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Systematic review

The effect of wound dressings on infection following total joint arthroplasty

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ABSTRACT

Background: The use of perioperative surgical wound dressings is an important factor in the mitigation of infection following total joint arthroplasty (TJA). Few studies have been published comparing wound dressings and infection rates after TJA.

Methods: MEDLINE, PubMed, and EMBASE were searched for studies published between 2006 and 2016 reporting infection rates in patients using various wound dressings after undergoing TJA. All studies comparing Hydrofibre dressings to Standard dressings or Absorbent dressings were included in this meta-analysis. Studies looking at TJA secondary to trauma were excluded. Two individuals independently extracted data, and study results were divided based on type of treatment. The primary outcome was to compare the infection rate of Hydrofibre dressings to that of both Standard Dressings and Absorbent dressings.

Results: Of a total of 3721 participants, 1483 were treated with Standard dressings (non-impregnated gauze), 1911 with Hydrofibre dressings, and 327 with Absorbent dressings. The risk ratio for infection comparing Standard with Hydrofibre was 4.16 (95% confidence interval, 1.71-10.16) as compared to 2.60 (95% confidence interval, 0.66-10.27) when comparing Absorbent with Hydrofibre dressings.

Conclusions: Our analysis suggests that Hydrofibre dressings may be significantly better than Standard and Absorbent dressings with respect to reducing infection. However, given the observed heterogeneity and small number of studies included, more comparative studies are needed to definitively recommend superiority among dressings following TJA.

Level of Evidence: Level 1.

Introduction and background

Infection remains one of the most serious complications following total joint arthroplasty (TJA) [1-3]. Even with the advent of multiple prophylactic measures to prevent infection after TJA, the rate of infection is still reported to occur in 0.3% to 2.5% of patients undergoing total knee arthroplasty (TKA) and nearly 1% of total hip arthroplasty (THA) [4-7]. Furthermore, periprosthetic joint infection (PJI) has been associated with significant morbidity after TJA and requires further examination [8]. As such, infection after TKA or THA will remain a significant factor in the cost of TJAs in the future [6]. This issue is made even more significant by the projected rise in the rate of TKAs and THAs, which are expected to increase by 673% and 174% respectively, by 2030 [9]. Moreover, infection has been reported to be the greatest contributor for revision TKA (25.2%) and the third most common cause of revision THA (14.8%) in the United States [10,11].

A protective barrier is often used to cover wounds, limit contamination, and promote healing following surgery. It has been shown that a moist occlusive wound environment greatly improves the healing process as compared to a dry wound environment by preventing tissue dehydration and cellular death

