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## International Delphi Study on Wound Closure and Incision Management in Joint Arthroplasty Part 2: Total Hip Arthroplasty

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### ABSTRACT

**Background:** This modified Delphi study aimed to develop a consensus on optimal wound closure and incision management strategies for total hip arthroplasty (THA). Given the critical nature of wound care and incision management in influencing patient outcomes, this study sought to synthesize evidence-based best practices for wound care in THA procedures.

**Methods:** An international panel of 20 orthopedic surgeons from Europe, Canada, and the United States evaluated a targeted literature review of 18 statements (14 specific to THA and 4 related to both THA and total knee arthroplasty). There were 3 rounds of anonymous voting per topic using a modified 5-point Likert scale with a predetermined consensus threshold of  $\geq 75\%$  agreement necessary for a statement to be accepted.

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modified Delphi study  
consensus development  
orthopaedic surgery practices

**Results:** After 3 rounds of voting, consensus was achieved for all 18 statements. Notable recommendations for THA wound management included (1) the use of barbed sutures over non-barbed sutures (shorter closing times and overall cost savings); (2) the use of subcuticular sutures over skin staples (lower risk of superficial infections and higher patient preferences, but longer closing times); (3) the use of mesh-adhesives over silver-impregnated dressings (lower rate of wound complications); (4) for at-risk patients, the use of negative pressure wound therapy over other dressings (lower wound complications and reoperations, as well as fewer dressing changes); and (5) the use of triclosan-coated sutures (lower risk of surgical site infection) over standard sutures.

**Conclusions:** Through a structured modified Delphi approach, a panel of 20 orthopedic surgeons reached consensus on all 18 statements pertaining to wound closure and incision management in THA. This study provides a foundational framework for establishing evidence-based best practices, aiming to reduce variability in patient outcomes and to enhance the overall quality of care in THA procedures.

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Optimal wound management is a critical aspect of care for patients undergoing total hip arthroplasty (THA) [1,2]. Despite major efforts in the past decade, deep infection rates for total joint arthroplasties still range between 1 and 2% for primary surgeries and markedly higher for revision procedures [3–5]. In addition to reducing the risk of deep infections, proper wound management may be important to minimize other complications, patient inconveniences, and costs [6,7].

Detailed studies on managing wound closure and incisions specifically after THA are scarce, leading to a lack of agreement and absence of any practical guidelines [8–13]. For instance, a notable study by Lychagin et al. investigated the impact of persistent wound drainage in THA [14]. They found no significant difference in post-operative wound infection rates, which were 0.4% in both cohorts (standard versus negative pressure wound management) [14]. However, the cohort with persistent drainage experienced a greater mean drop in hemoglobin (2.2 versus 1.6 gr/dL,  $P < .01$ ) and hematocrit (16 versus 11%,  $P < .01$ ), along with a higher need for allogeneic blood transfusions (4.9 versus 3.9%,  $P < .05$ ), indicating increased blood loss without a corresponding increase in infection rates [14]. These findings highlight the nuanced and critical nature of wound management decisions in THA. Many care protocols are based on less robust evidence, lacking comprehensive analyses. There is a clear need for well-supported medical guidance, especially as healthcare systems are increasingly focused on cost-effectiveness [15,16]. Using evidence-based methods to inform healthcare decisions is crucial, particularly for substantial and pressing health issues [17]. In response, Delphi methods for achieving consensus are becoming a popular tool across the medical field to address critical questions and highlight areas needing further research.

Based on this need, we organized a modified Delphi panel to address wound closure and incision management after THA. The panel included international experts, including 10 orthopedic surgeons from Europe, 1 from Canada, and 9 from the United States. This report will concentrate on the specific practices and challenges in THA (Part 2), incorporating insights from recent studies to address the 18 questions identified by the Delphi panel on this topic. A previous report focused on total knee arthroplasty (Part 1), and a subsequent report (Part 3) will focus on Delphi panelist-identified key unanswered questions and evidence gaps identified during the extensive review and discussions.

## Methods

### Modified Delphi Method

The Delphi method is a structured technique often used to gather and refine the knowledge of experts through a series of

voting rounds, aiming to reach a consensus on specific issues. In this study, we have adapted the Delphi method to focus specifically on best practices and methodologies in THA. From April 1, 2023 to September 30, 2023, we conducted a 3-round Delphi process: (1) Round 1: an initial electronic survey to gather preliminary opinions and insights on THA practices, (2) Round 2: a virtual meeting where experts discussed the initial findings and provided further detailed insights, and (3) Round 3: a follow-up electronic survey to refine the consensus and finalize the recommendations (Figure 1 for the process flow).

