INTRODUCTION

Total knee replacement (TKR) is a widely used operation that has radically improved the quality of life of millions of people during the last few decades. (1)

Prosthetic Joint Infection (PJI) is one of the most challenging problems in orthopaedic surgery and musculoskeletal infections specifically. Some very important controversies remain and strong evidence-based recommendations are still lacking in many clinical aspects. Therefore, an undisputed methodology of treatment does not exist yet and there are many different valid approaches. (2)

Infection after total knee replacement presents the most devastating complication of arthroplasty for the patient as well as the surgeon, it represent a big economic and health problem, revision procedures for infection are associated with a longer operating time, greater blood loss, increase the duration of hospitalization, it is between 0.4% and 2% after primary arthroplasty and between 3.2% and 5.6% after revision arthroplasty. (3)

There are many causative bacteria that lead to infection after total knee replacement the most common of them are Staphylococcus Aureus, Staphylococcus Epidermidis and Escherichia coli that can get way to the knee joint via blood born or direct transmission in immune compromised patients

like in patients with diabetes, malnutrition, smokers, alcoholics, obesity and rheumatoid arthritis. [4]

Infection after total knee arthroplasty can be classified in to acute which can appear before four weeks postoperative, sub acute and chronic which appear after four weeks postoperative. [5]

A recent analysis of historical procedure data indicated that the prevalence of primary and revision total knee arthroplasty increased steadily between 1990 and 2002. A massive demand for primary and revision surgeries is also expected in the next two decades. [6]

Two stage revision arthroplasty consists of debridement of all non-viable tissues, resection of the infected implant with or without placement of a temporary antibiotic-impregnated cement spacer and delayed reimplantation of a new prosthesis in a separate surgery after infection is deemed to be eradicated. [7]

Many literatures approved that two-stage surgery with antibiotic impregnated articulsating spacer is traditionally considered to be the safest option in regard to the chance for successful eradication of infection. [8]

Aim of the Work

To assess the re-infection rate and the functional outcome in patients undergone two stage revision and one stage revision arthroplasty for infected total knee replacement in studies published from 2012 to December 2017.

MATERIALS AND METHODS

This review was done using standard methodology outlined in the Cochrane Handbook and reported the findings in accordance with the Preferred Reporting Items for Systematic Reviews and Meta-analyses (PRISMA) statement guidelines.

Inclusion criteria in the analysis:

1. **The design:** a comparative and non comparative studies between two stage revision arthroplasty and one stage revision arthroplasty

2. **Population**: patients of all ages with infected total knee replacement

3. **Outcome measures:** greater than or equal to one pre-specified quantifiable outcome measure (They included re infection rate in both revision strategies and measures of functional and clinical outcomes).

4. **Level of evidence:** papers provides levels I to IV of evidence.

5. **Follow up period:** not less than two years of continuous follow up.

Exclusion criteria:

1. Non English papers.
2. Non human trials.
3. Articles with no clinical data.
4. Duplicates.
5. Patients treated by other modalities like arthrodesis, amputation and DAIR (debridement antibiotic irrigation and implant retention).

Type of included participant

Patient with advanced knee "osteoarthritis"(OA) who had undergone total knee replacement that become infected and operated on by two stage or one stage revision arthroplasty.

Methodology

Search of Medline (PubMed), the Cochrane Library and Cumulative Index to Nursing and Allied Health Literature (CINAHL).

We used Medical Subject Headings (MeSH) terms and key words to generate sets for the following themes: Total knee Arthroplasty, infected knee replacement, revision, one stage and two stage.

We then used the term "AND" to find their intersection. No limits were used, except for language (non English excluded). This basic approach was modified as necessary to search each electronic database.

Studies that were clearly not related to our research question were immediately excluded.

A standardized form for collecting data related to study methodology, participant characteristics, and outcomes of interest were developed.

When studies provided data with standard error (SE) we converted to standard deviation (SD) via the formula ($SD=SE \sqrt{n}$).

Variability in the design:

Our included studies (Randomized trials, Prospective comparison studies and Retrospective comparison studies).

Tools used:

- The Cochrane Risk for Bias Assessment Tool,
- The Newcastle-Ottawa Tool.
- The Emergency Care Research Institute (ECRI) Before & After Assessment Tool.

