

## 1.16. PREVENTION: OPERATING ROOM, SURGICAL TECHNIQUE

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### QUESTION 1: Should the knife blade be changed after skin incision for deep dissection?

RECOMMENDATION: Yes. The scalpel should be changed after making the skin incision. There are studies demonstrating that bacteria from the superficial planes of the skin can contaminate the scalpel and potentially transfer this into deeper tissues.

LEVEL OF EVIDENCE: Limited

DELEGATE VOTE: Agree: 92%, Disagree: 6%, Abstain: 2% (Super Majority, Strong Consensus)

#### RATIONALE

Since infections can have such a devastating effects on total joint arthroplasty, it will always be necessary to search for methods to reduce contamination. The main sources of contamination come from skin and particles in the air of the operating room [1,2]. Controversy remains about the use of separate blades for skin incision and internal use, although this practice has been discredited [3–10].

Preoperative preparation of skin with antiseptics can help reduce the number of microorganisms, but cannot completely eradicate them, especially resident flora. Hypothetically, whenever the skin is incised microorganisms that colonize the deeper layers of skin can contaminate the exposed tissues and lead to surgical site infections (SSIs) [11–13].

A systematic review was conducted on this subject following the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) guidelines and the PRISMA statement. A comprehensive search of the literature was carried out in February 2017 using electronic databases PubMed, Medline and the Cochrane Library. The search terms used were “Arthroplasty AND Infection AND Knife OR Blade.” Only English studies were reviewed. This yielded four results after duplicates were removed. Because of the low numbers of studies done on this subject, there was no limitation on the type of the articles that were reviewed. Cross references revealed four more results. One study was not analyzed as it was not comparative, leaving seven reports for analysis.

The contamination rates of skin and deep knives were assessed with the Fisher’s exact test. Seven studies were included in the final analysis (Table 1). None of the studies showed a direct relationship between knife contamination and SSIs. Six studies could not demonstrate a difference in the contamination rates between the skin and deep knives [5,8–12]. In one study, the deep knife was significantly more contaminated than the skin knife [7]. Analysis of all seven studies together shows higher contamination rate for deep knives than skin knives, mostly due to the latter study.

TABLE 1. Summary of included literature pertaining to knife blade contamination and deep infection

Author	Year	Total			Contaminated			Same Organism at Skin and Deep Knife	Deep Infection	P Value
		Skin knife	Deep knife	Control knife	Skin knife	Deep knife	Control knife			
Fairclough [5]	1983	187	187	-	8	8		2	1*	1
Hill [8]	1985	93	93		8	8		2	0	1
Grabe [7]	1985	358	358		29	67		11	7**	0.0003
Ramón [9]	1994	115	115		6	13		2	2	0.15
Schindler [12]	2006	203	203	203	31	22	13	3	-	0.18
Ottesen [10]	2014	277	277	277	8	5	5	1	0	0.58
Trikha [11]	2016	92	92	92	6	7	0	2	5**	1
<b>Total</b>		<b>1,325</b>	<b>1,325</b>	<b>572</b>	<b>96</b>	<b>130</b>	<b>18</b>	<b>23</b>	<b>15</b>	<b>0.03</b>

\*Identified pathogen of wound infection was not identified at either skin or deep knives

\*\*Superficial infection

One recent study by Schindler et al. performed on patients having hip or knee arthroplasty compared the contamination rated of skin blades, inner blades and controls [12]. Even though there were no differences between the groups with regards to contamination rates they found higher incidences of skin pathogens isolated in the skin knife than the deep or control knives, leading to the assumption that these specimens were not contaminated in the laboratory. The development of deep or superficial infection was not evaluated in this study. Given the scarce literature, even with advanced research technologies, and the difficulty with which researchers are able to define the question, a low level of strength is provided.