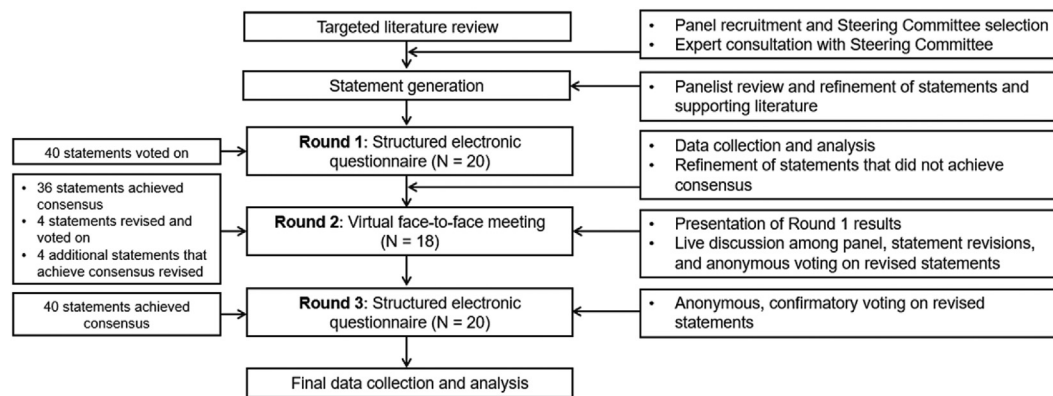
### Selection and Recruitment of Panelists

Our Delphi panel consisted of 20 orthopedic surgeons, each specializing in THA, from Europe, Canada, and the United States. This included 3 steering committee members (2 from the United States and 1 from the United Kingdom) and a working group of 17 surgeons (7 from the United States, 1 from Canada, and 9 from Europe). We selected panelists based on several criteria: recognized expertise in THA nationally or internationally, a high number of publications on the subject, experience with advanced THA techniques, membership in key professional orthopedic organizations, and performing more than 100 THA surgeries annually.

### Targeted Literature Review and Statement Development

Over a period of 4 months, the steering committee team worked diligently on developing clear and practical statements specifically for managing wounds and incisions after THA. They focused on the critical issues during and immediately after surgery, ensuring that the statements were directly relevant and helpful for those specific situations. To form a solid base for these statements, the team referred to 4 systematic reviews, making sure to update this information to include the latest findings up to April 5, 2023 [18–21]. They also conducted additional searches to evaluate any recent studies or information that might have been initially overlooked, ensuring a thorough and up-to-date knowledge base focused on hip surgery care. The committee omitted certain factors affecting wound healing that were beyond the scope of this panel, but covered elsewhere, such as patient preoperative optimizations, patient risk factors for untoward wound healing, and various other specific intraoperative techniques.

The review process was meticulous and collaborative. Each statement drafted was thoroughly examined by 3 experts from the panel, each with specific expertise related to the topic. This team of 20 experts collectively reviewed each statement in the initial round, offering a wide range of perspectives and insights. They scrutinized every detail for accuracy and completeness, making



**Fig. 1.** The Delphi process for developing consensus statements (note that this includes total knee arthroplasty and total hip arthroplasty together).

thoughtful revisions based on their extensive knowledge and experience with the unique aspects and challenges of hip surgery. After refining the statements, they compiled them into an easy-to-navigate online survey. This marked the beginning of a consensus-building process, aiming to unify the experts around the most effective and practical approaches for wound and incision management in THA.

The overarching goal was to create a set of statements that were not only based on the latest and most relevant information but also clear and easy to implement in the clinical setting. The team prioritized straightforward language and practical advice to ensure that the statements would be accessible and useful to all medical professionals involved in THAs. By maintaining a focused and clear approach throughout the development and review process, the team aimed to produce a comprehensive guide that would enhance the quality of care and outcomes for patients.

