 - 99)	+ 15	238	[12, 13]
Knee Society	0/100	40 (28 - 46)	69 (55 - 79)	40 (28 - 46)	69 (55 - 79)	+ 29	654	[10, 16-18]
D'Aubigne	1/6	2.5	4.8	30	76	+ 46	100	[19]

11-pt. VAS	11/0	6.55 (6.5 - 6.6)	3.9 (3.6 - 4.5)	40 (40 - 41)	65 (59 - 67)	+ 25	97	[20]
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* Mean score unless otherwise noted.

**Standardized to a 100-point scale with 100 as the best score.

† Median score.

In the domain of function, 3,773 preoperative scores were used from a total of 2,244 surgeries in 13 studies. Of the surgeries reported, 858 were on the hip (1,273 scores), and 1,128 were on the knee (1,986 scores). The scores on the remaining 258 surgeries (514) were not separated into hip and knee categories. Table 2 summarizes the aggregate of standardized scores for hip, knee, and them all combined at various intervals of time. Preoperative scores appeared to be consistent at approximately 40. (See Appendix D for more details on scores.)

Table 2: Median standardized scores (0/100 worst/best) for function by assessment interval and type of surgery							
Site	Preop	3 mo.	6 mo.	1 yr.	2 yrs.	Later*	# of scores**
Hip	39.5	64.5	70.8	71	93	73.5	1273
Knee	39.6	65	62.5	74	73	79	1986
Both†	48.7	85.9	-	82.2	-	-	514
Combined	40.0	72.4	64.5	74	73.0	79.0	3773

* Average assessment interval for this column was between 5 and 7.2 years.

** Number of median scores. For some studies, this number includes the median scores on more than one measurement for the same patients. For example, if a group of hip patients were assessed with both the SF-36 and the WOMAC at one year, both of those scores have been calculated into the median.

† Scores in which hip and knee patients were not separated.

4.2 Pain

Measures of pain were available from the SF-36, the WOMAC, the Health Assessment Questionnaire (HAQ), the McGill Pain Questionnaire, the Nottingham Health Profile (NHP), the Charnley modified D'Aubigne-Postel assessment, and one ten point and one 11-point visual analog scale. The measurement tools again differ in the range of points used in the scales, from three to 100 points, and in their direction. The pain scores were also standardized to 100 points for comparison purposes. As summarized in Table 3, standardized median scores for function ranged preoperatively from 24 - 58.

Table 3: Pain								
Measure	Worst /Best Score	Median (Range of Scores)*		Standardized Scores: 0/100 (worst/best)			n =	Reference
		Median (Range of Scores)**		Pre-op	Post-op	Change		
		Pre-op	Post-op					
SF-36	0/100	34 (27 - 38)	62 (46 - 70)	34 (27 - 38)	62 (46 - 70)	28	1,671	[7-10, 21-24]
WOMAC	25/5	16	7.9	45	86	41	291	[10]
WOMAC	0/100	44 (43 - 44)	79 (77 - 85)	44 (43 - 44)	79 (77 - 85)	35	712	[7, 9]
WOMAC	15/0	11.4 (11.7 - 12)	6.6 (4.6 - 8.6)	24 (20 - 22)	56 (43 - 69)	32	63	[11]
WOMAC	10/0	5.6 (5.2 - 6)	0.8 (0.6 - 1)	44 (40 - 48)	92 (90 - 94)	48	438	[12, 25]
HAQ	3/0	1.7	0.6	43	80	37	23	[26]
HAQ	100/0	42	12 (2 - 22)	58	88	30	50	[13]
McGill	5/0	2.8 (2.5 - 3†)	0.7 (0.0† - 1.3)	44 (40† - 50)	86 (74 - 100†)	42	45	[14, 26]
NHP	100/0	63 (52 - 78)	22 (17 - 26)	37 (22 - 48)	78 (74 - 83)	41	538	[15, 27, 28]
D'Aubigne	1/6	2.6	5.8	32	96	64	100	[19]
10-pt. VAS	10/0	7.6 (7.3 - 8.0)	4.8 (3.3 - 6.3)	24 (20 - 28)	52 (37 - 67)	28	63	[11]
11-pt. VAS	11/0	6.3	3.8 (3.2 - 4.5)	43	65 (59 - 71)	22	97	[20]

*Mean score unless otherwise noted.

**Standardized to a 100-point scale with 100 as the best score.

†Median score.

Regarding the topic of pain, 4,091 preoperative scores were used from a total of 3,007 surgeries in 19 studies. Of the surgeries reported, 1,485 were on the hip (1,752 scores), and 1,240 were on the knee (1,830 scores). The scores on the remaining 282 surgeries (509) were not separated. Table 4 summarizes the aggregate of standardized scores for hip, knee, both, and them all combined at various intervals of time. Preoperative scores had a median of 38. (See Appendix E for more details on scores.)

Table 4: Median Standardized Scores (0/100 worst/best) for Pain by Assessment Interval and Type of Surgery

Site	Preop	3 mo.	6 mo.	1 yr.	2 yrs.	Later*	# of scores**
Hip	36.9	67.3	75.9	70.9	82.6	86.3	1752
Knee	38	47.3	76.9	61	74.6	-	1830
Both†	44.3	88	77.4	78.7	-	-	509
Combined	38	62.9	76.9	70.9	78.3	86.3	4091

* Average assessment interval for this column was 5 years.

