Simultaneous versus staged bilateral total knee replacement. Comparison of trilogy of cost, complications, and functional outcome. A systematic review and Suggestions for practice in Low income countries

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Abstract

Background: When patients present with end-stage bilateral knee arthritis, the decision facing both the patient and the surgeon is whether to replace both knees in one sitting (simultaneous bilateral total knee replacement) SMBTKR or to undertake one knee replacement and after an interval of time and as a separate episode, replace the other knee (staged bilateral total knee replacement) STBTKR. There is concern regarding the safety of undertaking SMBTKR. The study is a review to determine the risk benefit profile of SMBTKR compared to a staged procedure (STBTKR).

Methods: A literature search of MEDLINE and EMBASE from inception to April 2019 was carried out. 26 studies qualified for inclusion in the review. A systematic review was undertaken using narrative synthesis. Methodological quality was assessed with the use of risk of bias tool developed by Warby et al (2014).

Results: The studies were of moderate quality with low to moderate risk of bias. There is evidence that the risk of complications may be increased when patients with chronic cardiac and pulmonary illness undergo SMBTKR. There may also be increased risk of confusion and mortality in the frail elderly patient (>75yrs). There is increased blood loss with this approach. Benefits include superior rehabilitation and functional outcome and lower cost associated with SMBTKR. Patients not suitable for SMBTKR are best treated as STBTKR.

Abstrait

Contexte: Lorsque les patients présentent une arthrite bilatérale du genou au stade terminal, la décision à laquelle sont confrontés à la fois le patient et le chirurgien est de savoir s'il faut remplacer les deux genoux en une seule séance (arthroplastie totale bilatérale simultanée du genou) SMBTKR ou entreprendre une arthroplastie du genou et après un intervalle de temps et en tant qu'épisode distinct, remplacer l'autre genou (arthroplastie totale bilatérale par étapes du genou) STBTKR. Il existe des inquiétudes concernant la sécurité de l'entreprise SMBTKR. L'étude est une revue visant à déterminer le profil risque-bénéfice du SMBTKR par rapport à une procédure par étapes (STBTKR).

Méthodes: Une recherche documentaire sur MEDLINE et EMBASE depuis leur création jusqu'en avril 2019 a été réalisée. 26 études ont été qualifiées pour être incluses dans la revue. Une revue systématique a été entreprise à l'aide d'une synthèse narrative. La qualité méthodologique a été évaluée à l'aide de l'outil de risque de biais développé par Warby et al (2014).

Résultats: Les études étaient de qualité modérée avec un risque de biais faible à modéré. Il existe des preuves que le risque de complications peut être augmenté lorsque les patients atteints d'une maladie cardiaque et pulmonaire chronique subissent un SMBTKR. Il peut également y avoir un risque accru de confusion et de mortalité chez les patients âgés fragiles (> 75 ans). Cette approche entraîne une perte de sang accrue. Les avantages comprennent une réadaptation et des résultats fonctionnels supérieurs ainsi qu'un coût inférieur associé au SMBTKR. Les patients qui ne conviennent pas au SMBTKR sont mieux traités comme le STBTKR.

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Introduction

Simultaneous bilateral total knee replacement (SMBTKR) refers to bilateral total knee replacement performed during the same anaesthetic session [1]. Staged bilateral total knee replacement (STBTKR) involves undertaking one knee replacement followed, after an interval of time and under a separate anaesthetic, undertaking the second knee replacement. Despite divided opinion in literature regarding safety and clinical outcome of SMBTKR [1,2.3] there are evidences suggesting an increase in trend towards SMBTKR [1,1]. The functional outcome following SMBTKR had also been reported to be superior in terms of range of motion, improvement in motion and knee scores compared to unilateral total knee replacement in patients with bilateral knee pathology as it eliminates the painful and restricted rehabilitation effect of the contralateral knee arthritis [1].

Recent discussions about total knee replacements had focused on the trilogy of cost, complications, and outcome [6] and striving for a balance between these three principles has remained a thorny issue amongst practicing arthroplasty surgeons worldwide.

The cost effectiveness of SMBTKR compared to STBTKR carried out during two separate hospital admissions, or even a staggered procedure performed two to seven days apart during the same admission is well documented and seems to be the only non-controversial area of discussion [1,6,1,2,3,4,5,6].

With the undisputed benefits of increased cost savings and decreased recovery time and with no difference or even better functional outcomes, some authors believe that the benefits of SMBTKR outweigh the economic costs of potential complications [11].