#### Round 1 Electronic Survey

The initial electronic assessment featured 18 statements (14 specific statements about THA and 4 statements common to both THA and total knee arthroplasty). Each statement was linked to relevant academic studies. Panel members expressed their level of agreement using a 5-point Likert scale, where 1 represented 'strongly agree' and 5 'strongly disagree'. Disagreement prompted the panelists to provide reasons and suggest necessary changes for their endorsement. The consensus for agreement was set at a stringent  $\geq 75\%$ , slightly higher than the  $\geq 70\%$  typically used in Delphi studies [22–25].

#### Round 2 Virtual Face-To-Face Meeting

The subsequent interactive virtual meeting highlighted the findings from the initial survey. The steering group led in-depth discussions on THA-related statements that did not reach consensus in the initial phase. These were then anonymously reconsidered and voted upon during the live session. Additionally, panelists had the chance to reassess and potentially modify previously agreed-upon statements. The session concluded with an identification of major research gaps in the field of THA, particularly focusing on aspects such as recovery and long-term patient outcomes.

#### Final Electronic Confirmation

Following the outcomes of the second meeting, a concluding electronic survey was dispatched to the panel. Since all statements

had already reached the consensus threshold ( $\geq 75\%$  agreement) by the conclusion of Round 2, this last survey aimed to confirm the decisions. This final round also included queries designed to gather more details on the crucial evidence gaps pinpointed during the previous round. To illustrate the evolution of the discussion and decision-making process, examples of statements that were revised throughout the Delphi rounds are included in Table 1.

## Results

A detailed discussion of all 18 statements can be found in Appendix 1. This comprehensive analysis of various surgical interventions and techniques in THA provides insights into their effectiveness in terms of wound complications, closure time, cost implications, and patient preferences. The following are the summarized findings. See Table 2 for the complete statements.

#### Deep Fascia Closure

- (1) Barbed versus nonbarbed sutures:
  - (1) Wound Complications: There is not enough evidence to assess differences between barbed sutures and traditional interrupted closure with nonbarbed sutures when addressing the deep fascial layer.
  - (2) Closure Time: Barbed sutures significantly reduce the time required for closing the deep fascial layer compared to traditional methods, offering a more efficient option for surgeons.
  - (3) Cost Efficiency: Using barbed sutures may lead to overall cost savings.

#### Skin Closure

##### Sutures Versus Staples for Skin Closure

- (1) Surgical Site Infections (SSIs): Using sutures for skin closure may lower the risk of superficial SSIs compared to staples, suggesting a potential advantage in preventing postoperative complications.
  - (1) Based on the available evidence, triclosan-coated sutures are likely to reduce the risk of SSI versus standard sutures in total hip and knee arthroplasty.
  - (2) Closure Time: Staples significantly shorten the time required for skin closure compared to other methods, offering a quick and efficient option for completing the surgical procedure.

**Table 1**  
Example of Statement Flow Through the Delphi Process.

Original Draft Statement Prior to Review	Mesh-Adhesives are Associated with Fewer Wound Complications than Conventional Dressings in Total Hip Arthroplasty
After review and revision, first consensus round	Mesh-adhesives may be associated with fewer wound complications than conventional dressings in total hip arthroplasty (70% agreement)
Final Statement	There is insufficient evidence to determine if mesh-adhesive dressings lead to less wound complications than other dressings in total hip arthroplasty (95% agreement)

- (3) Cosmetic Outcome: There is not sufficient evidence to assess the difference in appearance of the surgical site postrecovery between staples and sutures.

### Skin Glue Versus Other Methods

- (1) Wound Complications: Rates do not significantly differ between skin glue and other skin closure methods, suggesting a comparable safety profile.