Taking into account the low costs of changing blades, the methodology of all the studies discussed above and the potentially devastating consequences of prosthetic joint infection, we find it hard to recommend against changing the knife after skin incision is made. Therefore, we advocate maintaining the old surgical technique of changing the skin scalpel to continue to deeper planes with a new blade.

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## QUESTION 2: Does operative time affect the risks of surgical site infections/periprosthetic joint infections (SSIs/PJIs)?

**RECOMMENDATION:** Yes. There is an association between prolonged operative times and SSIs. Prolonged operative times may be a result of a considerable and inescapable level of complexity of the surgery. Coordinated efforts to reduce the operative times without technically compromising the procedure can provide additional benefits for infection prevention.

**LEVEL OF EVIDENCE:** Moderate

**DELEGATE VOTE:** Agree: 99%, Disagree: 0%, Abstain: 1% (Unanimous, Strongest Consensus)

## RATIONALE

Several systematic reviews and meta-analyses have demonstrated an association between operative times and SSIs as well as PJIs. Urquhart et al. [1] published a systematic review on risk factors for SSIs after primary total hip arthroplasty (THA), and found longer durations of surgery to be an independent risk factor for deep SSIs based on two studies [2,3], one of which was not specific to joint arthroplasty surgery. Kong et al. published a meta-analysis and found operative times to be associated with SSIs following primary THAs or total knee arthroplasties (TKAs) (standardized mean difference: 0.49, 95% confidence interval (CI) 0.19 to 0.78) [4]. Cheng et al. performed a meta-analysis over a variety of surgical procedures including orthopaedic surgery [5]. Pooled analysis demonstrated that the associations between extended operative times and SSIs typically remained statistically significant, with close to twice the likelihood of SSIs observed across various time thresholds [5]. The likelihood of SSIs increased with increasing time increments. For example, a 13%, 17% and 37% increased likelihood for every 15, 30 and 60 minutes of surgery, respectively [5]. On average, across various procedures, the mean operative time was approximately 30 minutes longer in patients with SSI compared to those patients without [5].

Administrative and registry databases have also linked increased operative times to SSIs/PJIs with statistical significances. Investigating 99,444 patients using the National Surgical Quality Improvement Program (NSQIP) database between 2011 and 2013, Duchman et al. found SSI was increased for primary total joint arthroplasty (TJA) procedures lasting > 120 minutes [6]. In their multivariate analysis, operative times exceeding 120 minutes remained an independent predictor for any complication and for wound complication, with each 30-minute increase in operative times beyond 120 minutes further increasing risks [6]. In an analysis of 56,216 primary TKAs from a registry collecting data from 45 locations in 6 US geographical regions, Namba et al. identified a 9% (95% CI 4 to 13%) increase in the risk of deep SSI per 15-minute incremental increase in operative time [7]. Decreased operative times were also associated with a lower risks of infections [7]. A study of 66,650 primary total hip arthroplasties reported to the Norwegian Arthroplasty Register during 1987 to 2001, revealed that cemented implants with operating time over 150 minutes were associated with an increased risk of revision due to infection [8]. Kurtz et al. investigated 69,663 patients over the age of 65 years undergoing TKAs from a Medicare claims database between 1997 and 2006, and found that longer duration procedures were at greater risk of PJI (adjusted hazard ratio for > 210 minutes vs. < 120 minutes

= 1.59) [9]. In a multivariate analysis of 6,848 cases from 26 hospitals participating in the Korean Nosocomial Infections Surveillance System, Song et al. found that prolonged duration of surgery (above the 75th percentile) was an independent risk factor for SSIs in THA, but not for TKA [10]. Dicks et al. found patients undergoing TKAs or THAs that had an operative duration > 75<sup>th</sup> percentile had a higher risk of SSI [11]. Additionally, Peersman et al. found that an operating time of more than 2.5 hours for TKA was associated with an increased incidence of infection and that operating time can predict those patients at risk [12].