Osteoarthritis of the knee is common in Nigeria with a prevalence rate of between 19% and 20% in community-based studies in South-Western and North-Eastern geopolitical regions of the country [13,14,15]. Despite the high burden of osteoarthritis of the knee, the rate of total knee replacements performed in Nigeria has been low. This has been attributed to many factors, key among which is the lack of funds since most of the populace live below the poverty line and yet have to pay out of pocket for healthcare [1,2]. Therefore, the concept of SMBTKR becomes relevant to the realities on ground in a resource poor setting like ours.

The aim of this study was to systematically review published literature that compare SMBTKR with STBTKR using a narrative synthesis, and highlight the advantages and concerns identified in the literature to suggest a pragmatic way of practicing SMBTKR with in a resource poor setting while maximizing the advantages and reducing complications.

Method

This review is compliant with Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) guidelines. We undertook a literature search of publications using the Population, Intervention, Comparator and Outcome (PICO) format, defining the population as patients with bilateral end-stage knee arthritis, intervention as SMBTKR, comparator as STBTKR. Outcome was defined as the trilogy of complications, overall cost, and functional outcome. Included are articles from database inception until April 2019. They must compare SMBTKR with STBTKR. There is no limitation on the interval between the two knees replacement in the staged group provided they are undertaken on separate admissions. Studies that specify the population such as rheumatoid or morbidly obese patients only, are excluded. Non-English language articles are excluded. Also excluded are cross -sectional studies and national registry data. Population studies and surveys are excluded. Systematic reviews or review articles, case series and case reports are excluded. Animal studies are also excluded. While literature search included the following databases; Medline (including Cochrane database) and EMBASE. Search terms include MESH (Medical Subject Headings) and 'Free text' keywords within the title and abstract fields. Similar terms were combined with OR while concepts are combined with AND. Medline search generated 42 articles.

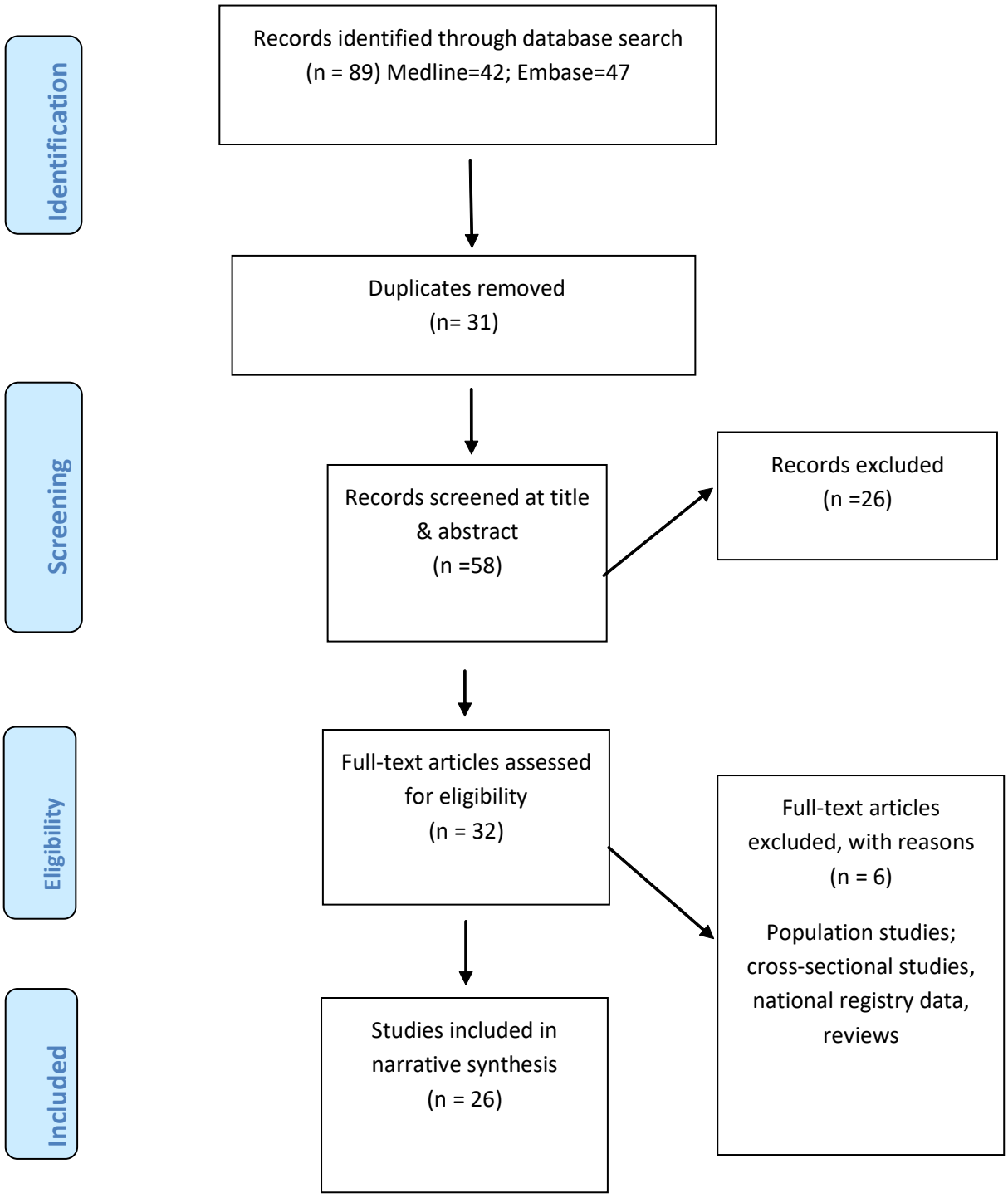
Search repeated in EMBASE revealed 47 articles. Both results were combined, and duplicates removed leaving 58 unique references.

