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Case Series

Deep infection rate in primary total knee arthroplasty: a case series from Oman

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ABSTRACT

The aim of this report is to assess deep infection rate in total knee arthroplasty (TKA), in a clean theatre, but without using laminar flow. This report is a retrospective case series of TKA conducted in the same hospital and same single operating room, by a single surgeon, to assess the percentage of post operative deep infection, that needed surgical intervention between June 2016 and December 2023. Infection rate was compared to the rate reported in the literature. A total of 430 knee replacements were reviewed, with data obtained from the electronic medical record system. All of these cases were performed under strict vigilance to prevent infection, all were given pre operative prophylactic antibiotics, and all had a surgical drain that was removed at the first post operative day. Prosthetic joint infections (PJI) was defined as a TKA that needed further surgical intervention for a clinical picture and investigations suggestive of deep infection. In this report, four patients out of a total of 430 patients (0.93%), who underwent primary TKA had developed PJIs as defined. Patient's age ranged from 57 to 71 years (mean 66 years), with three females and one male patient. Two patients underwent staged revision TKA after confirmation of PJI, while other two patients underwent debridement, change of insert, and implant retention. This report has concluded a rate of deep infection that is comparable to the reported rate in the literature, despite that no laminar flow was used in this case series. Using a surgical drain did not seem to increase the infection rate. Two of the infected cases were from bacteria that cannot be surgically acquired, making the surgically acquired rate of infection even lower (0.47%).

Keywords: Infection, Laminar flow, Revision, Surgery, Total knee arthroplasty

INTRODUCTION

Total joint replacement has become a highly effective surgery, with a growing number of procedures being carried out than in previous years.[1]

Post-operative joint infection following TKA, is an uncommon but highly impactful and costly complication.[2]

Joint replacement procedures have been carried out in operating rooms with laminar flow ventilation since Sir John Charley's early contributions and the development of the laminar flow concept in arthroplasty.[3] During that time, a number of studies shown a considerable decrease in infection rates, confirming the efficacy of laminar flow theatres.[4-6] These investigations were unable to definitively identify whether the recent introduction of prophylactic antibiotics or the air circulation system itself was responsible for the decline in infections.

By generating a positive air pressure that forces polluted air away from the surgical site, laminar flow devices are thought to lessen airborne bacterial contamination. These systems draw air from the operating room's ceiling level, and a number of fans filter it to get rid of bacteria. High-efficiency particulate air (HEPA) filters are most frequently used for this.[7]

CASE SERIES

This report of case series of knee replacements were performed in one operating room which had no laminar flow system, yet this theatre room was always reserved for clean cases, and on the occasion of being used for an unclean case, it was always subjected to carbonization prior to being used for clean cases again. All cases had a surgical drain inserted before closure, and removed at the first post operative day.

So, does the laminar flow ventilation in operating theatre reduces post-operative infection in TKA patients. Does a surgical drain increase the rate of infection when compared with the general reporting of deep infection rate in total knee replacement.

This is a single-center, single surgeon, level III retrospective case series report.

This report is a retrospective case series of knee replacements conducted in the same hospital and operating room, by a single surgeon. To assess the percentage of post operative deep infection that needed surgical intervention between June 2016 and September 2024.

A total of 430 knee replacements were reviewed, with data obtained from the electronic medical record system.

Data collected was age, gender, postoperative out-patient follow-up notes, readmission notes.

All patients who had primarily total knee arthroplasty, in the same exact clean operating room that has no laminar flow were included and revision knee arthroplasty cases were excluded.

Descriptive statistics in terms of using the incidence of the parameter of concern, which is infection as defined.

In this report, 4 patients out of a total of 430 patients (0.93%), who underwent primary TKA had developed PJIs.

Patient's age ranged from 57 to 71 years (mean 66 years), with three females and one male patient.

PJI was defined as a subject who underwent TKA and needed further surgical intervention for clinical picture and labs suggestive of deep infection.

Two patients underwent staged revision TKA after confirmation of PJI, while other two patients underwent debridement, change of insert, and implant retention.

One patient had Coxiella infection which required chronic Q fever treatment as per protocol and the second and third patients grow brucella and *E. coli* on the intra operative biopsies culture respectively, while the third patient had negative intraoperative cultures.

Neither of these two bacteria could be the surgically acquired.