** Number of median scores. (See explanation in Table 2)

† Scores in which hip and knee patients were not separated.

4.3 Other quality of life measures

Two measures, the SF-36 and the Nottingham Health Profile have been used most often in hip and knee surgery studies to measure aspects of quality of life. Tables 5 and 6 summarize scores for each of these measures by a number of different subscales. As previously, scores were standardized to enable comparison.

Table 5: SF-36 (0/100 worst/best scores)

Domain	Median (Range of Scores)*		Change	n =	Reference
	Pre-operative	Post-operative			
Role-Functional	23 (9 – 32)	40 (21 – 64)	17	1,127	[7-9, 22-24]
Role-Emotional	62 (48 – 79)	71 (58 – 79)	9	1,174	
Vitality (Energy)	47 (40 – 51)	56 (45 – 63)	9	1,127	
Social Function	63 (50 – 70)	78 (69 – 88)	15	1,174	
Mental Health	72 (57 – 78)	75 (56 – 81)	3	1,174	
General Health	66 (62 – 69)	68 (65 – 71)	2	1,127	

* Mean score unless otherwise noted

Domain	Median (Range of Scores)*		Standardized Scores: 0/100 (worst/best)		n =	Reference	
	Pre-op	Post-op	Median (Range of Scores)**				Change
			Pre-operative	Post-operative			
Energy	37 (29 – 69)	19 (7 – 37)	63 (31-71)	81 (63 – 93)	18	390	
Sleep	41 (35 – 55)	18 (12 – 26)	59 (45-65)	82 (74 – 88)	23	390	
Emotions	20 (15 – 31)	8 (4 - 16)	80 (69-85)	92 (84 – 96)	12	390	
Social Isolation	8 (7 – 19)	5 (0 – 8)	92 (81-93)	95 (92 – 100)	3	390	

* Scores from two studies were reported as mean; the other two studies reported median scores.

**Standardized to a 100-point scale with 100 as the best score.

Part 2 of the Nottingham Health Profile was used to determine the limitations of the participants.[29] This study involved 56 hip patients. Prior to surgery, 77 percent of the patients reported trouble doing housework; 71 percent reported trouble participating in holidays; 64 percent had trouble doing hobbies; 46 percent said their social lives were affected; 34 percent reported difficulty in their sex lives; and 23 percent indicated difficulty participating in family life.

5. Surgical Outcomes

In order to evaluate surgical outcomes, preoperative scores were compared to the mean of postoperative scores. In the studies reviewed, follow-up evaluations were conducted at intervals ranging from 50 days to 12 years. In studies where more than one postoperative assessment took place, the mean of those results was calculated.

5.1 Function

From Table 1 the standardized median scores for function ranged postoperatively from 44 – 99 with 100 as the best score. When the standardized scores were averaged, the preoperative mean function score was calculated to be 43, while the postoperative mean function was 73, an improvement of 30 points. The median point change was also 30, and the range, 14 – 50 points. Scores improved by an average of 79 percent. Table 2 shows that the median standardized preoperative scores were approximately 40, and the postoperative median scores being greater than 62.5.

5.2 Pain

From Table 3, the standardized median scores for pain ranged postoperatively from 52 to 96, with 100 as the best score. The average preoperative mean pain score on the standardized scale was 39, while the postoperative mean pain score increased to 77, a 38-point improvement. The

median point change was 36, with a range of 22 to 64 points. Scores increased an average of 101 percent. Table 4 shows that the median standardized preoperative scores were approximately 38, with median postoperative scores being greater than 47.3.

5.3 Other quality of life outcomes

Scores for other quality of life outcomes showed improvement in all domains on the SF-36 and the Nottingham Health Profile. However, the difference in scores from preoperative to postoperative were not as great in comparison to the categories of pain and function. The largest changes observed postoperatively on the SF-36 were for the domains of Role-Functional (+ 17 points) and Social Function (+ 15) (Table 5). There was little difference in the postoperative scores for SF-36 General Health and Mental Health, + two and +two, respectively.

On a standardized NHP 100-point scale, the scores for the Energy domain improved by 18 points after surgery (Table 6). Whereas, in the Sleep domain, patients improved by 23 points. The Emotion domain improved by 12 points, while Social Isolation changed by 3 points.

Three of the domains in the NHP are similar to the SF-36 and may be compared on the standardized scale. In the Energy domain, the score improved by nine points on the SF-36 (four questions), and by 18 points on the NHP (three questions). The SF-36 Emotion domain improved by nine points (four questions), compared to a 12 point change on the NHP (nine questions). Indicators of social involvement were the most widely varied. On the SF-36, Social Function improved by 15 points, but only by 3 points on the NHP. On the SF-36, the questions related to social activity are limited to two, while the NHP has five questions.