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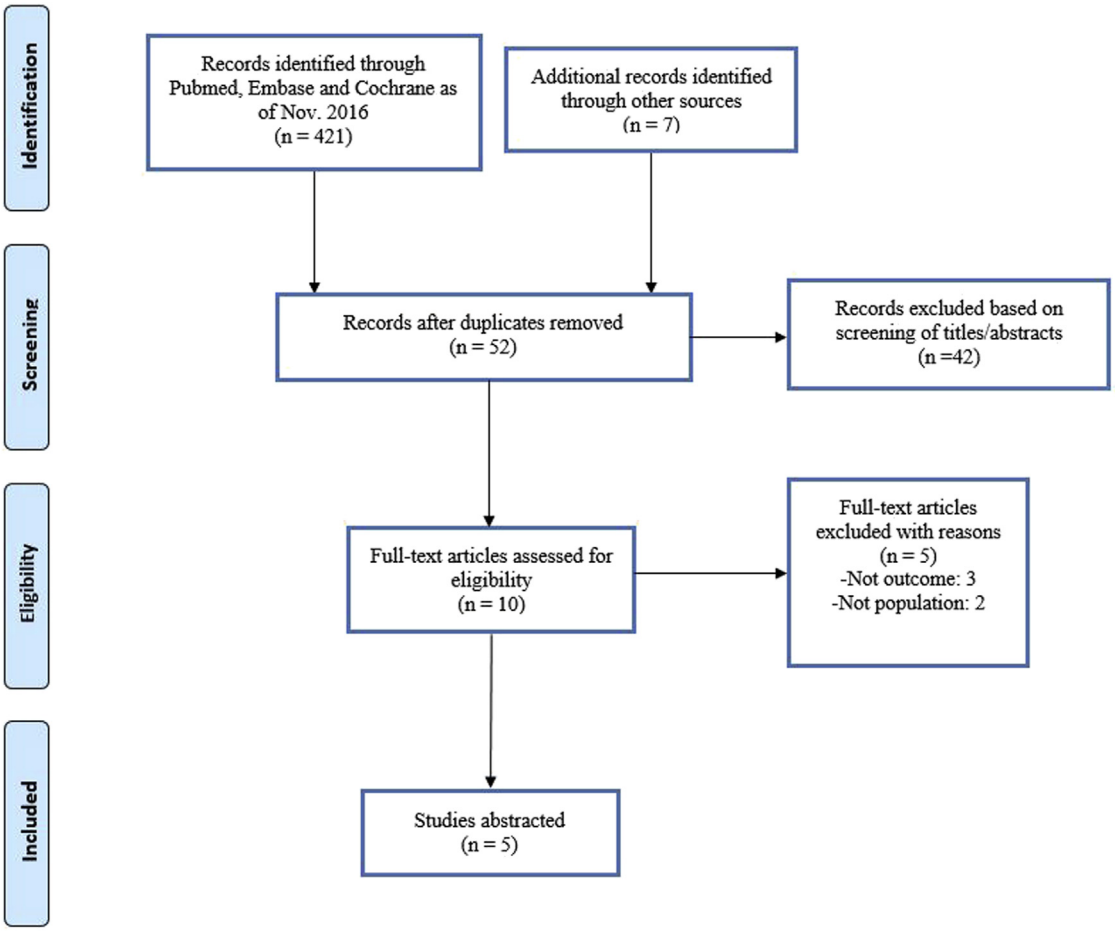

Figure 1. Flowchart of systematic search strategy.

[12-15]. However, such an environment can increase the risk of microbial colonization. The most effective dressings must therefore protect the incision area from contamination and further damage while still maintaining a moist environment for proper wound healing [16,17]. Traditionally, wounds are protected by use of a simple dressing such as a gauze that is removed after 24-72 hours allowing adequate time for re-epithelialization [18]. Many different types of surgical wound dressings have been developed for use after TJA [2]. In this secondary analysis of published literature, we specifically compare Hydrofibre (Aquacel, ConvaTec Inc., Princeton, NJ), Absorbent dressings (Primapore [Smith & Nephew] and Mepore [Mölnlycke]), and Standard (non-impregnated gauze) dressings. Standard dressings are generally considered to be low adherence cotton pads placed directly in contact with the wound [19]. Alternatively, Absorbent dressings such as Mepore and Primapore, also placed directly over the wound, are said to have secondary absorbent layers helpful for heavily exuding wounds [19]. Finally, Hydrofibre dressings such as Aquacel and Aquacel Ag (ConvaTec, UK) are thought to have the benefit of maintaining an environment necessary for optimal wound healing and supposedly require less dressing changes. These Hydrofibre wound dressings are composed of sodium carboxymethylcelluose and are reported to have up to 30 times its weight in absorptive capacity to limit exudate spread, blistering, and epidermal stripping [2,19,20]. Silver-impregnated Aquacel (Aquacel Ag) differs from generic Aquacel dressings in that the ionic silver has properties that help to prevent microorganism growth through its bacteriostatic effect [2,21,22].

Despite advances in wound dressing designs, there is still no consensus as to whether any particular type of wound dressing has decreased infection, blistering, or mean number of dressing changes. A review of randomized controlled trials (RCTs) comparing wound dressings concluded that there was insufficient

Table 1
Evidence profile of studies in systematic review.

Characteristics	Standard	Absorbent
No. of studies	1 RCT; 2 retrospective	2 RCTs
No. of patients (comparator)	1487	327
No. of patients (Hydrofibre)	1548	363

Table 2
Study design and sample size information.

