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In-vitro evaluation of surgical helmet systems for protecting surgeons from droplets generated during orthopaedic procedures

R. Wendlandt [a,*], M. Thomas [a], B. Kienast [b], A.P. Schulz [a,b]

[a] University Medical Center Schleswig-Holstein, Clinic for Orthopaedic and Trauma Surgery, Lübeck, Germany
[b] BG Trauma Hospital Hamburg, Hamburg, Germany

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SUMMARY

Background: Operating theatres and surgical clothing are designed to protect the patient from surgical site infections. However, there is still a risk of infection of the surgical team with blood-borne pathogens via ocular or mucocutaneous exposure. Whereas conventional surgical clothing provides some protection against contamination, surgical helmet systems (SHS) are intended to provide a high level of protection by forming a barrier for particles, aerosols and fluids between surgeon and surgical field of work.

Aim: The aim of this study was to quantify the contamination of the surgeon by droplets during orthopaedic procedures by an in-vitro simulation of hip and knee arthroplasty while wearing SHS versus conventional surgical clothing.

Methods: Hip and knee arthroplasty procedures were performed on artificial foam bone, which was continuously kept wet with a marker fluid. Each of the procedures was carried out by ten subjects wearing conventional surgical clothing or wearing SHS with integrated toga. After the simulated operation, pictures of the subjects were taken under ultraviolet illumination. Images wearing the full gown, and after removal of the gown, were evaluated for stained areas.

Findings: The contamination risk was 30% while wearing conventional clothing. In none of the 20 subjects using the SHS stains could staining be detected after removal of the protective clothing.

Conclusion: This study has demonstrated that the protective properties of the SHS are superior to conventional surgical clothing. Using SHS in high-risk procedures could reduce occupational exposure to blood-borne infections in surgeons.

Introduction

Surgical site infection is a severe complication in arthroplasty procedures as it may lead to reduced functional outcome or revision operations.[1,2] Quality improvement measures including well-designed operation rooms, surgical technique and aseptic precautions can reduce the number of surgical site infections.[3,4] Yet the surgical team is also at risk of infection by

* Corresponding author. Address: University Medical Center Schleswig-Holstein Clinic for Orthopaedic and Trauma Surgery, 23538 Lübeck, Germany. Tel.: +49 451 500 6762.
E-mail address: robert.wendlandt@uksh.de (R. Wendlandt).