In Part 2 of the Nottingham Health Profile (referred to in Section 4.3), at one year after surgery, 33 percent of the patients reported trouble doing housework as compared to 77 percent before surgery; 25 percent reported trouble participating in holidays compared to 71 percent; 23 percent had trouble doing hobbies compared to 64 percent; seven percent said their social lives were affected compared to 46 percent; nine percent reported difficulty in their sex lives compared to 34 percent; and two percent indicated difficulty participating in family life compared to 23 percent.[29]

6. Prognostic Indicators of Treatment Benefit

6.1 Age

Age has been frequently evaluated to determine its impact on the outcome of THA and TKA surgeries. In a study of hip and knee patients by Rissanen et al., using the 15D HRQOL assessment, knee patients younger than 60 years had greater improvement in quality of life than older knee patients.[31]

Johnsson and Thorngren[32] reviewed 505 cases of surviving THR for primary osteoarthritis. When the influence of significant risks for pain were linked to mobility factors, the patient's likelihood of impaired mobility was affected by older age. A study using the WOMAC and the RAND found that increased age in THR patients was associated with decreased function in both assessments.[33]

Age also appeared to affect other areas of health. A study of THR patients over 80 years found a significant increase in complications, but also a worthwhile relief of pain.[34] One study reported that older patients had greater improvement in mental health than younger patients.[35] While younger patients seem to benefit more in the domain of function, older patients (over 75) also receive great relief from pain[19, 36-40], although one study reported that younger patients (under 70) had a higher risk for hip pain on standing[32], and in a study by Lieberman et al., men younger than 65 scored lower than published norms after THR with respect to physical functioning, role physical, and bodily pain.[41]

6.2 Gender

Walsh et al., in a study on a group of age- and gender-matched control subjects (13 women and 16 men) who underwent TKR[42], reported that women demonstrated less functional improvement on a stair-climbing test (developed at the Centre for Studies of Physical Function at the Orthopaedic and Arthritic Hospital, Toronto) postoperatively, with slower times and increased pain and exertion, than did the male patients. In addition, women showed lower performance on a walking pace test than men. Of the women, 62 percent walked below the threshold required for safe crossing of street intersections at a normal pace, and 31 percent at a fast pace. In comparison, of the men, 25 percent were below the threshold at a normal pace, and 6 percent at a fast pace.

A study of 114 THR and TKR patients[43] used the SF-36 to evaluate participants pre and postoperatively in order to determine predictive relationships. Men scored higher than women in social function, physical role function, mental health, energy, and pain. There was some difference, although not significant, in physical function. There were no differences in the areas of emotional role function, health perception, and health change.

Van Essen et al., using the SF-36, found that women showed significant improvement in the areas of bodily pain, vitality, role-emotional, and mental health after TKR, while men demonstrated statistically significant improvements in physical functioning and bodily pain ($p < 0.05$).[24]

In a study by Lieberman et al. on THA outcomes, women in all age groups consistently scored lower than the published norms in physical functioning, role physical, and bodily pain, while only men younger than 65 scored lower.[41]

Ranawat et al. conducted a study of the 15-year survivorship of TKR patients (75 percent women and 25 percent men). After 13 years, men in the study had a significant drop in survivorship as compared to women (83.3 percent compared to 95.3 percent).[44]

6.3 Comorbidities

Three studies looked at the effect of comorbidities on outcomes. In one study of 504 hip and knee arthroplasty patients, the number of comorbid conditions was significant in predicting pain relief in patients with THA. Every additional comorbid condition reported by a patient resulted in a 1.7 point decrease in joint pain relief on the SF-36. After adjusting for age, gender, waiting

time and length of stay, patients with comorbid conditions were less likely to show functional improvement regardless of the joint replaced.[9] In a study of 442 hip replacement patients[45], after adjustment for other risk factors, the number of comorbid conditions was found to have an effect on both pain and physical function improvement at six months. With each additional comorbid condition, there was a corresponding decrease of 4.6 points in pain score change and a decrease of 4.7 points in physical function score change on a 100-point scale. In a study by Lieberman et al., THA patients of all ages with multiple comorbidities had lower scores on the Harris Hip Score and the SF-36.[41]

6.4 Preoperative pain and function

In several cases, patients who reported worse preoperative pain showed more improvement. This factor is usually explained by the fact that patients with worse pain have more room to improve. The pain scores for this group did, however, remain lower at follow-up than those for the patients who reported less preoperative pain.

In a study of 442 hip replacement patients[45], patients with low preoperative scores were found to have lower scores postoperatively as compared to patients with high preoperative scores. However, each 1.0-point increase in preoperative score was associated with a corresponding decrease of 0.6 points in physical function score change and a decrease of 0.7 points in pain score change on a 100-point scale. Good preoperative function was hypothesized to be a risk factor for poor outcome in the study because individuals who already had high preoperative scores may have had a smaller opportunity to benefit. The authors noted that one implication of these results is that surgeons should carefully consider all alternatives before operating on patients with high preoperative function because these patients will improve only slightly. A second implication is that improvement, not just the final score, is an important outcome measure for patients receiving THR.

Fortin et. al.[46], concluded that the best predictor of pain and function at six months after surgery was the subject's baseline pain and function. Low-functioning groups receiving TKR or THR improved more than high-functioning groups. However, even the maximum level of improvement observed within the low-functioning group, never did reach the levels that were attained by the high-functioning group did. In addition, advanced functional loss due to OA of the hip or knee was associated with worse outcome at six months. The authors suggested that patients with more advanced OA may have worse postoperative results, and that more research should be done to determine if 1) a patient on a long waiting list or 2) a patient whose doctor is waiting until all other options have been exhausted, may have worse outcomes.

Heck et al.[10] reported that TKA patients who had a higher preoperative WOMAC function score (low function) were more likely to show improvement according to the SF-36. Worse preoperative knee function was found to be one of the most important factors associated with an improvement in the patient's physical health.

