

# INTRAOPERATIVE EVALUATION AND LEVEL OF CONTAMINATION DURING TOTAL KNEE ARTHROPLASTY

## AVALIAÇÃO E NÍVEL DE CONTAMINAÇÃO INTRA-OPERATÓRIA DURANTE A ARTROPLASTIA TOTAL DO JOELHO

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### ABSTRACT

**Introduction:** Despite numerous articles on intraoperative contamination in total knee arthroplasty (TKA) procedures, the available data on tissue contamination are scarce and mainly based on evaluating bacteriological swabs. **Methods:** Two hundred and forty specimens, divided between bone and soft tissue, were obtained from 40 consecutive unilateral primary TKAs. The specimens were evaluated for aerobic and anaerobic bacterial growth. Colony-forming units/gram (CFU/g) were calculated on the contaminated specimens to determine the level of contamination. **Results:** The contamination rate in intraoperative specimens was 15% during TKA. The contamination level had a mean of 10.6 and a median of 5, ranging from 1-70 CFU/g. The most common contaminating organisms in all samples were *Staphylococcus aureus* (38.9%) and *Staphylococcus epidermidis* (30.6%). No clinical infections were detected in TKAs in the follow-up period. **Conclusion:** The contamination rate during TKA is relatively high, despite the practice of standard preventive measures. Contamination levels, measured by CFU/g, are considered low when compared to the infection threshold of 10<sup>5</sup> reported in the literature. However, contamination should not be underestimated due to the presence of foreign bodies (implants), which are known to significantly lower this threshold. **Level of evidence IV; case series.**

**Descriptors:** Knee Arthroplasty. Intraoperative Period. Surgical Wound Infection.

### RESUMO

**Introdução:** Apesar dos inúmeros artigos sobre a contaminação intraoperatória em procedimentos de artroplastia total do joelho (ATJ), os dados disponíveis sobre a contaminação tecidual são escassos e baseiam-se principalmente na avaliação de swabs bacteriológicos. **Métodos:** Duzentos e quarenta espécimes, divididos entre ossos e tecidos moles, foram obtidos de 40 ATJ primárias unilaterais consecutivas. Os exemplares foram avaliados quanto ao crescimento bacteriano aeróbio e anaeróbio. As unidades formadoras de colônias/grama (UFC/g) foram calculadas nas amostras contaminadas para determinar o nível de contaminação. **Resultados:** A taxa de contaminação em espécimes intraoperatórios foi de 15% durante a ATJ. O nível de contaminação teve uma média de 10,6 e uma mediana de 5 variando de 1-70 UFC/g. Os organismos contaminantes mais comuns em todas as amostras foram *Staphylococcus aureus* (38,9%) e *Staphylococcus epidermidis* (30,6%). Nenhuma infecção clínica foi detectada nas ATJ durante o período de acompanhamento. **Conclusão:** A taxa de contaminação durante a ATJ é relativamente alta, apesar da prática de medidas preventivas padrão. Os níveis de contaminação, medidos por UFC/g, são considerados baixos quando comparados ao limiar de infecção de 10<sup>5</sup>, relatado na literatura. No entanto, a contaminação não deve ser negligenciada devido à presença de corpos estranhos (implantes) que são conhecidos por reduzir significativamente esse limiar. **Nível de evidência IV; séries de casos.**

**Descritores:** Artroplastia do Joelho. Período intraoperatório. Infecção da Ferida Cirúrgica.

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### INTRODUCTION

Total knee arthroplasty (TKA), which was first performed in 1968, has been the standard of care in patients with end-stage arthritis.<sup>1,2</sup> It is estimated that over 1,324,000 TKAs are performed annually around the world.<sup>3</sup> The satisfaction rate after TKA is high, reaching up to 86% in terms of pain relief and 84% for functional improvement.<sup>4</sup> However,

post-operative complications, including infection, can lead to a devastating outcome.<sup>5,6</sup> The risk of deep infection in TKA ranges from 0.39-3.4 percent.<sup>7-9</sup> This dreaded complication is the most common cause behind revision procedures.<sup>10</sup> Numerous studies in the literature discussed the causes, prevention and management of infection in TKA.<sup>11,12</sup>

All authors declare no potential conflict of interest related to this article.

The study was conducted at College of Medicine in King Saud University and conducted at the Medical Microbiology Laboratory Riyadh, Saudi Arabia. Correspondence: Abdulaziz Z. Alomar. Orthopaedic Department, College of Medicine, King Saud University Medical City, King Saud University, P.O. box 7805, Riyadh 11472, Saudi Arabia. [dr\\_abdulaziz@yahoo.com](mailto:dr_abdulaziz@yahoo.com)

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The fear from infection in arthroplasty led the surgeons to investigate the intraoperative contamination in the gloves, electrocautery devices and splash basins among many other factors related to the surgeons, patients and intraoperative environment.<sup>13-15</sup> Furthermore, researchers have investigated the air contamination in the operating rooms (ORs); they found various levels of microbial contamination which were mainly influenced by the type of ventilation system.<sup>16,17</sup> Despite the numerous articles on the intraoperative contamination in TKA procedures, the available data about tissue contamination is scarce and are mainly based on the evaluation of bacteriology swabs.<sup>18</sup> Our aim is to investigate the contamination rate and level during TKA surgery. Our hypothesis was that the intraoperative contamination rate is high with a low level of colony forming units/gram (CFU/g) below the 10<sup>5</sup> threshold reported in the literature.