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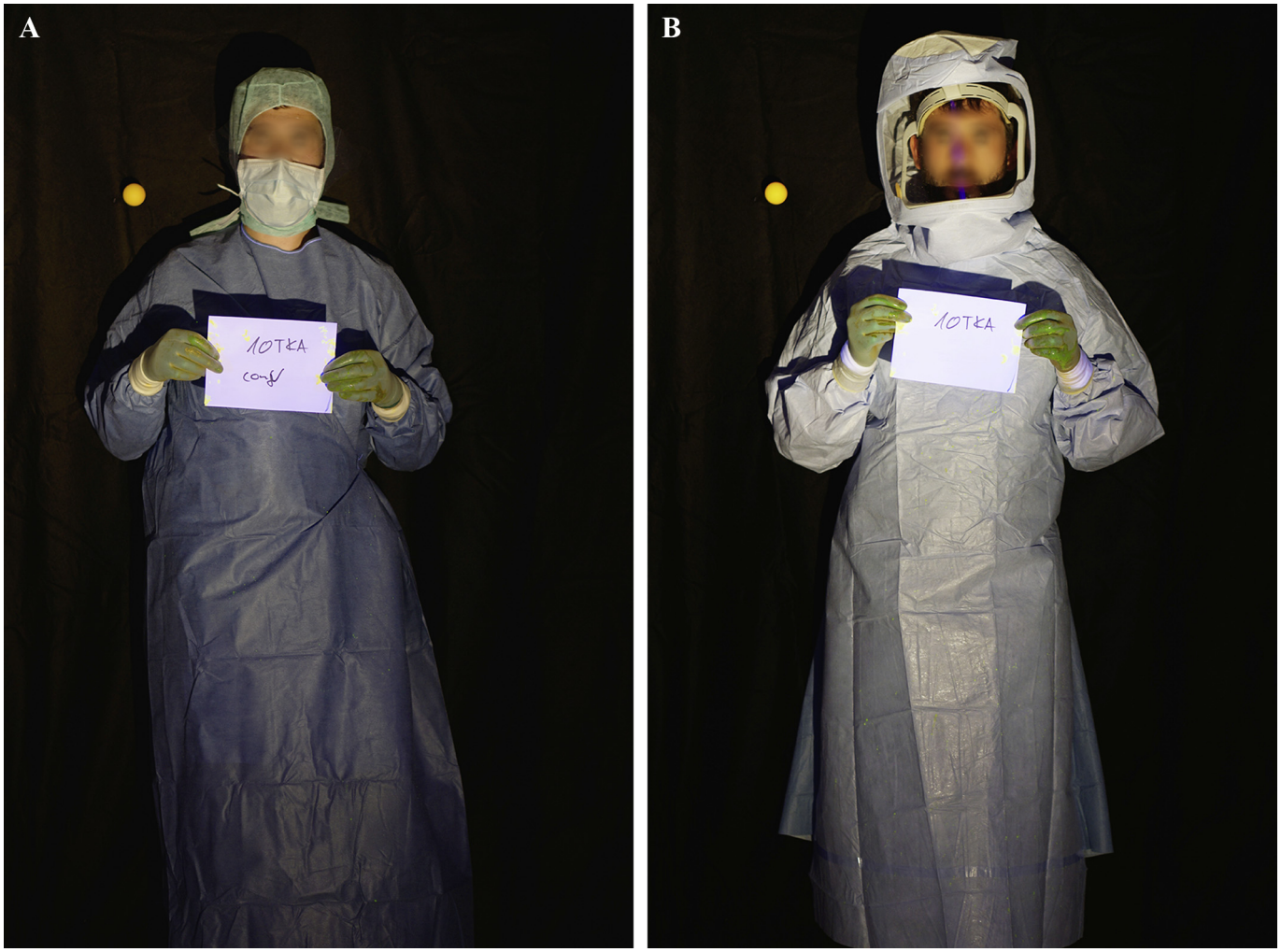

Figure 1. (A) Subject with conventional gown. (B) Subject with surgical helmet system.

exposure to blood-borne pathogens from patients, the most important being human immunodeficiency virus (HIV), tuberculosis and hepatitis B and C virus.[5–7] Although about 75% of reported exposures to blood-borne pathogens in healthcare workers are accounted for by percutaneous injuries — which are associated with a higher risk of transmission — ocular or mucocutaneous exposure, in spite of a lower risk of transmission, bears an underestimated hazard of infection.[6–10] A small but not negligible seroconversion rate of 0.63% (95% confidence interval: 0.018–3.47) after mucocutaneous exposure to blood of HIV-infected patients is reported.[11] Whereas conventional surgical clothing and protective eyewear provide some protection against contamination of the surgeon by splashes and spray, surgical helmet systems (SHS) are intended to provide a high level of protection by forming a barrier for particles, aerosols and fluids between the surgeon and the surgical field of work, including the patient.[5,10,12] This aspect of SHS use has attracted particular attention, given the intensified interest in healthcare worker protection against blood-borne pathogens in hospitals today.

The personal and socio-economic consequences of such infections among highly trained medical specialists are severe but a randomized controlled trial assessing infection rates of surgeons, comparing standard with protective clothing, would require many thousands of procedures to be examined given the limited number of incidents.[13] Such a trial would also be aggravated ethically by the required screening for pre-procedure infection status of a large series of patients and surgeons.

To evaluate the hypothesized reduction of contamination of surgeons wearing SHS during orthopaedic procedures compared to conventional surgical clothing in-vitro, we conducted simulations of hip and knee arthroplasty.

Methods

The study was conducted identically for the two arthroplasty procedures under evaluation except for the specific work steps necessary. Ten subjects participated in each of the trials, which were conducted separately for the hip arthroplasty and the knee arthroplasty simulation. In the first part of the trials the subjects were dressed with SHS (helmet, power pack and zippered toga of the Steri-Shield Flyte Personal Protection System; Stryker Instruments, Kalamazoo, MI, USA) and surgical gloves (Biogel Eclipse; Mölnlycke Health Care AB, Gothenburg, Sweden). The subjects conducted the specific operative procedures with artificial foam bone, which was

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