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HIP ARTHROPLASTY

Contamination rate of the surgical gowns during total hip arthroplasty

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Abstract

Introduction Surgical instrument contamination during total joint replacement is a matter of major concern. Available recommendations suggest changing suction tips, gloves and avoiding light handle manipulation during the procedure. There is a paucity of data regarding surgical gown contamination. The aim of the present study was to evaluate the contamination rate of surgical gowns (SGs) during total hip arthroplasty (THA) and secondarily compare it with other orthopedic procedures.

Materials and methods One hundred and forty surgical gowns (from 70 surgeries) were screened for bacterial contamination using thioglycolate (a high-sensitivity culture broth). The THA contamination rate was compared with those of knee and spine procedures. Controls were obtained at the beginning of every surgery and from the culture broth. The procedure's duration and the level of training of the surgeon were evaluated as potential risk factors for contamination.

Results Bacterial contamination was identified on 12% of surgical gowns (22% of surgical procedures). The contamination rate during THA was 4.1% (2% in primary THA and 8.3% in revisions) vs 21.67% during other surgeries (spine and knee) (OR 6.15, $p = 0.012$). There were no contaminated SGs during THAs performed in ≤ 2 h (0/33 SGs) vs 7.5% (3/40) for THAs that took ≥ 2 h ($p = 0.25$).

Conclusion There was a high rate of SG contamination during orthopedic procedures that was higher during non-arthroplasty procedures and prolonged THAs. There were no contaminated surgical gowns in THAs under 120 min, efforts should point keeping primary THAs under this cutoff time. As a general recommendation, SGs should be changed every time there is concern about potential contamination.

Keywords Surgical gowns · Periprosthetic joint infection · Surgical field contamination · Revisions · Complications

Introduction

Despite multiple efforts to reduce complications during orthopedic surgeries, periprosthetic joint infections (PJIs) still affect approximately 2% of total joint replacement patients, with major functional and economic implications. Contamination of surgical instruments during surgery has been repeatedly shown. Gloves, suction tips, light handles and, more recently, electrocautery tips were found to be contaminated during surgery [1–4]. Davis et al. reported a 17% contamination rate of surgical gowns (SGs) during surgery, despite using low-sensitivity culture techniques [5]. Multiple techniques intended to reduce the incidence of postoperative infections have achieved only modest results. Strict protocols for preoperative optimization and antisepsis are part of current guidelines that aim to control infection rates [6]. However, there are no recommendations on changing SGs during prolonged procedures during which they could get contaminated, risking the outcome of the entire surgery.

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Total hip arthroplasty (THA) is the main treatment option for end-stage osteoarthritis of the hip. It was identified as the best surgical procedure of the twentieth century due to its tremendous positive impact on quality of life and for being a highly cost-effective procedure [7].

The aim of the present study was primarily to measure the contamination rate of SGs during THA using up-to-date high-sensitivity culture techniques. Secondarily, we aimed to compare the contamination rate during THA with that of other orthopedic procedures (i.e., spine, knee and trauma surgery) and between the first surgeon and the assistant. Lastly, we aimed to correlate procedure duration with contamination rate.

Material and methods

Subjects

This study was approved by our institutional ethics committee.

The inclusion criteria were the following: clean wound surgeries (primary THA, revisions, knee osteosynthesis and major spine surgeries) with an expected duration of ≥ 90 min. Procedure duration was defined as the time between skin incision and wound dressing. The exclusion criteria were as follows: septic surgeries (septic revisions or THA with a history of a prior joint infection) and surgeries during which any of the surgeons had to change their SG or ask for an arm sleeve because of known or suspected contact with unsterile surfaces. We intentionally excluded cases of known or suspected infections, as it was not the aim of the present study to document the presence of known causative bacteria of the patient infection in the surgical field.

Sample collection

Surgeries fulfilling inclusion/exclusion criteria were included consecutively until reaching the calculated sample size. All surgeries were performed with sterile impervious disposable SGs (AAMI level 4) in a positive pressure, clean air operating room without laminar airflow. Surgeons used filtered exhaust helmets, and the surgical site was covered with IobanTM (3M, St Paul, Minnesota, USA) during all THA procedures. Before starting the surgery (after setting the surgical field), the surfaces of both volar-radial forearms and the front chest-abdomen (from approximately the xiphoid process proximally and 5 cm in distal direction) of the primary surgeon's SG were swabbed three times at each site (Fig. 1) with one sterile swab (Stuart, Copan Brescia, Italy) previously moisturized with five drops of sterile 0.9% saline. The same process was repeated on the assistant's SG. The swabs