There are inherent limitations to database studies, such as significant heterogeneity of the samples, differences in data collection, and varying definitions of PJIs within the sample. Single institutional work is therefore useful in this context because patients are subjected to the same care protocols, and more reliable data collection may be obtained. However, high-quality institutional studies have been limited by a lack of adequate sample size, absence of multivariate analysis and varying definitions of PJI. Peersman et al. compared a cohort of 113 PJIs following TKA with a control cohort of non-infected primary TKA matched for gender and age [13]. The mean duration of surgery for PJI vs. non-infected cases (127 vs. 93 minutes) was found to be a statistically significant risk factor for infections. Limitations of this study were that the control group was only matched for age and gender, but not for other important confounding factors. Additionally, the infection group included both index primary and revision cases, while the control group only included primary cases. In another single institutional study of 5,277 TJA, overall infection rate was 0.98% (51/5,277) [14]. Using a binomial generalized linear model, prolonged operative time was found to be associated with an increased incidence of infection ( $z = 4.325$ ,  $p < 0.001$ ). In TKA, a longer tourniquet time ( $z = 2.867$ ,  $p = 0.004$ ) was predictive of SSIs as well [14]. Again, the major limitation of this study was that it did not include confounding factors such as diabetes mellitus, rheumatoid arthritis or obesity. In a retrospective review by Wang et al. [15], 17,342 unilateral primary TKA and THA performed by 7 high volume surgeons, patients with an operative time of > 90 minutes were found to have higher incidence of SSIs and PJIs (2.1 and 1.4%,) compared to cases lasting 60 to 90 minutes (1.1 and 0.7%), and those lasting  $\leq 60$  minutes (0.9 and 0.7%). This trend was statistically significant ( $p < 0.01$ ). After controlling for multiple confounding factors with multivariate regression, prolonged operative times remained an independent risk factor for 90-day SSI (odds ratio (OR): 1.01, 95% CI 1.002 to 1.016,  $p = 0.009$ ) and PJI within 1 year (OR: 1.01, 95% CI 1.00 to 1.02,  $p = 0.040$ ) [15].

In contrast, some studies have failed to demonstrate such a correlation, especially when aiming to control for confounding variables. In a retrospective review of 9,245 TJA patients (4,185 TKAs and 5,060 THAs), longer operative times were a predisposing factor for PJI with univariate analysis, but multivariate analysis that adjusted for confounding factors revealed that operative time was not an independent predisposing factor for PJI [16]. Similarly, Naranje et al. found that after controlling for age and sex, there was no significant evidence that increased operative time increased the hazard of revision resulting from infection [17]. However, they did show a 15-minute increase in operative time increased the hazard of revision for infection by 15.6% on average ( $p = 0.053$ ; 95% CI 0.0% to 34.1%) [17]. Saleh et al. retrospectively reviewed 1,181 TKA and 1,124 THA primary procedures. Of the factors examined, only hematoma formation and days of postoperative drainage were significant predictors of SSI or deep wound infection, and operative time was not a significant risk factor [18]. Carroll et al. conducted a retrospective cohort study of 964 patients undergoing THA and TKA in one institute over 18 months.

Although tourniquet times were found to be an independent risk factor for superficial wound complication (defined by either a superficial incisional SSI or prolonged wound ooze within 30 days of surgery) in the TKA cohort, operative times were not an independent risk factor in their analysis [19]. Lastly, Kremers et al. found no significant relationship between SSIs and operative times (per 10-minute intervals) [20].

There is considerable evidence that suggests an association between prolonged operative times and SSIs/PJIs with a few studies suggesting no correlation. Steps to minimize intraoperative delay should be taken, and care should be exercised when introducing measures which prolong the duration of joint arthroplasty surgery.

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### QUESTION 3: Do antibiotic coatings on implants reduce the rates of surgical site infections/periprosthetic joint infections (SSIs/PJIs)?