**Table 2**  
Consensus Statements on Wound Closure in Total Hip Arthroplasty.

Consensus Statement	Level of Agreement, % (N/N)
<b>Wound Closure and Sutures</b>	
There is not enough evidence to assess differences in wound complication rates between barbed sutures and interrupted closure with nonbarbed sutures for closure of the deep fascial layer in total hip arthroplasty.	100% (20/20)
There are shorter closing times with the use of barbed sutures versus interrupted closure with nonbarbed sutures for the closure of the deep fascial layer in total hip arthroplasty.	100% (20/20)
While barbed sutures may cost more than interrupted closure with nonbarbed sutures, closure with barbed sutures may save costs due to faster closing times and reduced operating room time in total hip arthroplasty.	85% (17/20)
Sutures are associated with a lower risk of superficial surgical site infections compared with staples for skin closure in total hip arthroplasty.	95% (19/20)
There is insufficient evidence to determine the difference in cosmesis between staples and sutures for skin closure in total hip arthroplasty.	100% (20/20)
<b>Skin Closure Alternatives</b>	
There are no differences in rates of wound complications between skin glue and other skin closure methods in primary total hip arthroplasty.	80% (16/20)
There may be a higher patient preference for subcuticular wound closure versus staples in total hip arthroplasty.	100% (20/20)
Closing time with skin staples is significantly shorter than with other skin closure methods in total hip arthroplasty.	100% (20/20)
<b>Dressings and Postoperative Care</b>	
There may be a lower rate of wound complications with mesh-adhesives versus silver-impregnated dressings in total hip arthroplasty.	80% (16/20)
There is insufficient evidence to determine if mesh-adhesive dressings lead to fewer wound complications than other dressings in total hip arthroplasty.	95% (19/20)
Occlusive dressings (silver-impregnated) require fewer changes than conventional dressings in total hip arthroplasty.	85% (17/20)
<b>Surgical Approaches and Techniques</b>	
No significant differences in wound complication rates between direct anterior, postero-lateral, and bikini incision direct anterior approaches.	80% (16/20)
The use of drains during total hip arthroplasty does not reduce the risk of wound complications.	100% (20/20)
<b>Patient Risk Stratification and Outcomes</b>	
Except for dabigatran and warfarin, which have higher rates of wound complications, there are no differences in rates of wound complications and infection between different venous thromboembolism chemoprophylactic methods after total hip arthroplasty.	95% (19/20)
<b>Total Knee and Total Hip Arthroplasty</b>	
<b>Negative-Pressure Wound Therapy</b>	
In high-risk patients, there is a lower risk of wound complications with negative-pressure wound therapy compared with other dressing types in total hip and total knee arthroplasty.	100% (20/20)
In high-risk patients, negative-pressure wound therapy is associated with lower rates of reoperation compared with other dressing types in total hip and total knee arthroplasty.	95% (19/20)
In high-risk patients, negative-pressure wound therapy is associated with a reduction in dressing changes compared with other dressing types in total hip and total knee arthroplasty.	100% (20/20)
<b>Triclosan-coated sutures</b>	
Based on the available evidence, triclosan-coated sutures are likely to reduce the risk of surgical site infection in total hip and knee arthroplasty.	95% (19/20)

- (2) Patient Preference: There may be a higher patient preference for subcuticular wound closure versus staples.

### Wound Dressings and Postoperative Care

- (1) Mesh-Adhesive Versus Silver-Impregnated Dressings:
- (1) There may be a lower wound complication rate with mesh-adhesives versus silver-impregnated dressings.
  - (2) There is insufficient evidence to determine if mesh-adhesive dressings lead to fewer wound complications than other dressings (ie, other than silver-impregnated).
- (2) Silver-Impregnated Dressings:
- (1) Occlusive dressings (silver-impregnated) lead to a longer duration until the first dressing change compared to conventional dressings, with fewer changes and lowered need for postoperative intervention.

### Surgical Approaches and Techniques

- (1) Incision Approaches: The direct anterior, postero-lateral, and bikini incision direct anterior approaches show no significant



differences in wound complication rates, suggesting that the choice of approach can be tailored to the patient and surgeon preference without compromising safety.

- (2) Drain Usage: Employing a surgical drain during THA does not significantly affect wound complication rates, indicating its usage can be based on surgeon discretion and specific patient circumstances.

#### *Patient Risk Stratification and Outcomes*

- (1) Venous Thromboembolism Prophylaxis: Among normal-risk patients, wound complication rates appear to be higher in patients dabigatran and warfarin, compared to other anti-coagulation modalities.
- (2) High-Risk Patients (Article-Defined or Revision Cases):
  - (1) Negative Pressure Wound Therapy: This method reduces wound complications, lowers reoperation rates, and decreases the frequency of dressing changes compared to other types, indicating a major benefit for high-risk patient groups.