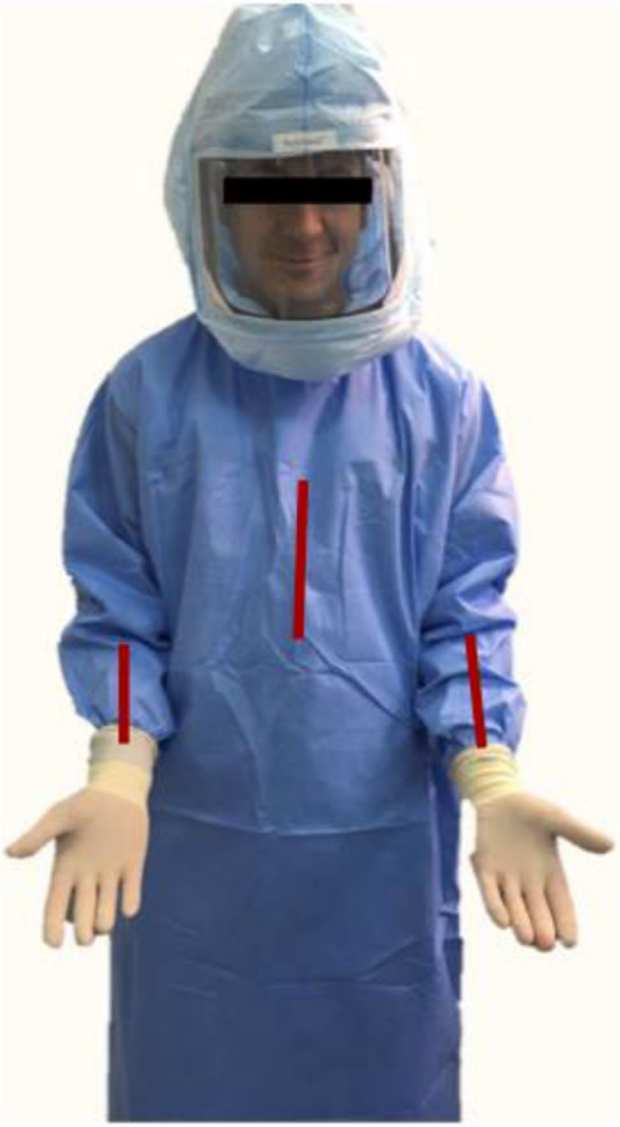

Fig. 1 Sample collection zones

were immediately placed in thioglycolate broth tubes that were transported to the microbiology laboratory at room temperature. Thioglycolate is a high-sensitivity culture medium that has been reported to be ideal for detecting the contamination of sterilized material [8]. The same procedure was repeated on both surgeons at the end of the surgery (after wound draping was complete). For every surgery, a fifth thioglycolate tube was brought into the operating room (OR) and sent back to the microbiology laboratory without opening as a control for the sterility of the culture broth. In cases of a positive control broth, all of the tests carried out with the same batch of culture medium were excluded. SGs with a positive culture at the beginning of the surgery were not included in this study.

Culture of samples

Thioglycolate tubes that contained the swabs were incubated at 35 ± 1 °C for 24 h. Both growth-positive and negative cultures were seeded on chocolate and blood agar plates and incubated at 35 ± 1 °C for 14 days or until bacterial retrieval. Positive cultures were identified using matrix-assisted laser desorption ionization—time-of-flight mass spectrometry (MALDI-TOF MS) (Bruker, Bremen, Germany) using MALDI Biotyper® 2.0 software (Bruker Daltonics, Fremont, California, USA). All strains from positive cultures were stored at – 80 °C for genetic identification in case of the development of ISS/PJI in study subjects.

Statistical methods

A sample size of 69 surgical gowns (35 surgeries) was calculated for the primary objective of the present study (to measure the contamination rate of surgical gowns during THA) using 17% as the expected contamination rate as previously reported by Davis et al. [5], which assumes a 3% contamination of controls at the beginning of the surgery, a power of 80% and a confidence level of 95%. Data distribution was analyzed with the Kolmogorov–Smirnov test. Parametric and nonparametric tests were used according to data distribution, and results are reported as median (range) or average (standard deviation) depending on the distribution. The contamination rates of different groups were compared with the *t* test. A logistic regression was performed to evaluate the effects of surgery type, duration and surgeon level of training on the risk of SG contamination. Significance was assumed with $p < 0.05$. Statistical calculations were performed using STATA13 (StataCorp. 2013. Stata Statistical Software: Release 13. College Station, TX: StataCorp LP).

Results

One hundred and forty SG samples (from 70 surgeries) were tested. Seven controls (six SGs and one closed thioglycolate tube) from six surgeries were positive and discarded from the analysis. One hundred and thirty-three SG samples from 69 surgeries were, therefore, analyzed. The number of samples and positive cultures by type of surgery are summarized in Table 1. Surgical procedure description, identified bacteria, and duration are detailed in Table 2. Bacterial contamination was identified in 16/133 SGs from 15/69 procedures, representing 12% of the SGs tested (22% of surgical procedures). The SG contamination rate for THA was 4.1% (2% during primary THA and 8.3% during revisions) vs 21.67% during other surgeries (spine and knee). The most frequent bacteria identified were *Staphylococcus epidermidis* ($n = 6$) and *Staphylococcus capitis* ($n = 5$). Identified species are detailed in Table 2.

Table 1 Type of procedure and the number of positive cultures

Surgical procedure	Number of contaminated SGs	Samples
THA	1	49
RTHA	2	24
Non-THA surgery (spine/knee)	13	60

Eleven percent of the first surgeon's gowns and 13% of the assistant's gowns were contaminated ($p = 0.61$). There were no contaminated SGs during THA ≤ 2 h (0/33 SGs) vs 7.5% (3/40) during THA ≥ 2 h ($p = 0.25$).