Search strategy

The Embase and Medline databases were searched from 15th December 2012 to December 2017 using the Ovid interface. The search strategy was modified from that used by Beswick and colleagues to identify similar papers regarding treatment of infected knee replacement. References were transferred into Endnote referencing software and duplicates were discarded. Firstly titles and abstracts were reviewed for relevance according to the research question. The remaining studies were analysed in their entirety. References of full texts were also reviewed to identify any other potentially relevant study.

Our review has been registered in the PROSPERO prospective register of systematic reviews (CRD42015017327) and was conducted using a predefined protocol and in line with PRISMA and MOOSE guidelines. We searched for longitudinal studies (retrospective, prospective, or randomized controlled trials) reporting re-infection outcomes following one- or two-stage surgical revision of infected knee prosthesis in MEDLINE, EMBASE, Web of Science, and Cochrane databases from inception up to December 2017. The search strategy used a combination of key words related to knee replacement, infection, and revision with focus on one- and two-stage surgeries. We complemented the search by manually scanning reference lists of identified articles and review articles for relevant publications missed by the original search.

The primary outcome:

Reinfection rate is the primary outcome and it is the percentage of patients that become infected after revision arthroplasty either by one stage or two stage revision.

The Secondary out come measures:

Postoperative range of motion

Functional knee scores

As regard the functional knee scores the response to each item is scored using an ordinal method (i.e., 0 for responses that represent the highest level of symptoms or lowest level of function). The most recent version has assigned scores for each possible response printed on the questionnaire. Scores for each item are summed to give a total score (excluding item 10a). The total score is calculated as (sum of items)/(maximum possible score) × 100, to give a total score of 100. An online scoring sheet is available.

Five domains: 1) pain frequency and severity during functional activities; 2) symptoms such as the severity of knee stiffness and the presence of swelling, grinding or clicking, catching, and range of motion restriction; 3) difficulty experienced during activities of daily living (ADL); 4) difficulty experienced with sport and recreational activities; and 5) knee-related quality of life (QOL).

Knee society score:

In 1989, The Knee Society Clinical Rating System was developed to rate both the knee prosthesis function and patients' functional abilities after total knee arthroplasty (TKA) (Insall). While this scoring system became the most popular method of reporting outcomes after total and partial knee arthroplasty it was felt to not provide enough detail specifically in documenting the functional capabilities of more contemporary knee arthroplasty patients. The original score was only physician-derived, leaving unresolved the poor correlation between objective physician-assessed knee scores and patient-derived satisfaction scores. It became clear that an updated and validated Knee Society scoring system, with improved responsiveness and reliability was needed.[9]

Pain	
○	None
○	Mild / Occasional
○	Mild (Stairs only)
○	Mild (Walking and Stairs
○	Moderate – Occasional
○	Moderate - Continual
○	Severe

Flexion Contracture (if present)	
○	5°-10°
○	10°-15°
○	16°-20°
○	>20°

Extension lag	
○	<10°
○	10-20°
○	>20°

Total Range of Flexion					
0-5	6-10	11-15	16-20	21-25	
26-30	31-35	36-40	41-45	46-50	
51-55	56-60	61-65	66-70	71-75	
76-80	81-85	86-90	91-95	96-100	
101-105	106-110	111-115	116-120	121-125	

Alignment (Varus & Valgus)				
0	1	2	3	4
		5 – 10		
11	12	13	14	15
		Over 15°		

Score 80-100 excellent

Score 70-79 good

Score 60-69 fair

Score below 60 poor [10]

Oxford knee score [11]

1. How would you describe the pain you usually have in your knee?	7. Could you kneel down and get up again afterwards?
None	Yes, easily
Very mild	With little difficulty
Mild	With moderate difficulty
Moderate	With extreme difficulty
Severe	No, impossible

2. Have you had any trouble washing and drying yourself (all over) because of your knee?	8. Are you troubled by pain in your knee at night in bed?
○ No trouble at all	○ Not at all
○ Very little trouble	○ Only one or two nights
○ Moderate trouble	○ Some nights
○ Extreme difficulty	○ Most nights
○ Impossible to do	○ Every night

3. Have you had any trouble getting in and out of the car or using public transport because of your knee? (With or without a stick)	9. How much has pain from your knee interfered with your usual work? (including housework)
◉ No trouble at all	○ Not at all
○ Very little trouble	○ A little bit
○ Moderate trouble	○ Moderately
○ Extreme difficulty	○ Greatly
○ Impossible to do	○ Totally