Table 1: Patient's series,

Age (in years)	Gender	Presentation	Intervention	Cultures
71	M	Painful swelling	Stagged revision TKA	Coxiella
63	F	Painful swelling	Debridement and change of insert	Brucella
70	F	Painful swelling	Stagged revision TKA	*E. coli*
57	F	Painful swelling	Debridement and change of insert	Negative

Case 1

A 71-year-old male, hypertensive, initially underwent primary TKA. five years later he experienced a traumatic knee dislocation with a posterior lateral wound requiring closed reduction and wound management. three months after that incidence and after wound healed, he underwent revision TKA for instability with negative intraoperative cultures.

Two years after revision surgery he presented with features of PJI, he underwent first stage revision with cement spacer, and another debridement and change of spacer three months later. Six months after second debridement final implantation of complex TKA done with negative intraoperative cultures.

His histopathology and cultures during surgery confirmed Coxiella Q fever. He received an 18-24 months course of antibiotics.

Throughout his treatment the patient underwent multiple debridement and change of cement spacer.

After the last debridement his brucella serology went down and with involvement of the infectious disease team, decision was made for final implantation of a complex TKA with negative intraoperative cultures.

At two years follow up post-revision, he had no signs of infection, though mild pain and the limb swelling persisted.

Figure 1 (A-D): X-Ray through different stages of treatment (case 1). A-X-ray shows dislocation primary TKA, B-X-ray after revision into semi-constrained TKA, C-X-ray show cement spacer after debridement and D-X-rays show final revision with mega-prosthetic.

Case 2

A 63-year-old female with dyslipidemia and hypothyroidism on treatment, underwent primary TKA. A month after TKA she presented with features of septic shoulder joint for which she underwent washout and the intraoperative cultures grew brucella, targeted antimicrobial treatment was started. Within 2 weeks and during her hospital stay, she developed right knee swelling and pain, ultrasound scan of the knee revealed fluid collection, a decision was made to go for debridement and change of insert. The patient received anti-brucella treatment, after which she showed clinical improvement and was discharged on oral antimicrobial therapy.

Case 3

A 70-year-old hypertensive and obese female, who initially underwent primary TKA, two years later she presented with anterior knee pain and required patellar resurfacing, 16 months after resurfacing procedure she presented with knee pain, swelling and cellulitis. She underwent first stage revision with cement spacer, intraoperative cultures grew *E. coli*, she received appropriate antimicrobial therapy. till she achieved clinical and laboratory improvement. Six weeks later she underwent second stage TKA with negative intraoperative cultures. The patient was successfully discharged without further signs of infection in follow up.

Figure 2 (A-D): X-ray through different stages of treatment (case 3). A-X ray shows primary TKA. B- X ray shows primary TKA after patellar resurfacing procedure. C-X-ray after explanation debridement and cement spacer. D-X-ray after final complex TKA.

Case 4

A 57-year-old obese female who underwent primary TKA, developed a pulmonary embolism (PE) two weeks post-op (treated at another facility), and returned four weeks post-op with knee swelling, redness, and pain.

Diagnostic aspiration revealed high synovial fluid counts, leading to a second procedure (Debridement and change of insert). Intraoperative cultures were negative, but she received IV antibiotics and showed clinical improvement.

During her follow-up, she was satisfied with her progress and had no further complaints.

DISCUSSION

PJI is a catastrophic complication and a major cause of failure after primary and revision total joint arthroplasty (TJA).[2] As the number of TJA procedures performed annually continues to increase, so will the rate of subsequent PJI.[8]

Laminar flow ventilation systems were developed by Sir John Charnley in the 1960s and 1970s, and when paired with other sepsis-reduction strategies, they were found to reduce post-operative wound infection.[3] After a number of studies shown a notable drop in laminar flow theatre infections, laminar flow was introduced with a large scale to orthopaedic theatres.[4-6]

There are three different kinds of ventilation systems: ex-flow (Howarth enclosure), laminar flow, and plenum. By creating a positive air pressure that pushes polluted air away from the operating site, ventilator devices are believed to lessen airborne (bacterial) contamination.[9]

Laminar flow systems, which are described as a full mass of air moving in a single direction along parallel flow lines at a constant speed within a certain space (the theatre suite), are the focus of this study. True laminar flow only happens when the HEPA filter coverage is around 100%. Laminar flow ventilation is a continuous flow of highly filtered ultraclean air (UCA) with less than 10 colony-forming units (cfu/m^3) of bacteria per metre cubed. As this is recirculated into the operating area under positive pressure, surgically created contaminants are continuously removed.[7]