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RECOMMENDATION: The use of antibacterial coatings on implants has been shown to reduce SSIs and/or PJIs based on in vitro and pre-clinical animal model studies. The use of antibiotic-coated implants in small series of patients appears to be encouraging. Larger-scale studies to prove the value of these technologies are needed.

LEVEL OF EVIDENCE: Limited

DELEGATE VOTE: Agree: 90%, Disagree: 6%, Abstain: 4% (Super Majority, Strong Consensus)

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#### RATIONALE

Implanted biomaterials continue to play a key role in orthopaedic surgery. However, infections surrounding these implanted biomaterials remain a leading cause of failure, especially in total hip and knee arthroplasties [1–3]. The biofilm theory and its role in the propagation of bacterial growth is postulated to play a quintessential role in the etiology and pathogenesis of PJIs in modern-day total joint arthroplasties (TJAs) [4–8]. Surface roughness, hydrophobicity and electrostatic charge are important characteristics of implanted biomaterials that are exploited by bacteria to promote adherence [9,10]. Strategies proposed to reduce the rates of these complications have included the use of implants coated with antiseptic materials or antibiotic agents. Antibacterial coatings engineered for the surfaces of implanted biomaterials have been an evolving technology over the last three decades [11]. Romano et al. described ideal characteristics of future antibacterial coatings, namely that they would be proven in vivo by demonstrating acceptable antibacterial properties towards a large spectrum of organisms, easy handling, cost-effectiveness and lack of local or systemic toxicity while ensuring bone healing, on-growth or in-growth [9].

Antibacterial coatings can be categorized into three groups: (1) perioperative antibacterial local carriers or coatings (LCC), (2) passive surface finishing/modification (PSM) and (3) active surface finishing/modification (ASM) [9].

The first group, LCC, are antibacterial carriers or coatings that are applied to implants at the time of surgery. The most popular and well-studied vectors in this category include antibiotic-laden bone cement, used when coating intramedullary nails or total joint components [12]. Antibiotic-laden hydrogel that may be applied to the implant by the surgeon has been shown to reduce surgical site infections in a multicenter randomized controlled trial of 380 patients undergoing primary and revision total hip and total knee arthroplasties [13]. Similarly, a pilot study of second-stage implantation for prosthetic joint infections utilized implants coated with a resorbable calcium based bone substitute mixed with gentamycin or vancomycin [14]. At a minimum follow-up of one year, 95% of patients did not show any clinical signs of infections. However, no control group was used in this pilot study [14]. Furthermore, these studies, as well as other smaller cohorts that have been reported, are underpowered to make definitive recommendations for its widespread use.

The second group, PSM, revolves around the premise that chemical and/or physical modifications to the surface of an implanted biomaterial may reduce bacterial capabilities of adherence, and thus, prevent biofilm formations. These modifications are made without the planned release of bacteriostatic or bacteriocidal agents into the surrounding tissues. Such technology includes treatment of the surface layer of an implant with ultraviolet (UV) light irradiation to increase the hydrophilicity of the implant, which decreases bacterial adherence [15]. Changing the morphology of the surface layer of implants without decreasing the reliability of osseointegration has been proven capable of decreasing bacterial adherences in in vitro studies [16–19]. Polymer coatings (hydrophilic polymethacrylic acid or polyethylene oxide) or hydrogel coatings can also be applied to titanium implants, which helps deter bacterial adhesions [18,20–24]. PSM has great potential for future use on implanted biomaterials, however, there is concern regarding the osseointegration with coatings or surface modifications with strong anti-adhesive capabilities. Future in vitro and in vivo studies are needed prior to widespread clinical application.

