Operating Room Traffic in Total Joint Arthroplasty
One Simple Measure Toward Solving a Complex Problem

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Background: Periprosthetic joint infection remains a devastating complication of total joint arthroplasty (TJA). The literature suggests that unnecessary operating room (OR) traffic increases the risk of surgical site infection by increasing bacterial load in the OR. We attempted to determine whether the posting of “restricted access” signs on the outside and inside of OR doors during primary TJA procedures would result in a reduction of OR door openings.

Methods: This prospectively designed, 2-phase study investigated the number of door openings per case for primary TJA. An independent observer collected data for each TJA case; the OR staff were blinded to the data collection to avoid bias. The first phase of this study recorded OR traffic without the use of “restricted access” signs. In the second, interventional phase of the study, OR traffic was monitored with the concomitant application of “restricted access” signs on the doors. The number of openings per case, from the time of incision to the time of dressing application, was collected.

Results: The average number of openings per case during the first phase was 75, with 0.59 door openings per minute. The average number of openings per case during the second phase was 40, with 0.28 door openings per minute. Therefore, a 47% reduction in openings per case and a 53% reduction in the number of openings per minute during primary TJA cases were observed.

Conclusions: We demonstrated that the simple addition of “restricted access” signs on the outside and inside of OR doors produced a significant reduction (p < 0.001) in OR traffic during primary TJA.

Clinical Relevance: Posting signs can decrease door openings, potentially decreasing infection.

Periprosthetic joint infection (PJI) remains a feared and devastating complication associated with total joint arthroplasty (TJA). With the considerable improvement in wear characteristics and design of TJA implants, infection has superseded traditional complications, such as aseptic loosening and implant wear, as possibly the most ubiquitous and disastrous complication faced by TJA surgeons and patients. Prevention is the most sensible and effective method of managing PJI. This approach, however, must be multifaceted and employ multiple strategies to reduce the modifiable risk factors of PJI. Operative-theater factors, such as skin-preparation techniques, antibiotic prophylaxis, draping, airflow, surgical time, and even ultraviolet light, have been investigated. Furthermore, it has been demonstrated that unnecessary operating room (OR) traffic increases the risk of surgical site infection (SSI). This has been theorized to be secondary to disturbed OR airflow caused by the opening of doors, which may increase air and wound contamination and contribute to the potential colonization by bacteria. There have been multiple studies addressing the difference in OR traffic during primary versus revision TJA, with an increase in traffic during revision TJA. However, to our knowledge, no previous studies have assessed OR traffic during TJA to measure the impact of “restricted access” signs on the flow of traffic.

The aim of the current study was to determine the effectiveness of instituting “restricted access” signs posted on both the inside and outside of OR doors during TJA procedures. Specifically, we sought to measure the average number of OR door openings, and the average number of OR door openings per minute, during TJA procedures at our institution in order to ultimately determine whether “restricted access” signs posted on the outside and inside of each OR door would result in a reduction in the average number of OR door openings during TJA procedures. Our hypothesis was that the average number of door openings would be significantly decreased by posting “restricted access” signs on the outside and inside of the OR doors during TJA.

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Materials and Methods

This prospectively designed, 2-phase study was approved by our institutional review board. We investigated the number of door openings per TJA case at our academic center. There are 3 ORs that are used for TJA cases at our institution, and each was used to collect data. Each OR has 2 doors to enter and exit. These ORs are not restricted to TJA cases; they are primarily used for all types of orthopaedic procedures, but occasionally are used by the general surgery service as well. Our institution does not have anesthesia or nursing staff trainees. There are mandatory breaks for nursing and scrub technician staff.

All TJA procedures were performed by 2 orthopaedic surgeons, both coauthors of this study (J.O. and R.M.). Primary total hip and primary total knee arthroplasty performed at our institution by either of these 2 orthopaedic surgeons in any of the 3 ORs were included in our analysis. Excluded were non-arthroplasty cases, revision TJA cases, shoulder arthroplasty cases, unicompartmental knee arthroplasty cases, and any primary TJA cases with revision components.

The first phase of this study observed OR traffic without the use of “restricted access” signs. Data were collected from March 2018 to June 2018. This was done by having an observer in the back of the room collect data in an unobtrusive manner so that other members of the OR staff did not know data were being collected. The observer was not scrubbed in to the case, and was present before, after, and during the entirety of the procedure. Specifically, the observer recorded the time from the first incision to the application of dressings as the “total time” of surgery and documented the raw number of door openings for each case. The observer did not document which OR personnel contributed to door openings. To minimize the opportunity for measurement bias, OR personnel were blinded in that they did not know data were being recorded. The observer did not contribute to any door openings.

In the second, interventional phase of the study, OR traffic was monitored with “restricted access” signs having been applied on the front and back of each OR door. Data were collected from July 2018 to October 2018. The signs were placed on the inside and outside of both doors of each OR (each of the 3 ORs has 2 doors). The signs were only used during TJA cases and were applied within 30 minutes of the starting time of the procedure. The signs were either bright red (entrance) or yellow (exit) and had boldfaced text instructing staff members not to enter unless authorized or not to exit unless absolutely necessary (Fig. 1). The OR staff was not made aware of the function of these signs explicitly; if OR staff questioned the signs, they were given general knowledge of the associated risks of door openings with respect to PJI. During this phase of the study, observers discreetly recorded data in an identical manner to the methods used to record data in phase 1.