It can function either vertically or horizontally. High-efficiency particle air filters are mounted entirely or partially on one of the operating room walls in horizontal laminar flow systems. the vertical structure uses ceiling-mounted HEPA filters to guide air vertically downward into the operating field, it relies less on scrub team placement. However, theatre workers moving with the laminar flow area's edge may cause entrainment of flow, which would divert contamination inward towards the surgical site.[10]

Both systems aim to provide a one-way air flow devoid of turbulence and eddies. Theoretically, this keeps bacteria from falling on and infecting the incision by directing any material that the surgeon and assistant(s) shed throughout the procedure outward and away from the wound site. lowering the risk of infection, protecting the patient from related morbidity and mortality, and saving the hospital money that might be up to four times higher than the initial procedure's cost.[11]

Although it has been widely accepted that laminar flow systems reduce the post operative infection, which was confirmed by multiple studies.[4,6] Including multicentric study in 1982 by Lidwell et al who concluded that the incidence of confirmed sepsis was higher in conventional theatres.[5] This trial has also been widely criticized because of the variable and uncontrolled use of peri-operative prophylactic antibiotics.

In recent years more focus has been directed toward the efficacy of laminar flow systems, in the New Zealand study done by Hooper et al and colleagues, They collected the retrospective data from between the years 1999 and 2008 and 88,311 cases recorded on the New Zealand joint registry, they concluded that there is no benefit in the use of laminar flow or space suits in reducing the rate of revision for early deep joint infection in total joint replacement, and questions the added cost of their use.[12]

Brandet et al in their survey of sixty-three surgical departments, with 99,230 orthopaedic and general surgical procedures performed in Germany. They found that laminar flow did not lower surgical site infection and might have increased the infection rate in total hip replacements.[13]

Holton and Ridgeway have argued that once a certain level of air quality is achieved any further reductions in infection rates will be due to quality of aseptic technique.[6] It is therefore important that we look to assess the value of laminar airflow ventilation in terms of patient benefit post procedure rather than purely in terms of air quality.[14]

Following TKR, laminar flow does not seem to further lower the risk of PJI in Asian patients when prophylactic antibiotics, patient optimization, and modern aseptic methods are used, in addition of it being expensive to buy and maintain, as stated by Teo et al in their study.[15]

And in more recent meta analysis done by Ouyang et al stated that the incidence of surgical site infections (SSIs), the number of bacteria in the air, and the occurrence of SSIs in orthopaedic operating rooms are not significantly decreased by the use of LAF systems.[16]

If we looked into the causing organisms, most of the PJIs were monomicrobial 70% with 25% being polymicrobial and the rest 5% being culture-negative.[17] Analysis of infecting bacteria revealed *Staphylococcus* species were the most common infecting organism (Methicillin-

susceptible *S. aureus* (MSSA) 21%, methicillin-resistant *S. aureus* (MRSA) 10% and Coagulase negative (CoNS 15%).[18]

A cohort study found that incidence rates of PJIs were higher in the early and delayed vs late post-TKA period, moreover, there were differences in microbiological cultures as *S. aureus* was the most common organism isolated overall. However, gram-negative infections were isolated in 15.4% (86) of early PJIs.[19] It was noticed by Rosteius et al that patients with PJI have a specific risk profile that includes numerous comorbidities, such as obesity and advanced age. The increase of high-resistance infections is demonstrated by the microbiological trend that has been seen.[20]

In this report, two of the subjects exhibited organisms that are not hospital acquired, being Brucella in case 2 and Coxiella in case 1, while case 3 showed *E. coli* it's also not considered one of the common organisms. Yet if it was hospital acquired then the infection rate drops to (0.23%).

Despite the results of the current report limitations include being retrospective study, relatively small sample size, the absence of control group, relatively short follow-up period of some patients.

CONCLUSION

This report has found low infection rate, although laminar flow system was not implemented for this case series, which comes in coherence of reports showing no additional benefit in using laminar flow in the reduction of infection rate for total knee arthroplasty. Furthermore, all the cases had a surgical drain, with this cases series reported infection rate, using a drain did not report a high infection rate.

Strong vigilance to infection control seems to be the key for low infection rate.

Recommendations

Follow known protocols of infection control, vigilance to those protocols will yield good results, laminar flow is not a necessity in knee arthroplasty surgeries. Surgical drain is safe and does not seem to cause a high rate of infection.

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