Using the Nottingham Health Profile and the 15D assessment, Rissanen[28] found that patients with the poorest preoperative HRQOL scores in general also gained the most.

Jones[9], reported that multiple linear stepwise regression analyses could not identify any strong predictors of pain for either THA or TKA. However, when controlling for age, gender, waiting time and length of stay, less preoperative bodily pain on the SF-36 was associated with less pain relief.

6.5 Living alone

Patients living alone, rather than with friends or family, tended to have lower scores on assessments. Both Jones[9] and Braeken et al.[33], found that living alone was associated with poor functional outcomes for THA. Johnsson and Thorngren[32] reviewed 505 cases of surviving THR for primary osteoarthritis. Upon comparing the pain and mobility elements with “activities of daily living,” patients who were living alone were more likely to be elderly, need walking support, could not walk more than a limited distance, and had trouble taking a bath or shower.

6.6 Body mass index

Two studies, Konig[16] and Chan[47], reported that patients with a Body Mass Index (BMI) of 25 or over had similar improvement to patients with a lower BMI. In a study on THR, however, a higher BMI was associated with more pain and functional disability postoperatively as measured by the RAND and the WOMAC questionnaires.[33] Hawker et al. had similar results in the function domain of the WOMAC with a sample of 700 patients.[48] Regarding survivorship, at 15 years, clinical survivorship in knees in patients weighing <80 kg was 96.2 percent; clinical survivorship in knees in patients >80 kg was 89.3 percent; clinical and roentgenographic survivorship in knees in patients >80 kg was 70.6 percent.[44]

6.7 Osteoarthritis versus rheumatoid arthritis

In a study on 97 THR patients[49], which compared the outcomes of RA vs. OA, osteoarthritis patients improved more than RA patients in the area of state of mind and experienced fewer problems with work and study postoperatively. In fact, the OA group showed more improvement than the RA group in all quality-of-life areas, particularly the psychological dimension and the disease impact scale. The explanation proposed by the study authors indicated that THR solves a major local somatic problem in the OA group, whereas RA patients suffer from more than one inflamed joint. Twenty percent of the RA patients in the study needed a second prosthesis during the first postoperative year as opposed to 9.7 percent in the OA group. For the reduction in disability, OA patients receiving hip or knee joint replacement showed more improvement than RA patients.[43, 49-51]. McGuigan et al.[43] also found OA patients to have more improvement in the pain dimension than the RA group.

Kristensen et al.[52] reviewed the results of 71 primary knee arthroplasty surgeries in RA patients postoperatively at an average of ten years. In addition, the patients of the RA study were compared to the participants of a simultaneous study receiving TKA for OA. The OA group had a significantly better ten-year crude survival of the prosthesis than the RA group. While the preoperatively walking ability had been equal for the two groups, postoperatively, the RA group scored lower than the OA patients. The difference was considered a reflection of the limitations of treating a systemic disease by local surgical intervention. The range of motion was also significantly less in the RA group.

In contradiction to the Kristensen study, Ranawat et al.[44] looked at TKR survivorship at 15 years on 112 knees, and found that knees replaced for rheumatoid arthritis had a survival of 95.2 percent compared to 91.1 percent for osteoarthritis.

6.8 Technical factors

Some technical factors were assessed within the quality of life studies to determine their effects on outcome. Conclusions about cementless vs. cemented were mixed. One study found that patients with cemented prosthesis reported less improvement in mental health and had more incidence of dislocation[35], while another reported that patients with cementless prostheses reported less pain relief than patients with at least one component cemented.[9]

Johnsson and Thorngren[32] determined that a prosthesis with a 35 mm head (in comparison to a 22 mm and 32 mm head) increased the risk of pain at rest or on standing. Kristensen et al.[52] reported a highly significant correlation between the severity of the residual pain and the radiolucency score ($r=0.33$, $p<0.01$).

6.9 Ethnicity

In a study of 442 hip replacement patients[45], African-American ethnicity was associated with a decrease of 9.5 points in pain score change and a decrease of 10.9 points in physical function score change on a 100-point scale at six months after adjustment for all other risk factors. In another study on hip replacement, Caucasian patients showed greater improvements on a Basic Activities of Daily Living assessment and reported less pain.[35]

6.10 Education

In a study of hip replacement patients[45], low education was associated with a decrease of 6.2 points in pain score change and a decrease of 7.7 points in physical function score change. The authors noted that patients with lower education are hypothesized to have a reduced knowledge of disease and related factors such as promotion of healing, avoidance of complications, and the need to seek prompt medical care when necessary.

Fortin[46] reported that independent of baseline pain or function, a higher education level was associated with less pain and better function at 6 months after surgery.

6.11 Other

Other factors which appeared to predict better outcome were Social Functioning, Role Functioning-emotional, and Motivation on the SF-36[22], mental health[10], and being married.[35] Johnson and Thorngren[32] reviewed several factors together in patients which received THR for osteoarthritis. Upon comparing the pain and mobility elements with “activities of daily living,” restrictions in activity were found to be influenced by elderly age, the need for walking support, and the inability to walk more than a limited distance. With the cumulative effect of these functions, patients who had a markedly limited walking distance and could not bathe or shower were more likely to be living away from home. Finally, the cumulative effect of all these functions was correlated with the patient’s subjective assessment of the restrictions placed on him or her by THR. The patient at risk for feeling more restricted was younger, had

hip pain on activity, and used some walking support. However, the patients who were not living at home felt less restricted. These patients tended to be older, were more likely to be suffering from neurological and other disorders, and had hip pain at rest.