The third group, ASM, includes modifications to the surface of the implant that impart pharmacologically-active antibacterial agents such as antibiotics, antiseptics, metal ions and/or organic compounds [9]. Antibacterial surface innovation largely revolves around metal ions such as magnesium, gold or silver [25–31], as well as non-metal elements such as chlorhexidine [32]. Antibiotics may be sprayed on or covalently bonded to the implant surface [33], applied via hydrogel or coating [13,34] or contained in and released via nanotubes [35,36]. While there is a myriad of vectors to deliver antibiotics to the surrounding tissue, there is a paucity of conclusive in vitro studies, and a relative lack of in vivo studies demonstrating safety and efficacy with this technology. Further confounding ASM is the wide variability of coatings studied. This makes it tremendously difficult to draw conclusions from the current literature regarding ASM. While studies have shown that antibiotic coatings do not affect bone healing in animal models [37,38], this technology has not been studied clinically.

Perhaps the most well-studied antibacterial coating are antiseptics, such as metal ions impregnated into the implant or applied via coating. Both in vitro and in vivo animal models have demonstrated significant antibacterial effects [23,25,26,28,31,36,39–41]. Additionally, clinical studies of silver-

coated endoprostheses have demonstrated the efficacious antiseptic effects of the metal-ion coating in reducing infection [42–44]. However, these studies are largely retrospective in nature, and underpowered to render conclusive evidence supporting the widespread application of such technologies. While there are concerns of metal-ion toxicity that may result from such coatings, several studies have demonstrated little to no evidence of toxicity or side-effects [30,40,45]. Metal-ion coatings appear to be the most promising in terms of efficacy and near-future implementation based on review of the present literature surrounding antibacterial coatings.

Despite the promise of these individual reports, the paucity of high-level controlled trials in the setting of arthroplasty, suggests that it is too early to conclude that antibiotic coatings will reduce the rates of SSIs/PJIs following primary or revision procedures. However, these strategies could prove to be beneficial in high-risk primary or revision cases. Further high-quality studies are needed to address these questions.

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#### QUESTION 4: Does the size of an implant (volume) used during orthopaedic procedures influence the incidence of subsequent surgical site infections/periprosthetic joint infections (SSIs/PJIs)?

RECOMMENDATION: While a smaller implant may theoretically represent a smaller substrate for colonizing bacteria, there have been no conclusive studies linking implant size and the incidence of subsequent PJIs.

LEVEL OF EVIDENCE: Limited

DELEGATE VOTE: Agree: 85%, Disagree: 10%, Abstain: 5% (Super Majority, Strong Consensus)

#### RATIONALE

An OVID Medline search failed to identify any literature investigating relationships between component sizes and incidences of PJIs. There are several retrospective studies reporting lower incidences of PJIs in patients undergoing unicompartmental knee arthroplasties (UKAs), than those undergoing total knee arthroplasties (TKAs) [1–3]. Furnes et al. reviewed the Norwegian Arthroplasty Register and found an overall incidence of PJIs following UKAs to be much less than that for TKAs (0.2 vs. 1.2%, relative risk: 2.8,  $p = 0.01$ ) [3]. This finding may be attributed to the smaller implant burden of a UKA and thus a smaller substrate for colonizing bacteria however, there are many other potential explanations. Numerous factors are associated with an incidence of PJIs following arthroplasty, including host-related factors (e.g., gender and obesity) [4–9] and surgical factors. Sershon et al. also identified demographic variables in predicting component sizes in TKAs [10]. While increased weight and male gender were found to be associated with larger implants, there are other reasons for the causal association with PJIs that goes beyond the potential of implant size playing a role.

Even if a causal relationship between implant size and the incidence of PJIs were to be found, one needs to remember that larger implants are often used during more complex procedures such as revision or oncologic reconstructions. The nature of these procedures, in terms of increased operative times, higher blood losses and worse health status of the host, would play more critical roles in causing PJIs than the mere sizes of the implants. In addition, larger implants are used in cases with bone losses and the corresponding decreased soft tissue attachments to the bones, leading to higher areas of dead spaces and subsequent seroma or hematoma formations, eventually leading to wound related issues.