## MATERIALS AND METHODS

After the institutional review board approval of this study, 240 specimens divided between bone and soft tissue were obtained from 40 consecutive primary unilateral TKAs. The procedures were performed by three staff surgeons, with ten to fifteen years of experience, in two ORs designated for elective clean orthopedic cases. Those two ORs had unidirectional laminar flow ventilation systems equipped with high-efficiency particulate air (HEPA) filters.

All patients received 1-2 grams of Cefazolin 30 minutes before surgery with two additional doses administered post-operatively 8 hours apart. Pre-operatively, the three surgeons used a combination of isopropyl alcohol and povidone-iodine for skin preparation, and they followed similar draping techniques. A standard medial parapatellar approach was utilized in all procedures. Under meticulous sterile conditions intraoperatively, the anterior cruciate ligament (ACL), after its resection, was taken to a sterile back table and cut into three identical pieces representing the soft tissue specimens. After performing the distal femoral cut with an oscillating saw, the resected osteochondral block was transferred to the back table. Three osteochondral specimens with intact cartilage were retrieved. All specimens were collected in dry sterile containers and immediately sent to the microbiology lab in the same building.

In the microbiology lab, each specimen was weighed and rolled onto sheep blood agar and MacConkey plates for a minimum of 20 seconds. Robertson cooked meat medium was used afterwards for the cultivation of organisms. The aforementioned plates and medium were incubated in 5% carbon dioxide for 72 hours and 7 days to allow for aerobic and anaerobic bacterial growth, respectively. All isolated organisms were assessed through gram stain and colony morphology. Furthermore, an automated identification system (MicroScan WalkAway-96 System; Dade Behring) along with the identification and susceptibility panels (Negative Combo 42 and Positive Combo 28) were utilized to identify the contaminating microorganisms.

The calculation of the CFU/g was performed using the colony counter: Count D-37079; Schuett Biotec.de.

The IBM SPSS Statistics for Windows, Version 21.0 (Armonk, NY: IBM Corp.) was used to analyze the data. Descriptive analysis was performed for all variables. Chi-square test was used to compare between the contamination rates in bone and soft tissue groups. P-value <.05 was considered statistically significant.

All patients were seen in their routine clinical follow-up with a minimum follow-up duration of 3 years. In each visit, any signs or symptoms of superficial or deep surgical site infection (SSI) such as fever, erythema, local warmth, sinus tract and discharge were documented. The study was approved by the Institutional Review Board (IRB) of the College of Medicine in King Saud University and conducted at the Medical Microbiology Laboratory of King Saud University Medical City (Research Project No. E-13-959).

## Availability of data and materials

The datasets used and/or analysed during the current study are available from the corresponding author on reasonable request.

## RESULTS

The contamination rate was 15% during TKA. The contamination level had a mean of 10.6 CFUs/g and a median of 5 CFUs/g. The range of the contamination level was from 1-70 CFUs/g. The contamination did not significantly differ between bone (16.7%) and soft tissue specimens (13.3%) (p = .47).

The most common contaminating organisms in both groups were staphylococcus aureus and staphylococcus epidermidis, represented by 38.9% (n=14) and 30.6% (n=11), respectively (Figure 1). No post-operative SSI was detected throughout the follow-up period which ranged from 3-6 years.

## DISCUSSION

Maintaining the sterility in joint replacement surgeries cannot be overemphasized especially in the presence of a compromised immune system.<sup>19,20</sup> Despite practicing standard precautions to minimize intra-operative contamination in hip and knee arthroplasty, it has been reported that up to 63% of the surgical field is contaminated.<sup>21</sup>

In the current study, the intraoperative contamination rate and level in TKA were assessed using various microbiological methods to ensure accuracy. The contamination rates of the bone and soft tissue specimens were similar. The gram positive staphylococci were the most common contaminating organisms in both groups. The highest level of tissue contamination in our series was 70 CFU/g. The microbiology profile in our study matched those reported in the literature with staphylococcus aureus and staphylococcus epidermidis as the most common contaminating organisms in total joint arthroplasty.<sup>22</sup> Nevertheless, numerous etiologic agents, exceeding those reported in our study, have been identified.<sup>12,23</sup>

The patients' follow-up in this study ranged from 3-4 years. Although none of our patients, even those with contaminated specimens, had a post-operative infection, the development of infection is out of this study's scope since other factors can have an influential effect on the outcome. For instance, irrigation, especially when antibiotics or antiseptics are added to the solution, can alter the contamination status and reduce the risk of infection.<sup>7,24</sup> While infection is usually associated with a contamination level greater than 100,000 CFUs, the presence of implants can significantly