7. Conclusion

The evaluation of the presurgical status of patients scheduled for hip or knee surgery typically included a scale measurement in the studies reviewed. A variety of scales were used, with the SF-36 being the one most widely used for the evaluation of function and pain. The other tools used vary in the number of points in each scale, making comparisons between the scales challenging, since, for instance, the loss in sensitivity cannot be adjusted for with proportional standardization. Other quality of life measures can be assessed preoperatively using the SF-36 and the Nottingham Health Profile, Part 1.

Surgical outcomes were evaluated as differences in preoperative scores to, as in Tables 1 and 2, the mean of postoperative scores. In the domains of function and pain, patients consistently showed significant benefit after hip and knee replacement surgery. While other quality of life domains show improvement after surgery, the changes do not approach the significance of function and pain.

Of the prognostic indicators present in the studies, the conditions which appear to merit the most attention are pain, functional disability, and comorbidities. Patients with more pain and functional difficulties improve the most, while patients with significant comorbidities may not have a better quality of life after surgery. In the cases of body mass index, osteoarthritis versus rheumatoid arthritis, and age, there are indications that some patients do better than others, but these elements alone should not prevent a patient from receiving surgery that would significantly improve pain or function. Other factors such as living alone, and especially gender, ethnicity, and education, may appear to have an impact on surgery results, but should not be considered in the decision to schedule surgery. Overall, hip and knee replacement surgery was shown to significantly improve quality of life.

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Hip and Knee Replacement Literature Review Appendix A: Search Terms

Search terms combined with an “OR” statement (unless otherwise specified) included the following:

- (arthroplasty, replacement [majr]
 - knee prosthesis [Majr]
 - hip prosthesis [majr])
 - AND
 - (1989:1999[dp])
 - AND
 - (eng [la] hasabstract)
 - AND
 - activities of daily living [mh]
 - age factors[mh]
 - age of onset[mh]
 - contrast sensitivity[mh]
 - cost allocation[mh]
 - cost-benefit analysis [mh]
 - cost control[mh]
 - cost savings[mh]
 - costs and cost analysis[mh]
 - decision making[mh:noexp]
 - Delphi Technique[mh]
 - economic value of life[mh]
 - evaluation studies[mh]
 - geriatric assessment[mh]
 - health care costs[mh:noexp]
 - health care rationing[mh]
 - health priorities[mh]
 - health services needs and demand [mh:noexp]
 - health status [mh]
 - medical futility[mh]
 - needs assessment[mh]
 - nutritional status[mh]
 - outcome assessment [mh]
 - patient satisfaction [mh]
 - patient selection [mh]
 - population surveillance[mh]
 - predictive value of tests[mh])
 - quality-adjusted life years[mh]
 - quality of life [mh]
 - questionnaires [mh]
 - reference standards[mh]
 - risk factors[mh]
 - self assessment psychology [mh]
 - sentinel surveillance[mh]
 - severity of illness index [mh]
 - social responsibility [mh]
 - surgical procedures, elective/utilization [mh]
 - surgical procedures,operative/standards[mh]
 - time factors[mh]
 - treatment failure[mh]
 - treatment outcome [mh]
 - waiting lists[mh]
 - work capacity evaluation[mh]
- NOT
- (radiography [mh]
 - radiography [sh]
 - feasibility studies [mh]
 - intraoperative care [mh]
 - postoperative care [mh]
 - comorbidity[mh]
 - sensitivity and
 - specificity[mh]
 - case report[mh]
 - comparative studies [mh]
 - length of stay[mh])

Additional terms included:

- disability evaluation[mh]
- function recovery[mh]
- ADL[textword]
- disease management[mh]
- delivery of health care/standards[mh]
- outcome and process assessment (health care) [mh]

Articles were excluded which focused on technical procedures, materials, and methods, as well as articles on:

- comparison of methods;
- preoperative, perioperative, postoperative care;
- outcomes related to particular technique;
- surgical complications;
- patient guides;
- gender utilization;
- patient selection based on medical considerations only;
- rehabilitation;
- research methods (apart from subject of this project); and
- articles in foreign languages which had summaries (abstracts) too brief or general to be useful; and

Separate searches were also conducted with each of the major topic groups AND to the following list of non-MeSH test names:

- SF-#36 OR Short Form Health Survey
- MOS OR Medical Outcomes Study
- Harris Hip Score
- WOMAC
- MGQ OR McGill Pain Questionnaire
- FSI OR Functional Status Index
- GDS OR Geriatric Depression Scale
- McKnee Health Utilities Index
- NHP OR Nottingham Health Profile
- Rosser Index Matrix
- Knee Society Rating System

Hip and Knee Replacement Literature Review Appendix B: Article Coding Template (ACT)