Author by dressing comparator	Study type	Type of arthroplasty	# Comparator	# Aquacel
Standard dressings				
Cai et al., 2014 [21]	Retrospective	TKA/THA	875	903
Grosso et al., 2017 [22]	Retrospective	TKA/THA	568	605
Langlois et al., 2015 [24]	RCT	TKA/THA	40	40
Absorbent dressings				
Springer et al., 2015 [25]	RCT	TKA/THA	121 (Primapore)	141
Clarke et al., 2009 [26]	RCT	TKA/THA	186 (Mepore)	242

Table 3
Infection events by dressing type.

Author	Infection events		
	Standard	Hydrofibre	Absorbent
Cai et al., 2014 [21]	15/879	4/903	–
Grosso et al., 2017 [22]	9/568	2/605	–
Langlois et al., 2015 [24]	0/40	0/40	–
Springer et al., 2015 [25]	–	0/121	0/141
Clarke et al., 2009 [26]	–	3/242	6/186
Total	24/1487	9/1911	6/327

evidence as to whether any particular wound dressing was more effective than any other in the prevention of surgical site infections [19]. The purpose of this literature review is to compare the efficacy of various wound dressings in the prevention of infection after TJA. Thus, we sought to determine whether the newer Hydrofibre dressings may have a decreased infection rate after TJA when compared to these other dressing types.

Material and methods

Search strategy

We carried out a literature search using the PubMed, Cochrane, and EMBASE databases to identify all articles published between January 2006 and October 2016. This 10-year time frame was chosen as many of these novel wound dressing types were developed in the early 1990s. To ensure enough time for their practices to be standardized, we chose 2006 as the starting point of our search criteria. Studies not published in English and those directed at species other than humans were excluded from our literature search. Additionally, studies on any hip or knee surgery secondary to trauma were also excluded because this represents a separate cohort that is at higher risk of infection [23]. Reports relating to both primary, bilateral, and revision THA and TKA were included. A search of all bibliographies of retrieved articles was performed for reports that evaluated infection following TJA in patients using one of these wound dressings. Full-text eligibility was assessed for all articles to ensure that they all fit inclusion and exclusion criteria. Key words used to conduct the search were Aquacel arthroplasty, wound dressing arthroplasty, surgical dressing arthroplasty, Primapore, and Mepore (Appendix A). All relevant systematic reviews and meta-analyses were evaluated and their sources cross-referenced for missed publications.

Data analysis

All statistical analyses were performed using the Review Manager 5.3 (Cochrane, London, UK) package. Analysis of risk ratio was performed by evaluation of studies that compared occlusive dressings with any control dressings regiment, Hydrofibre dressings with any control dressing regimen or between groups. In order to create a more robust sample size, both Aquacel and Aquacel Ag data were combined into the Hydrofibre dressings group as both use a Hydrofibre-based dressing. A random effects model was used for our patient population. Assessment of heterogeneity and analysis of data were also operated by Review Manager 5.3. We used relative risk to express the effectiveness of Standard dressing vs Hydrofibre dressings and Absorbent dressings in the prevention of infection. The results of our analyses were expressed as forest plots, illustrating the relative risk of infection events following TJA with a 95% confidence interval for each study. Blistering rates were calculated by adding all blistering events out of the total subjects from which they were calculated. Mean number of dressing changes was calculated using a weighted mean which was determined based on number of participants the mean was derived from in each study.