The logistic regression showed an OR of 6.15 (IC 95% 1.49–25.29) for SG contamination during surgeries other than THA ($p = 0.012$). There was no impact from surgery duration ($p = 0.84$) or level of training ($p = 0.59$).

Discussion

This study found a 4.1% overall SG contamination rate after THA. Surgical procedures around the knee and spine had a higher contamination rate (23.3%).

The lower rate of contamination in THAs might be related to the use of exhaust helmets and to the length of the procedures which lasted in average approximately 90 min less than spine surgeries. The high contamination rate in spine surgeries might be explained also by the requirement for the surgeon to walk from one side of the patient to the contralateral several times during complex procedures.

These contamination rates are similar to those reported in other studies. One study of spine procedures reported a 6–48% SG contamination rate depending on the sampling site; they sampled the entire anterior surface of the SGs, including areas close to the surgeon's neck and below the knees [9]. In our study, we only sampled the supposedly sterile part of the gown, as areas under the waist, near the neck and shoulders, and the surgeon's back are always assumed to be unsterile. In the only study that directly tested SG contamination, 17% of SGs tested after TJR developed positive cultures, which were primarily coagulase-negative staphylococci. However, this study used only standard culture methods and did not report the use of control samples, the specific SG zones tested or the type of SGs used (disposable or cloth, level of impermeability) [5]. It has been reported that longer surgical times are related to higher infection rates [10]. Despite not being statistically significant, we observed a tendency towards a higher contamination rate during THAs that lasted longer than 2 h (7.5%) vs 0% during THAs of

Table 2 Positive samples; type of procedure, identified bacteria, surgeon and surgical time

Surgical procedure	Location	Identified bacteria	Surgeon (1st or 2nd)	Procedure duration (min)
THA	Hip	*S. warneri*	2nd	130
RTHA	Hip	*Brevibacterium casei*	1st	360
RTHA	Hip	*S. epidermidis*	1st	180
Spinal fusion	Spine	*S. epidermidis* *S. capitis*	2nd	240
Spinal fusion	Spine	*Kocuria* sp.	1st	180
Spinal fusion	Spine	*S. capitis*	2nd	390
Spinal fusion	Spine	*S. epidermidis*	2nd	180
Spinal fusion	Spine	*S. epidermidis*	1st	220
Spinal fusion	Spine	*S. epidermidis* *S. haemolyticus*	2nd	210
Spinal fusion	Spine	*S. capitis*	2nd	360
Spinal fusion	Spine	*S. hominis*	2nd	180
Spinal fusion	Spine	*S. capitis*	1st	420
Osteosynthesis	Knee	*S. warneri*	2nd	260
Osteosynthesis	Knee	*S. haemolyticus* *S. epidermidis* *S. warneri*	1st and 2nd	120
Osteosynthesis	Knee	*S. capitis*	1st	70

less than 2 h. Only some of the studies on contamination of the surgical field have reported results consistent with this correlation [11, 12]. Several studies recommend changing surgical gloves at intervals of approximately 90 min and after manipulating bone cement due to the higher risk of perforation, with the same threshold recommended for suction tips [2, 13]. The specific question regarding the utility of changing SGs was addressed at the International Consensus Meeting 2018, with no answer reported yet [14]. Regardless of the duration of any procedure, surgical gowns and drapes should be replaced if their permeability is compromised [15].The species retrieved were mostly gram-positive bacteria consistent with skin flora, similar to findings from prior reports [3]. These bacteria might come from the patient's skin, the surgeon's hands or the surgical drapes in cases of unnoticed glove or drape perforation. Those germs are the most prevalent causative agents of SSI/PJI, thereby supporting the importance of considering gown changes if the risk of contamination is high.

Our study has some limitations that must be commented upon. Our sample size calculation was performed for detecting the contamination rate of SG during THA. Despite the achievement of our calculated sample size and the doubling when evaluating knee and spine surgery procedures, surgical time was not significantly associated with contamination rate, most likely due to a lack of power (type 2 error). As the objective of the study was SG contamination, there was no clinical follow-up, which might have added value in case clinical infections occurred.

In light of our results and following the rationale of recommending the changing of electrocautery tips, suction tips and gloves due to the risk of perforation and contamination [3], we suggest considering surgical gown changes during prolonged orthopedic procedures. Regardless of our findings and recommendations, it is still a matter of paramount importance to perform orthopedic procedures efficiently and in the shortest time possible without compromising technique, as only the duration of surgery as a whole has been linked to a higher risk of infection. In our study there were no contaminated SG in THAs under 120 min. This could be considered a recommendation to keep primary THAs under this length [16].

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Compliance with ethical standards

Conflict of interest D. Schweitzer has received speaker honorarium from Zimmer/Biomet and Depuy/Synthes. E. Botello is a consultant for Zimmer/Biomet and associate editor of the Journal of The Orthopedic Society of Orthopedics and Traumatology of Chile.

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