Article ID:	First Author:	Year of publication:
Title:		
Rating of overall usefulness of article to study questions:		
Reviewer summary:		
Study name or center:		
Kind of study: Case series(fol'd thrgh time, no control group)		
Sample size:		
Study methods:		
Study's Inclusion criteria:		
Study's Exclusion criteria:		
PRE-SERVICE HEALTH STATE (Baseline Measurement)		
1. Does paper describe the <i>kinds of patients</i> with the condition, regarding GENERIC health state (ie QOL, functional impairment) or DISEASE SPECIFIC health state (degree of suffering, visual acuity, mobility)?		Blank
1a. If yes, how were they measured (what questionnaire[s] were used or factors assessed)?		
1b. Did paper distinguish among patients with <i>differing levels</i> of severity (e.g., mildly, moderately, severely affected; a scoring system with 100 representing absence of any suffering or impairment)?		Blank
1b1. If yes, what were the definitions of the ratings (range of scores, description)?		
1b2. If yes, how many patients were in the categories?		
1c. Does this method of grading severity allow comparison across different medical conditions?		Blank
Comments about above:		

HEALTH SERVICE BENEFIT (Outcome Measurement)	
2. Does paper describe postoperative degree of suffering, functional impairment, quality of life, or clinical symptoms?	Yes/No
2a. If yes, how were they measured (what questionnaire[s] were used or factors assessed)?	
2b. Did paper provide information to assess post-operative severity relative to pre-operative severity?	Yes/No
2b1. If yes, did paper permit quantitative estimation of degree of benefit?	Yes/No
2b2. What was the degree of quantitative benefit (either in relative or absolute terms)?	
2c. Does this method of measuring outcome allow comparisons across medical services?	Blank
Comments about above:	
PROGNOSTIC INDICATORS	
3. Did paper provide a basis for predicting which patients will benefit more or less than average (e.g., prediction models/rules for estimating small, medium, large benefit)?	Blank
If yes, what were the distinguishing factors?	
Save the form as a document in the ACT Document folder. Data elements will be extracted at the end of the review by AB.	

Hip and Knee Replacement Literature Review Appendix C: Description of Scales
Measurement Tools – Disease Specific

Tool	Score (worst/best)	Description/subscales	Details
Western Ontario and McMaster University Osteoarthritis Index (WOMAC)	0-100	Contains three subscales: pain (5 items), stiffness (2 items), and disability (17 items). The WOMAC can be self-administered, and is considered reliable and valid. Responsiveness was demonstrated in a randomized, controlled trial of non-steroidal anti-inflammatory drugs for the treatment of osteoarthritis. [53]	<p>Kelly[54] categorized the subscales of WOMAC into three equal groups for descriptive purposes.</p> <p><33.33 Mild pain or stiffness/good function 33.34 – 66.66 Moderate pain or stiffness/fair function >66.66 Severe pain or stiffness/poor function</p> <p>Kelly’s divisions were modeled after Williams[7]: (Scoring reversed to correspond to SF-36) 0 – 33.3 High (worst) pain, stiffness, or function 33.4 – 66.7 Medium pain, stiffness, or function 66.8 – 100 Low (best) pain, stiffness, or function</p>
Knee Society clinical rating system	0-100	Allots 50 points for pain, 25 for stability, and 25 for range of motion. Walking ability is measured in blocks (approximately 100 meters). Stair climbing is rated as normal if the patient is able to go up and down stairs without holding a railing. The system is divided into separate knee and patient function scores in such a way that increasing age or a medical condition will not affect the knee score. Patients are categorized into three levels: A) unilateral or bilateral (opposite knee successfully replace); B) unilateral, other knee symptomatic; or C) multiple arthritis or medical infirmity.[55]	<p>König et al.[16] designated the numeric scores of the Knee Society knee score assessment to categories as follows:</p> <p>90 – 100 Excellent 80 – 89 Good 70 – 79 Fair < 70 Poor</p>

Tool	Score (worst/ best)	Description/subscales	Details
D'Aubigne and Postel Hip Assessment as Modified by Charnley	2-12	Two subscales for pain and walking, each using a six-point scale.	<p>Used by Levy et al.[19]</p> <p>Pain:</p> <ul style="list-style-type: none"> 1 = severe and spontaneous 2 = severe on attempting to walk, prevents all activity 3 = tolerable, permits limited activity 4 = presents only after activity, disappears quickly w/rest 5 = slight or intermittent, decreases with activity 6 = no pain <p>Walking Ability:</p> <ul style="list-style-type: none"> 1 = bedridden or only able to walk a few meters 2 = walking very limited w/ or w/out a walking aid 3 = limited but able to stand for long periods 4 = long-distance walking possible but limited without aid 5 = walks without aids, but limps 6 = walks normally for age

Measurement Tools – Generic

Tool	Score (worst/best)	Description/subscales	Details
SF-36	0-100	Assesses eight separate domains of life quality: physical functioning (10 items); role limitations due to physical health (4 items); role limitations due to emotional problems (4 items); pain (2 items); general health perceptions (5 items); vitality (4 items); social functioning (2 items); emotional well-being (5 items); and change in health (1 item). Scoring for the SF-36 is calculated separately for each of the eight subscales, without the determination of a total score. An alternate scoring system reduces the subscales into two dimensions: a mental health score and a physical health score. Use of the two dimensions is less common than using all eight subscales, but is useful when there is a need to limit the number of outcomes being analyzed, or when a general effect in the physical or mental health domain is expected.[56]	<p>The reliability of the individual dimensions ranges from 0.80 to 0.90 or better.[57] Validations studies have shown that the physical and mental health scales each appropriately discriminate at least a moderate level of disability in patient groups due to physical or psychiatric illness.[56]</p> <p>Kelly[54] categorized SF-36 scores into three equal groups for descriptive purposes: <33.33 Poor (severe for bodily pain) 33.34 – 66.66 Fair (moderate for bodily pain) >66.66 Good (mild for bodily pain)</p> <p>Williams[7] used a somewhat different scale: <40High (worst) 40 – 60 Medium >60Low (best)</p>
Nottingham Health Profile	100-0	The first of two parts contains 38 yes/no questions dealing with six aspects of health (pain, energy, sleep, mobility, emotional reaction, and social isolation). Each item is weighted and has a value of between 0 (best) and 100 (worst). The second part has seven yes/no sections which reflect the frequency of problems with occupation, housework, social life, family life, sexual function, hobbies, and holidays.	Tested for its validity and reliability. The answers can be compared with the average scores in a population matched for age and gender. The items of the six items in the first part are added, and the total is divided by six to give the global score.[58]