There is currently no data that evaluates the relationship between the size of an implant used during orthopaedic surgery and the risks for subsequent SSIs/PJIs. Further studies are needed to establish any relationship between component size and the incidence of PJIs. These studies would be difficult to perform, as it would be difficult to isolate implant size as an independent variable.

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## QUESTION 5: Does the use of C-arm intraoperatively increase the risk for subsequent surgical site infection/periprosthetic joint infection (SSI/PJI) in patients undergoing orthopaedic procedures?

**RECOMMENDATION:** There are no studies that link the use of intraoperative C-arm with a higher rate of subsequent SSI or PJI in orthopaedic surgery. However, based on available studies, it appears that the “sterile” cover of C-arm is often contaminated during the surgery. We recommend that all efforts be made to prevent the cover (or any other part) of the C-arm from coming into contact with the operative field.

**LEVEL OF EVIDENCE:** Limited

**DELEGATE VOTE:** Agree: 97%, Disagree: 1%, Abstain: 2% (Unanimous, Strongest Consensus)

### RATIONALE

A comprehensive search of the literature was performed on PubMed and Google Scholar using the terms: C-arm, fluoroscopy, image intensifier with contamination, SSI, PJI and infection. A total of 96 articles potentially relevant to the subject were identified. The articles were reviewed and the majority were excluded due to being non-medical or technique papers. Of the studies that were reviewed, none used SSI/PJI as an outcome.

One study retrospectively reviewed 75 total hip arthroplasty (THA) procedures during which intraoperative fluoroscopy was utilized versus 72 THA procedures in which no fluoroscopy was utilized. There was no difference in the incidence of infection between the two cohorts [1]. It is acknowledged that the cohort size in the study was extremely small (possibly too small to be able to examine the potential risk for subsequent SSI/PJI added with the use of intraoperative C-arm). To our knowledge, no other study examining the potential link between the use of C-arm and subsequent SSI/PJI exists. We realize that such studies would be difficult to perform, as C-arm could be an essential part of an orthopaedic procedure and randomizing patients is only possible when the C-arm is not considered essential.

There have been studies performed to evaluate contamination of the C-arm during surgery. One study was performed during 30 consecutive cases undergoing fracture fixation. Cultures were obtained after initial draping and every subsequent 20 minutes. Interestingly, on initial draping 17% of covers were contaminated. By 80 minutes, 80% of covers were contaminated. Only five cases were not contaminated during the surgery [2]. The findings of the study are of concern in that a C-arm appears to be a potential source of contamination of operative field contamination. Surgeons should not assume that the “sterile” cover applied to the C-arm actually remains sterile.

There is an absence of any concrete evidence linking the use of an intraoperative C-arm to an increase in the incidence of subsequent SSI/PJI. There is, however, evidence that a C-arm can be a source of potential contamination of the operative field. The use of a C-arm should be limited to procedures that truly require intraoperative imaging. During these cases extreme caution should be applied to prevent contact between the cover, or any part, of a C-arm and the operative field. The C-arm and its cover should be considered contaminated from the start of the procedure.

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## QUESTION 6: Does the use of recently-introduced technologies (navigation, robots, etc.) influence the incidence of surgical site infection/periprosthetic joint infection (SSI/PJI) after orthopaedic procedures?

RECOMMENDATION: The use of computer-navigation, patient-specific instrumentation and robot-assisted surgery during total joint arthroplasty has not been shown to increase the risk of subsequent SSI/PJI. However, an increase in operative time that may occur as a result of use of these technologies may increase the risk of subsequent SSI/PJI.