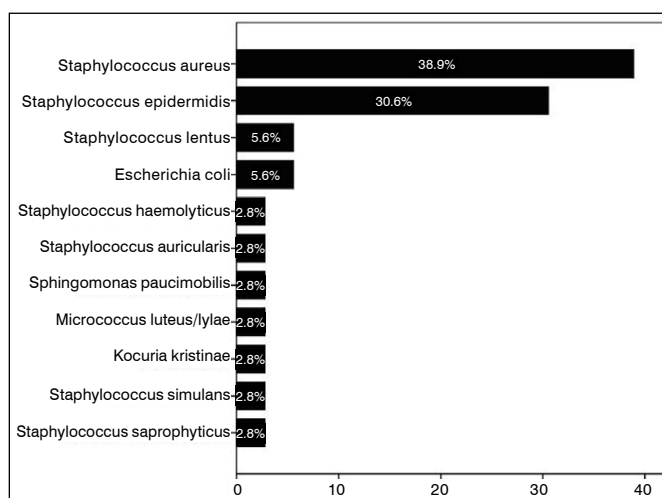


Figure 1. The identified organisms in the contaminated specimens.

reduce that threshold leading to a periprosthetic infection.<sup>22</sup> That being said, the contamination in bone and soft tissue specimens should not be neglected based on the low number of CFUs.

In the recent literature, Haenle et al. investigated the intra-operative contamination in TKA through obtaining bacteriology swabs immediately after opening the joint capsule. The contamination rate in their study was 43% with staphylococcus epidermidis as the main contaminating organism (27.8%). Approximately 2.9% of their patients had a periprosthetic infection; they found no association between positive bacteriology swabs and the development of post-operative infections in those patients. In our point of view, this could possibly be related to a contamination that occurred after obtaining the swabs.

Several intraoperative contamination rates have been reported. For instance, around 15.2% of the surgeons' gloves in total joint replacement are contaminated.<sup>14</sup> It is estimated that the contamination rates in skin and inside blades are approximately 9.4% and 3.2%, respectively, and the intraoperative contamination rates are even higher in suction tips (11.4%) and light handles (14.5%).<sup>25</sup> Coagulase negative staphylococci were the most common contaminating organisms.<sup>14,25</sup> Therefore, surgeons and nurses should be very careful as these organisms were the most identified in our contaminated tissue specimens.

The ventilation systems in the OR have been thoroughly discussed in the literature.<sup>16,26,27</sup> The unidirectional laminar flow with HEPA filter, which is the utilized ventilation system in our ORs, has been known for its efficiency in removing greater than 99.97% of airborne particles.<sup>26</sup> Nevertheless, it is recommended to minimize the number of people in the OR along with the number of door openings since they positively correlate with the intraoperative air contamination.<sup>27</sup> Despite using the unidirectional laminar flow ventilation system with HEPA filter and minimizing the number of people and door openings, we still cannot rule out airborne particles as a potential source of contamination in our series.

This article presents the contamination rates of bone and soft tissue biopsies which have proven to be relatively high. Despite the low contamination level, based on analyzing the CFU/g, care must be

taken intra-operatively since high level of bacterial contamination can occur at any time. The gloves, drapes and suction and electrocautery tips are known sources of contamination in arthroplasty procedures.<sup>13,14,28,29</sup> Thus, double gloving and changing the outer gloves regularly is advised.<sup>28,30</sup> In addition, surgeons should avoid using the suction tip for any fluid collection on the drapes.<sup>29</sup> We also advise surgeons not to use any potentially contaminated instruments after surgical site irrigation.

Our specimens were retrieved at a relatively early stage during the procedure and not at various intervals throughout the surgery; thus, the possibility of further contamination was not assessed. Another limitation is that we did not investigate the effect of irrigation and lavage, usually performed at end of surgery, on the rate of contamination. We could not correlate the detected strains in our series to any of the known contamination sources since we did not take any intraoperative samples from those potential sources. Although none of our patients developed an infection, this study was not meant to address the rate or risk of post-operative infection because of the insufficient sample size. The follow-up was solely based on our clinical assessment. Laboratory work-up, including the ESR and CRP levels, were not requested; thus, we were not able to detect any alterations in the inflammatory markers based on the contamination status or level in the absence of infection. Furthermore, we did not investigate the effect of patient-related risk factors for infection development such as diabetes, corticosteroid use and smoking.

In conclusion, the contamination rate during TKA is relatively high despite practicing the standard preventive measures. The levels of contamination, measured by CFU/g, are considered low compared to the 10<sup>5</sup> infection threshold reported in the literature. However, the contamination should not be neglected due to the presence of implants which are known to significantly reduce that threshold.

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**AUTHORS' CONTRIBUTION:** Each author contributed individually and significantly to the development of the manuscript. AA and SA were the main contributors in the drafting of the manuscript. AB and FA performed surgeries, followed patients and gathered clinical data. AA and SA evaluated the data of the statistical analysis. All authors review the manuscript and contributed to the intellectual concept of the study.

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