Tool	Score (worst/best)	Description/subscales	Details								
Sickness Impact Profile	100-0	Everyday activities in 12 categories (sleep and rest, emotional behavior, body care and movement, home management, mobility, social interaction, ambulation, alertness behavior, communication, work, recreation and pastimes, and eating) are measured.	<p>A 136-item self- or interviewer-administered, behaviorally based, health status questionnaire. Respondents check items “yes” that describe themselves and are related to their health. The SIP is scored according to the number and type of items endorsed. Scoring can be done at the level of categories and dimensions as well as at the total SIP level. The overall score ranges from 0 (best) to 100 (worst).[59]</p> <p>The SIP Model:</p> <table border="1" data-bbox="1178 672 1902 1114"> <thead> <tr> <th data-bbox="1178 672 1423 708">Dimension</th> <th data-bbox="1423 672 1902 708">Category (No. of Items)</th> </tr> </thead> <tbody> <tr> <td data-bbox="1178 708 1423 812">Physical</td> <td data-bbox="1423 708 1902 812"> <ul style="list-style-type: none"> - Ambulation (12); - Mobility (10); - Body Care & Movement (23) </td> </tr> <tr> <td data-bbox="1178 812 1423 945">Psychosocial</td> <td data-bbox="1423 812 1902 945"> <ul style="list-style-type: none"> - Communication (9); - Alertness Behavior (10); - Emotional Behavior (9); - Social Interaction (20) </td> </tr> <tr> <td data-bbox="1178 945 1423 1114">Independent Categories</td> <td data-bbox="1423 945 1902 1114"> <ul style="list-style-type: none"> - Sleep and Rest (7); - Eating (9); - Work (9); - Home Management (10); - Recreation and Pastimes (8) </td> </tr> </tbody> </table>	Dimension	Category (No. of Items)	Physical	<ul style="list-style-type: none"> - Ambulation (12); - Mobility (10); - Body Care & Movement (23) 	Psychosocial	<ul style="list-style-type: none"> - Communication (9); - Alertness Behavior (10); - Emotional Behavior (9); - Social Interaction (20) 	Independent Categories	<ul style="list-style-type: none"> - Sleep and Rest (7); - Eating (9); - Work (9); - Home Management (10); - Recreation and Pastimes (8)
Dimension	Category (No. of Items)										
Physical	<ul style="list-style-type: none"> - Ambulation (12); - Mobility (10); - Body Care & Movement (23) 										
Psychosocial	<ul style="list-style-type: none"> - Communication (9); - Alertness Behavior (10); - Emotional Behavior (9); - Social Interaction (20) 										
Independent Categories	<ul style="list-style-type: none"> - Sleep and Rest (7); - Eating (9); - Work (9); - Home Management (10); - Recreation and Pastimes (8) 										
Health Assessment Questionnaire (HAQ)	3-0	Items cover daily activities, amount of assistance needed, symptoms, health behaviors, medications, health history, the SF-12 Health Survey, the Ritchie Articular Index (RAI), employment status, and income.	The HAQ was originally designed to evaluate general medical illness, but versions have been created for Rheumatoid Arthritis, Osteoarthritis, Lupus, Scleroderma, Ankylosing spondylitis, Fibromyalgia, other rheumatic diseases, and HIV/AIDS. A score of 0 indicates normal function, and 3.0 indicates the patient is unable to do most activities of daily living.[51]								

Tool	Score (worst/ best)	Description/subscales	Details
Present Pain Intensity Scale of the McGill Pain Questionnaire (PPI)	5-0	The PPI is a small portion of the McGill Pain Questionnaire, which contains 20 other groups of adjectives describing pain. The form is administered by a professional who selects the adjectives which the patient identifies as those which most closely identify the type of pain.	0 = no pain, 1 = mild, 2 = discomforting, 3 = distressing, 4 = horrible, 5 = excruciating[30]

Hip and Knee Replacement Literature Review Appendix D: Function Scores
 Mean (standard deviation) function scores in patients undergoing hip or knee replacement