LEVEL OF EVIDENCE: Limited

DELEGATE VOTE: Agree: 84%, Disagree: 9%, Abstain: 7% (Super Majority, Strong Consensus)

## RATIONALE

There has been an influx of new technology in the realm of total joint arthroplasty (TJA) over the past two decades with the aim of improving outcomes. New technologies include computer-assisted arthroplasty, robotic-assisted arthroplasty and patient-specific instrumentation (PSI). Some of these technologies are gaining acceptance in the field of hip and knee arthroplasty. There is, however, a paucity of literature regarding the use of these technologies in other orthopaedic procedures and the link between the use of these technologies and the potential for an increase in the rate of subsequent SSI/PJI.

Computer-assisted surgical (CAS) navigation was introduced in the 1990s and has steadily gained traction in recent years. There are three distinct types of CAS arthroplasty including imageless, preoperative image-based and intraoperative image-based systems. Imageless systems feature accelerometer-based or optical navigation systems, whereas image-based CAS use radiological imaging to form 3D models of the patient's specific anatomy [1,2]. The main aim of CAS in arthroplasty is to improve component position and restore the mechanical axis [3,4].

While there are many studies examining the radiological and functional outcomes of CAS, only a limited number examine rates of SSI/PJI in computer-navigated arthroplasty. Regardless, both retrospective and prospective studies report similar rates of infection between CAS and conventional arthroplasty, with patient follow-up ranging from 12 weeks to 10 years [5–17]. Meta-analyses comparing the outcomes of navigated versus conventional knee arthroplasty performed by Bauwens et al. and Moskal et al. also revealed similar rates of postoperative infection for the two patient groups [18–19]. The longer operative time associated with full computer-navigated surgery are a potential risk factor for PJI, but does not appear to affect the rates of PJI in the current literature [7–21].

In most types of navigation-assisted surgery, several temporary pins must be placed (an exception being small handheld navigation devices), either within the operative field or percutaneously through separate stab incisions, hence introducing the possibility of contamination of the operative field and pin-site infections. However, studies by Kamara et al. and Owens et al. revealed low incidence of pin-site infections (0.36% and 1.2%, respectively), concluding that the complication rates due to temporary pin insertion is low [22,23].

Robotic systems were developed to improve the accuracy of implant selection, placement, alignment and bone resection during arthroplasty [1,24,25]. There have been no reports of increased rates of prosthetic joint infection after robot-assisted arthroplasty. Song et al. performed simultaneous bilateral total knee arthroplasty (TKA) on 30 female patients (1 knee replaced by robotic-assisted implantation and the other by conventional implantation) in a prospective randomized study and found no major adverse events related to the use of the robotic system (such as deep infection or loosening requiring revision) [26]. It is recognized that the cohort size in the latter study was excessively small to examine the issue of infection. Hill et al. proposed higher infection rates as a possible limitation to the use of robotic systems in arthroplasty due to the use of an autonomous system, yet there is limited data to support this assertion at this time [27].

PSI was recently introduced with the aim of improving component alignment and potentially reducing the risk of subsequent revision. For this, MRI, CT and/or plain radiographs are utilized by manufacturers to develop three-dimensional models of the patient's anatomy prior to surgery. From these, disposable cutting blocks are fabricated which are specific to each patient. In theory, PSI can reduce operative time as well as the number of surgical instrument trays required to perform TKA, which may in theory reduce the risk of PJI [28–30]. The literature is, however, sparse regarding infection rates post-arthroplasty for patients who have undergone TKA using PSI. Schoenmakers et al. followed 200 consecutive patients who had undergone PSI-aided arthroplasty by a single surgeon for 5 years and reported rates of prosthetic joint infection similar to those found in conventional arthroplasty [31]. Alvand et al. performed a prospective randomized controlled study comparing PSI versus conventional unicompartmental knee arthroplasty, and found similar rates of superficial infection between the two groups [32].

At present, there is no definitive literature to suggest that the rates of SSI/PJI are increased or decreased when TJA is performed using the recently introduced technologies such as robotics, navigation or patient-specific implants. Most studies examining these new technologies are not adequately powered to examine the rates of SSI/PJI. Larger-scale studies are needed to evaluate this issue.

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