Results

Study selection

Two independent investigators carried out a literature review using the PRISMA guidelines (Fig. 1) according to specified inclusion and exclusion criteria. The primary search protocol yielded 421 individual studies, of which 363 were duplicates. The abstracts to the remaining 58 studies were reviewed and resulted in the exclusion of 42 more studies deemed not relevant to our analysis for one of the following reasons: (1) not the correct outcome, (2) not the relevant patient population. The remaining 16 studies were critically appraised in their entirety resulting in the exclusion of an additional 11 studies based on the same reasoning as before: (1) not the correct outcome, (2) not the relevant patient population (Appendix B). The 5 articles identified by the 2 independent reviewers were then discussed and reviewed thoroughly by the 2 reviewers to ensure that the strict eligibility criteria had been met. There was excellent agreement among reviewers involving the title ($\kappa = 0.91$; 95% confidence interval [CI], 0.89-0.93), abstract ($\kappa = 0.94$; 95% CI, 0.92-0.96), and full text ($\kappa = 0.96$; 95% CI, 0.95-0.98).

Study characteristics

Our analysis included a comparison of Standard dressings (gauze-based dressings), Hydrofibre dressings (Aquacel and Aquacel Ag), and Absorbent dressings (Mepore or Primapore), representing a total of 5 different dressings among the 3 categories. In each study, a specific wound dressing was compared to Hydrofibre dressings. Of the 5 total studies, 3 were RCTs and 2 were retrospective cohorts (Table 1). All studies investigated infection rates in patients who underwent TJA, which was defined as TKA or THA (Table 2). Overall, 1487 wounds were treated by Standard dressings,

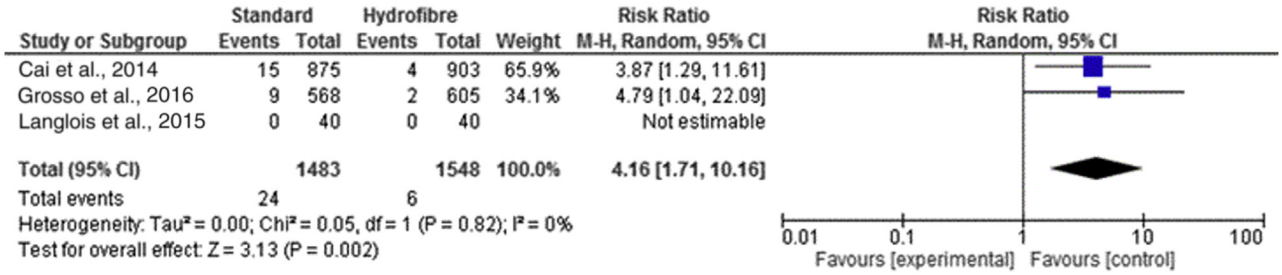

Figure 2. Standard vs Hydrofibre dressings.

Table 4
Blistering events and mean number of dressing changes.

Author	Blistering events			Mean # of dressing changes		
	Standard	Hydrofibre	Absorbent	Standard	Hydrofibre	Absorbent
Cai et al., 2014 [21]	–	–	–	–	–	–
Grosso et al., 2017 [22]	–	–	–	2	1	–
Langlois et al., 2015 [24]	1/40	0/40	–	–	–	–
Springer et al., 2015 [25]	–	7/121	1/141	–	0.14	2.8
Clarke et al., 2009 [26]	–	5/242	33/186	–	1.5	3.2
Total/weighted mean	1/40	12/363	34/327	2.00	0.39	3.03

1911 wounds treated with Hydrofibre dressings, and 327 wounds treated with Absorbent dressings.

Infections

In total, 1.61% (24/1487), 0.47% (9/1911), and 1.83% (6/327) wounds developed infection following TJA in wounds treated with Standard, Hydrofibre, and Absorbent dressings, respectively (Table 3). In a comparison of Standard dressings to Hydrofibre dressings, the risk ratio of infection was 4.16 (95% CI, 1.71-10.16; $I^2 = 0\%$) in patients who underwent TJA (Fig. 2).

Blisters and dressing changes

Blistering and mean number of dressing changes were measured in 4 of 5 studies with 3 of 5 studies recording each complication. The total blistering events were 1/40 (2.5%), 12/403 (3.0%), and 34/327 (10.4%) in the Standard, Hydrofibre, and Absorbent groups, respectively (Table 4). It should be noted that the blistering events in the Standard group were recorded in only one study [24], which examined only 40 patients. The mean number of dressing changes was 2.0, 0.4, and 3.0 for Standard, Hydrofibre, and Absorbent dressings, respectively (Table 4).