Measure	Worst/ Best	Pre-op	3 mo.	6 mo.	1 yr.	2 yrs.	Later	n =	hip/knee	Reference	
SF-36 – Physical Function	0/100	28.4 (19.0)			51.7			208	both†	[7]	
		31.9				64.3		151	hip	[8]	
		19e		49e					228	hip	[9]
		33.7				57.4			149	knee	[8]
		21e		45e					276	knee	[9]
		24.2 (1.0)		47.6 (1.5)		50.9 (1.6)			291	knee	[10]
WOMAC – Physical Function	0/100	41.3 (19.3)			71.3			206	both†	[7]	
	10/0	6.0 (1.61)	1.7	1.2	0.8	0.7		188	hip	[12]	
	54/0	38.5 (10.81)	24.79 (12.14) *					40	hip	[11]	
	0/100	39e		77e				227	hip	[9]	
	54/0	37.22 (11.05)	34.48 (11.86) *					23	knee	[11]	
	0/100	43e		71e				276	knee	[9]	
	85/17	55.1 (0.8)		33.7 (0.8)		31.2 (0.8)		291	knee	[10]	
Health Assessment Questionnaire - Mobility	100/0**	43.9 (23.7)	16.7 (27.1)		6.9 (24.7)			50	both†	[13]	
Nottingham Health Profile – Mobility	100/0	67			29		33 @ 5 yrs.	54	hip	[15]	
		54.6***	27.6** *					26	knee	[14]	
Sickness Impact Profile – Mobility	100/0	21.8 (14.4)	11.6 (12.0)		1.1 (10.4)			50	both†	[13]	
		9.3 (11.5)	2.4	1.2	0.6	0.7		188	hip	[12]	
Knee Society - Function	0/100	46	65		74	77		276	knee	[16]	
		38					79 @ 7.2 yrs.	87	knee	[17]	
		41.2 (1.1)		62.5 (1.6)		69 (1.6)		291	knee	[10]	
Charnley modified D'Aubigne-Postel	0/6	2.5					4.8 @ 5 yr avg	100	hip	[19]	

Visual Analogue Scale – Stiffness (11 pt.)	11/0	6.6 (2.3)	3.9 (2.6)	3.9 (2.6)	3.6 (2.9)			62	hip (OA)	[20]
		6.5 (2.2)	4.5 (2.5)	4.0 (2.5)	3.9 (2.8)			35	hip (RA)	[20]

† Study did not separate scores of hip and knee patients

e = estimated from graphical data

* Assessment at 50 days

** Adapted by the study authors to a 100 pt. scale

*** Median

Hip and Knee Replacement Literature Review Appendix E: Pain Scores

Mean (standard deviation) pain scores in patients undergoing hip or knee replacement

Measure	Worst/ Best	Pre-op	3 mo.	6 mo.	1 yr.	2 yrs.	Later	n=	hip/knee	Reference
SF-36 – Bodily Pain	0/100	34.1 (19.6)			65.4			208	both†	[7]
		27e		63e				228	hip	[9]
		33e			70e			90	hip	[21]
		35.5				68.6		151	hip	[8]
		31e		54e				276	knee	[9]
		35e			61e			117	knee	[21]
		38.1				61.2		149	knee	[8]
		33.1 (12.0)	48.6 (21.8)					47	knee	[22]
		37.9 (9.9)	45.9 (18.1)					41	knee	[23]
		38.0 (1.3)		62.1 (1.4)		64.2 (1.4)		291	knee	[10]
32.8 (19.4)	51.6 (24.4)					73	knee	[24]		
WOMAC – Pain	0/100	44.3 (20.1)			78.7			209	both†	[7]
	0/100	43		85				227	hip	[9]
	10/0	5.2 (1.7)	0.9	0.8	0.6	0.7		188	hip	[12]
	15/0	11.65 (3.36)	4.62 (3.51)*					40	hip	[11]
	10/0	6				1		250	hip	[25]
	0/100	44		77				276	knee	[9]
	15/0	11.96 (2.90)	8.61 (3.73)*					23	knee	[11]
	25/5	16.1 (0.2)		9.0 (0.2)		7.9 (0.2)		291	knee	[10]
Health Assessment Questionnaire - Pain	0/3	1.7 (.62)		0.58 (.57)				23	both†	[26]
	100/0**	42.3 (21.3)	22.0 (22.3)		2.4 (14.8)			50	both†	[13]
McGill Pain Questionnaire	5/0	2.5 (0.86)		1.3 (.84)				19	both†	[26]
		3.0***	0.0***					26	knee	[14]

Nottingham Health Profile - Pain	100/0	62.76 (5.33)				21.76 (6.96)		120	hip	[27]
		78			19		26 @ 5 yr avg	54	hip	[15]
		63.4 (4.01)		17.4 (4.04)		17.4 (4.04)		167	hip/ women	[28]
		56.57 (8.08)				25.42 (9.66)		63	knee	[27]
		52.4 (4.57)		23.1 (4.66)		21.7 (4.61)		134	knee/ women	[28]
Charnley modified D'Aubigne-Postel	0/6	2.6					5.8 @ 5 yr avg	100	hip	[19]
Visual Analogue Scale – Pain (10 pt.)	10/0	7.25 (2.24)	3.34 (2.35)					40	hip	[11]
		7.96 (2.23)	6.26 (2.32)					23	knee	[11]
Visual Analogue Scale – Pain (11 pt.)	11/0	6.3 (2.5)	3.6 (2.7)	3.4 (2.7)	3.2 (2.7)			62	hip (OA)	[20]
		6.3 (2.2)	4.5 (2.5)	4.0 (2.4)	4.0 (2.6)			35	hip (RA)	[20]

† Study did not separate scores of hip and knee patients.

e = estimated from graphical data.

* Assessment at 50 days.

** Adapted by the study authors to a 100 pt. scale.

*** Median