Data were first recorded by hand in the OR by the independent observer and then transferred and compiled in a Microsoft Excel spreadsheet by an author of the study. Differences in OR traffic between phase 1 and phase 2 were determined by utilizing the Student t test. With this test, a p value of <0.05 was considered significant.

Results

During this 2-phase study, 50 consecutive primary TJA cases were observed. We analyzed 25 cases in phase 1 and 25 cases in the interventional phase 2. The total number of door openings for all 50 cases was 2,890.

In phase 1, a total of 1,888 door openings over the 25 cases were observed. There was an average of 75 door openings per case during phase 1. The average case duration in phase 1 was 127 minutes. Therefore, our analysis demonstrated an average of 0.59 door openings per minute for phase 1.

During phase 2 of the study, there was a total of 1,002 door openings over the 25 cases. An average of 40 door openings per case was observed in phase 2. The average case duration during phase 2 was 143 minutes. Therefore, the average number of door openings per minute was 0.28 during phase 2.

Fig. 1
Examples of operating room (OR) traffic signs that were posted on the OR doors during the interventional phase-2 portion of this study. Signs were posted within 30 minutes of the start of the procedure and were only used in total joint arthroplasty cases. The red sign (left panel) was posted on the outside of the door warning staff not to enter, while the yellow sign (right panel) was posted on the inside of the door warning staff not to leave. Each of the 3 ORs used for TJA has 2 doors; we posted a set of signs on each door. The signs were produced inexpensively by the printing department at our institution.
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Using a Student t test, we compared the 2 phases in terms of the average number of door openings per minute. Tests of normality were performed to determine whether the order set was well modeled by a normal distribution. The Shapiro-Wilk test, which holds that the null hypothesis is a normally distributed and well-modeled collection of data, demonstrated that the collected data followed a normal distribution (p ≤ 0.05) and were therefore eligible for parametric testing. Analysis with this method revealed a significant difference between the 2 phases in the average number of door openings per minute (p ≤ 0.001).

Discussion

PJI is a major complication often requiring intense and expensive revision procedures. This yields substantial morbidity and mortality to the patient and also puts a large financial burden on the health-care system. The cost of a single PJI has been estimated to be as high as $60,000 (USD) per case, or 2.8 times more than a standard revision arthroplasty secondary to non-infectious pathology and 4.8 times more than a primary joint arthroplasty. It has been hypothesized that the cost of revision arthroplasty will reach $1.6 billion each year in the U.S. by 2020.

OR traffic is a possible modifiable contributor to PJI. By instituting a simple, low-cost solution to OR traffic in the form of “restricted access” signs, we were able to significantly decrease the amount of OR traffic during TJA cases at our institution. Our data demonstrated a significant decrease in total door openings as well as door openings per minute (p <0.001) in the phase-2 period of our study following the intervention, the usage of signs posted on the outside and inside of the OR doors. Ultimately, a 47% reduction in openings per case and a 53% reduction in the number of openings per minute during primary TJA cases were observed.

Our findings for the average number of door openings per case recorded for TJA cases in phase 1 were within the range of what has been previously described in the literature. For example, a cohort studied by Panahi et al. demonstrated an average of 60 to 135 door openings per case, an average of 0.65 to 0.84 openings per minute, and an average OR time of 92 to 161 minutes. This further reinforces that our data are relevant and may be extrapolated to other institutions.

It remains unclear whether such a simple improvement will have a lasting impact. It is possible that, with time, OR staff will return to their previous openings-per-case average and the effectiveness of the signs will diminish. However, with continued use of the signs and staff education, we believe it is possible to maintain a substantially lower openings-per-case average. Furthermore, we believe that our findings may be augmented by implementing an in-service educational session in which OR staff are made aware of the potential consequences of unnecessary OR traffic.

It is important to note that, as the primary end point to our study was door openings and not PJI, we cannot definitively say that implementing the use of “restricted access” signs will decrease PJI. However, as the literature implies an increased risk of infection associated with unnecessary OR traffic, we believe it is appropriate to surmise that the implementation of our signs will decrease PJI by way of decreasing unnecessary OR traffic and thus bacterial load. In addition, our ORs are not equipped with a laminar airflow system; we are not aware whether laminar airflow impacts or negates the effects of increased OR traffic. More data are necessary to enlighten whether OR traffic impacts bacterial load, ideally through a long-term prospective study. Moreover, although it is generally understood that unnecessary OR traffic increases the risk of PJI and infection, and there are multiple studies demonstrating reasonable evidence for this, we are not aware of a study focusing solely on PJI or infection as an end point related to OR traffic; such data would prove useful.

There were several limitations to this study. First, a power analysis was not performed to determine the appropriate study size; however, we believe that the strength of the significant result demonstrated by the study mitigates this limitation and shows that our findings are valuable. Second, there is a possibility that the OR staff became aware of the nature of the study and altered their behavior to decrease the amount of OR traffic; however, we found that openings per case remained consistent throughout all of phase 1 and all of phase 2, suggesting that OR staff behavior was not altered. Finally, this study was performed at a relatively low-volume TJA center; the OR teams at our center are not as experienced in TJA, which may produce unnecessarily high volume centers with staff who are more experienced in performing primary TJA.

Conclusions

The use of simple “restricted access” signs on OR entrance and exit doors significantly reduced OR traffic during TJA cases. This low-cost and easy solution has applicability as a preventive measure instituted during TJA cases to potentially help mitigate the risk of PJI.

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