Discussion

Although a rare complication, infection after TJA still remains a significant concern that can lead to increased morbidity while placing an increasing financial burden on the healthcare system [6].Therefore, it is imperative that all aspects of the perioperative period be examined closely to best mitigate the risk of infection after TJA. Several studies have examined perioperative prophylactic protocols and operating room conditions to optimize sterility and minimize infection; however, few published studies have reported on the specific benefit, if any, of various postoperative wound dressings [27-31]. Our study aimed at adding to the existing literature and providing new insights into ideal selection of wound dressing following TJA.

Although there has been some work examining postoperative infection rates in relation to wound dressing type, little has been done specifically looking at wound dressings after TJA [15,19]. The majority of research for wound dressings after TJA is centered on the use of Hydrofibre dressings such as Aquacel and Aquacel Ag [16,21,22,32-34]. Accordingly, we compared Hydrofibre dressings to 2 different types of dressings that were most commonly used in the literature. The studies by Cai et al. and Grosso et al. were the only retrospective studies included, but were also the largest cohorts (Table 2) [21,22]. These studies effectively showed strong evidence of the benefit of using a Hydrofibre dressing such as Aquacel Ag compared to other dressings [21,22]. All other studies were RCTs.

The goal of this study was to aggregate the existing information regarding wound dressings and their effectiveness to prevent specific complications following TJA. Infection, in particular PJI, was the target of our analysis. We were able to show that there was a significant risk difference when comparing Hydrofibre dressings to both Standard and Absorbent dressings (4.16 and 2.60, respectively). Interestingly, Hydrofibre dressings also were shown to require the least amount of dressing changes (0.4 vs 2.0 and 3.0), while also comparing favorably in terms of blistering events when compared to Standard and Absorbent dressings (3.0% to 2.5% and 10.4%, respectively) (Table 4). Thus, there appears to be a benefit to Hydrofibre over Standard and Absorbent dressings in preventing infection after TJA while also requiring the least number of dressing changes.

It has been suggested that switching the standard of care to use of Hydrofibre dressings for all TJA procedures would result in an increase of 27 million dollars [21]. However, as the authors mentioned, these costs may be accounted for if there is a concomitant decrease in infection rates following TJA, and therefore avoiding an increase in cost of care [21]. Accordingly, a thorough understanding of the potential implications of various wound dressings is critical in making a true cost analysis to determine the feasibility of using this more expensive dressing.

Limitations

There are several limitations in our study. First, in order to allow for a more comprehensive analysis of studies comparing these wound dressings, we did not limit our search criteria to include only RCTs. Furthermore, in one study, the authors did not distinguish whether they were evaluating for PJI or any wound complication in general. Another limitation is the number of level I studies included in this analysis. As a relatively unexamined topic, there were surprisingly few published works comparing wound dressing types and postoperative outcomes such as infection, particularly in patients undergoing TJA. Infection prevention remains a critical topic for TJA surgeons, and as traditional dressings continue to be replaced by newer, more sophisticated wound dressings, we will need more comparative research to establish efficacy in preventing perioperative infection. Another limitation was the fact that none of the studies distinguished between TKA and THA outcome rates. We also combined standard Aquacel dressings with Aquacel Ag dressings in the Hydrofibre group to create a more robust population size. These are potential confounding factors that need to be addressed in future analysis.

Conclusions

With the data presented, this meta-analysis suggests that the use of a Hydrofibre wound dressing type is helpful in preventing infection after TJA and in particular PJI. Despite these findings, it is important to note that in light of our limitations further research needs to be conducted before establishing Hydrofibre dressings as the definitive dressing of choice. However, this study has shown that the use of Hydrofibre wound dressings, as compared to

Standard or Absorbent dressings, is associated with a significantly lower relative risk of infection after TJA.

Appendix. Supplementary data

Supplementary data related to this article can be found at http://dx.doi.org/10.1016/j.artd.2017.03.002.

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