Screening of titles and abstracts eliminated 26 articles leaving 32 papers for full text review. 6 articles were eliminated at the full text stage (reasons for elimination are in the flow chart). This left 26 articles which are the subject of this review.

The various stages of the study selection process were undertaken independently by two of the authors. Any disagreement was resolved by consensus.

See Figure 1 for flow chart of the study selection process.

Figure 1. Prisma chart of the study selection process



Methodological quality was assessed with the use of risk of bias tool developed by War by et al (2014).

Result

A narrative synthesis of the evidence from the included studies was undertaken and grouped into a review of potential advantages and disadvantages of SMBTKR compared with STBTKR.

The included studies were of moderate quality with low to moderate risk of bias.

A review of potential advantages of SMBTKR compared to STBTKR.

The major advantages of SMBTKR are; One hospital admission, with both knees replaced during a single anaesthetic session [1,2,7] shorter mean surgical and

tourniquet time compared to STBTKR [1] and one episode of care resulting in lower cost compared to staged procedure and patient convenience [9,10,11]. Stefano Bini et al reported that there was no increase in complication rates for SMBTKR compared to STBTKR [16]. Closer scrutiny of the study revealed that the SMBTKR group had healthier patients (ASA I and II), younger patients and they were more likely to be operated on by high-volume surgeons, all of which may have confounded the conclusions of the study. Similar selection bias and findings were noted by Poutsides L et al who also reported that there were no differences in complication rates between SMBTKR and STBTKR except for post-operative anaemia, post-operative transfusion and higher referral to rehabilitation facilities in the SMBTKR group[17]. When the effect of confounders was reduced in the study by Sheth DS et al. involving 7866 SMBTKR and 14,370 STBTKR, they still reported no difference in mortality and complication rates between the 2 groups [4]. Bohm ER et al. in an analysis of the Canadian Hospital Morbidity database for fiscal years 2006/07 to 2012/13 for TKR patients involving 6349 SMBTKR and 25,253 STBTKR, reported that patients who underwent SMBTKR were more likely to be males, were younger and healthier than the STBTKR group likely reflecting selection bias by the surgeons [19]. They had shorter hospital stay but higher rates of transfer to rehabilitation facility and a lower frequency of prosthetic joint infection. The study by Sheth DS et al. also reported a protective effect of SMBTKR on risk of prosthetic joint infection compared to STBTKR [4]. Beneficial effects on length of stay reduced morbidity and reduced readmission rates following SMBTKR compared to STBTKR was reported by Lindberg-Larsen et al. in a Danish Nationwide study [20].