4. For how long are you able to walk before the pain in your knee becomes s eve re? (With or without a stick)	10. Have you felt that your knee might suddenly ï¾½give awayï¾½ or let you down?
○ No pain > 60 min	○ Rarely / Never
○ 16 - 60 minutes	○ Sometimes or just at first
○ 5 - 15 minutes	○ Often, not at first
○ Around the house only	○ Most of the time
○ Not at all - severe on walking	○ All the time

5. After a meal (sat at a table), how painful has it been for you to stand up from a chair because of your knee?	11. Could you do household shopping on your own?
Not at all painful	Yes, easily
Slightly painful	With little difficulty
Moderately pain	With moderate difficulty
Very painful	With extreme difficulty
Unbearable	No, impossible

6. Have you been limping when walking, because of your knee?	12. Could you walk down a flight of stairs?
Rarely / never	Yes, easily
Sometimes or just at first	With little difficulty
Often, not just at first	With moderate difficulty
Most of the time	With extreme difficulty
All of the time	No, impossible

Score 0 to 19_May indicate severe knee arthritis. It is highly likely that you may well require some form of surgical intervention, contact your family physician for a consult with an Orthopaedic Surgeon.

Score 20 to 29_May indicate moderate to severe knee arthritis. See your family physician for an assessment and x-ray. Consider a consult with an Orthopaedic Surgeon.

Score 30 to 39_May indicate mild to moderate knee arthritis. Consider seeing your family physician for an

assessment and possible x-ray. You may benefit from non-surgical treatment, such as exercise, weight loss, and /or anti-inflammatory medication.

Score 40 to 48 May indicate satisfactory joint function. May not require any formal treatment. [12]

Knee society functional score [13]

Walking	
○	Unlimited
○	>10 blocks
○	5-10 blocks
○	<5 blocks
○	Housebound
○	Unable

Stairs	
○	Normal Up and down
○	Normal Up down with rail
○	Up and down with rail
○	Up with rail, down unable
○	Unable

Walking aids used	
○	None used
○	Use of Cane/Walking stick deduct
○	Two Canes/sticks
○	Crutches or frame

WOMAC score [14]

The Western Ontario and McMaster Universities Arthritis Index (WOMAC) is widely used in the evaluation of Hip and Knee Osteoarthritis. It is a self-administered questionnaire consisting of 24 items divided into 3 subscales:

Pain (5 items): during walking, using stairs, in bed, sitting or lying, and standing upright

Stiffness (2 items): after first waking and later in the day

- Physical Function (17 items): using stairs, rising from sitting, standing, bending, walking, getting in / out of a car, shopping, putting on / taking off socks, rising from bed, lying in bed, getting in / out of bath, sitting, getting on / off toilet, heavy domestic duties, light domestic duties. [12]

Knee Injury and Osteoarthritis Outcome Score (KOOS) [15]

The KOOS is a knee joint specific questionnaire developed in 1998 originally for the purpose of evaluating short-term and long-term symptoms and functioning in subjects with knee injury and osteoarthritis (Table 1). It was originally validated in patients undergoing anterior cruciate ligament ACL reconstruction [38]. The KOOS is a 42-item survey designed to assess people's opinions about the difficulties they experience with activity due to problems with their knees. A higher score

indicates a better outcome. The questionnaire, scoring instructions, and translations are freely available at http://www.koos.nu/. The KOOS is widely used in younger and/or more active patients with knee injury and knee osteoarthritis. [13]

KOOS consists of 5 subscales; **Pain**, other **Symptoms, Function in daily living (ADL), Function in sport and recreation (Sport/Rec)** and **knee related Quality of life (QOL)**. The previous week is the time period considered when answering the questions. Standardized answer options are given (5 Likert boxes) and each question is assigned a score from 0 to 4. A normalized score (100 indicating no symptoms and 0 indicating extreme symptoms) is calculated for each subscale (scoring instructions are available in a separate document: KOOS Scoring). A total score has not been validated and is not recommended. For the purpose of an RCT, KOOS subscale scores can be aggregated and averaged as the primary outcome. The five individual KOOS subscale scores are then given as secondary outcomes to enable clinical interpretation. [13]