However, with the majority of SMBTKR performed under general anaesthesia as is the practice in the United States of America, the prolonged exposure to anaesthesia in these elderly groups of patients usually with comorbidities deserves more scrutiny [16,21]. The study by Lane *et al* revealed a higher rate of post-operative confusion in SMBTKR [22] whilst the risk of complications like pneumonia, deep vein thrombosis were reported to be higher in other studies [12]. It is yet to be seen if the effect of the current slowly shifting trend towards regional anaesthesia and multimodal analgesia [21,23] will ameliorate some of the unwanted effects of prolonged general anaesthesia and ultimately improve the safety of SMBTKR. A shorter mean tourniquet and cumulative surgical time is observed in SMBTKR when compared to unilateral or staged procedure [22,23]. However, of great concern is the effect of large volume of blood flowing back towards the heart in these elderly patients when tourniquets are used simultaneously after exsanguinations and also the effect of the large quantity of low pH metabolites released into the systemic circulation when the tourniquets are deflated with just a short interval in-between them [22]. The lower cost of SMBTKR is attributed to the effect of shorter hospital stay, lower cost for a single laboratory tests and medical consultations, single cost of operating room, anaesthesia and surgical fees, recovery room time, antibiotics, and physical therapy [4,9,10,11]. This had been the main attraction for the use of SMBTKR and there appears to be an agreement amongst published work regarding the cost efficiency of SMBTKR especially when acute in-hospital care cost is considered. In a review comparing SMBTKR and STBTKR performed in Canada, where in-patient rehabilitation facilities are frequently used, the lower cost has been found not to be as significant since patients who undergo SMBTKR have longer rehabilitation phases and accrue more cost [24].

Benefits of STBTKR compared to SMBTKR include reduction in the stress response and hence, reduction in the risk of complications that has been noted in some series following SMBTKR [25,27-29]. Undertaking the more painful knee in a STBTKR may obviate the need for a second knee replacement due to relief of weight bearing stress on the second knee. Recovery from the second knee replacement is faster with less hospital stay and earlier recovery of knee function due to the patient's familiarity with the surgery, less apprehension and better motivation [26]. Elderly patients, and patients with higher co-morbidities (ASA III-IV) are more suitable for STBTKR [4,22,27]

A review of potential disadvantages of SMBTKR compared to STBTKR

There is keen debate in literature regarding significant differences in the occurrence of cardiac complications including new onset arrhythmia, myocardial infarction (MI), and congestive cardiac failure (CCF)[27] with claimed increase in patients who undergo SMBTKR when compared to those who undertake a STBTKR. Increased risk of thromboembolic complications [27] (deep venous thrombosis (DVT) and pulmonary embolism (PE), potential increase in wound infection rates [3,26],

increased use of allogeneic blood transfusion [27], and increase perioperative mortality [1] are also claimed to be higher in patients who undergo SMBTKR. Bohm et al reported that the SMBTKR group had higher rates of blood transfusion, higher rates cardiac complications within 90 days and higher in-hospital mortality compared to the second knee replacement in staged patients [19]. Furthermore, the study by Hardley S et al reported that although not statistically significant, the incidence of complication was higher for SMBTKR than for STBTKR as was complication rates in patients with higher co-morbidities (ASAIII) [27].

There is almost universal agreement that SMBTKR is significantly associated with increased risk of allogeneic blood transfusion compared to STBTKR with the attendant risk of complications including prosthetic joint infection. Hadley S et al also reported that blood transfusion following SMBTKR was more than twice the two staged knee replacements combined.

STBTKR may not be suitable for patients with severe bilateral end-stage arthritis as patient satisfaction is reduced on account of on-going pain in the contralateral yet-to-be replaced knee, rehabilitation is prolonged, and recovery of function often remains elusive until the second knee is replaced. Meehan JP et al reported that post-operative knee stiffness requiring manipulation under anaesthetic was significantly higher after STBTKR compared to SMBTKR and resulted from the hindered rehabilitation by the painful unreplaced second knee. It is often unclear when it is best to undertake the second knee replacement as earlier staging of the second surgery may increase the risk from the first operation while a lengthy interval between the stages prolongs the pain, with on-going reduction in function and quality of life of the patient.

Discussion

Despite the benefits of SMBTKR noted by its proponents, concerns regarding the risk of complications, and other adverse outcomes have been expressed by others who prefer STBTKR and the choice of which approach to take remains controversial [28,29].

It will be prudent to give serious consideration to the concerns regarding the risks of complications attendant in either approach in a resource poor setting where appropriate resuscitative and intensive care facilities may not be readily available. A more robust pre-operative work up of patients, risk stratification and planning of the surgery may be the best way to prevent or at the least reduce the chances of occurrence of these issues of concern. Another trend towards offering SMBTKR to younger, fit patients has been noticed with consequent reduction in the risk of cardiac and other comorbidities and related complications [1].

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