#### **Discussion**

Today's healthcare environment demands that we deliver excellent patient care while being cost-conscious. In orthopedic surgery, especially with THA, this means finding the optimal surgical techniques that are both effective and economic [1,2,6,8,16,21,26]. While much focus has been on controlling costs associated with implants and hospital stays, smaller yet crucial aspects of care, like wound management, have often been overlooked [27]. These parts of the procedure are important because they are what the patient sees and feels, and they can greatly impact their satisfaction and recovery. Even more important, issues with wound healing can lead to more doctor visits, emergency room trips, and hospital readmissions, including the most cost-intensive revision surgery for periprosthetic joint infections [5,15]. Recognizing the importance of these issues, especially in our current push toward healthcare that gives great value, this study used a structured expert discussion method called a modified Delphi approach to increase our understanding of the best ways to manage wounds and incisions after THA.

We brought together 20 top experts in orthopedic surgery from around the world and went through 3 rounds of discussions. These experts agreed on all 18 statements about how to best handle wound closure and incisions after primary or revision hip arthroplasty. The process was set up to allow experts to share their opinions openly and without bias, considering the evidence and their own experience. In this manner, every point was thoroughly discussed, refined, and finally agreed upon. The fact that the experts concurred on all points by the second round of discussion and just confirmed these in the third round shows the strength and unity of their conclusions. We expect that these findings will help doctors agree on the best ways to care for patients after THA and also to point the need to develop an evidence-based approach.

#### *Potential Limitations*

This study had potential limitations. The way we chose experts might have introduced some bias, as we looked at their organizational ties and how many surgeries they do, not just their knowledge in the field. Also, getting a group of surgeons, especially from different countries, to agree on the exact wording for these points was a challenge. We deviated from a true Delphi in that we were not able to have anonymous discussion in our meeting, but instead

used a modified approach with a face-to-face virtual meeting. Sometimes, the points agreed upon were not backed by the strongest evidence, which might make them less reliable. Our statements are limited to the research currently available and have varied levels of evidence. Some findings might seem obvious and not need more research, but others clearly show where there are knowledge gaps and further study is needed.

#### **Conclusions**

Using this structured discussion method, 20 expert orthopedic surgeons agreed on 18 statements about managing wounds and incisions after THA, as noted in the Results section, Table 3, and fully described in the Appendix. These points provide a strong basis for improving how we practice and ensuring that patients get the best care possible. This study not only helps guide current practices but also should guide the direction for future research and improvements in this area.

#### **CRedit authorship contribution statement**

**Margaret Ainslie-Garcia:** Methodology, Project administration, Supervision, Visualization. **Lucas A. Anderson:** Formal analysis, Investigation, Project administration. **Benjamin V. Bloch:** Formal analysis, Supervision, Visualization. **Tim N. Board:** Methodology, Resources, Supervision. **Antonia F. Chen:** Methodology, Software. **Samantha Craigie:** Funding acquisition, Resources, Software. **Walter Danker:** Data curation, Supervision. **Najmuddin Gunja:** Conceptualization, Data curation, Investigation. **James Harty:** Formal analysis, Investigation, Project administration. **Victor H. Hernandez:** Resources, Software, Validation, Visualization. **Kate Lebedeva:** Formal analysis, Methodology, Project administration. **Daniel Hameed:** Formal analysis, Software, Validation, Visualization, Writing – review & editing. **Michael A. Mont:** Formal analysis, Methodology. **Ryan M. Nunley:** Formal analysis, Investigation, Validation, Visualization. **Javad Parvizi:** Conceptualization, Formal analysis, Funding acquisition, Project administration, Visualization. **Carsten Perka:** Conceptualization, Funding acquisition, Methodology, Project administration. **Nicolas S. Piuze:** Funding acquisition, Investigation, Project administration. **Ola Rolfson:** Funding acquisition, Methodology, Resources, Supervision. **Joshua Rychlik:** Conceptualization, Investigation, Project administration. **Emilio Romanini:** Funding acquisition, Resources, Software. **Pablo Sanz-Ruiz:** Conceptualization, Funding acquisition, Project administration, Resources. **Rafael J. Sierra:** Software, Supervision, Validation. **Linda Suleiman:** Methodology, Project administration, Validation. **Eleftherios Tsiridis:** Formal analysis, Funding acquisition, Methodology. **Pascal-André Vendittoli:** Conceptualization, Funding acquisition, Project administration, Resources. **Helge Wangen:** Investigation, Supervision, Visualization. **Luigi Zagra:** Investigation, Project administration, Validation, Writing – original draft.

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#### **Supplementary Data**

Supplementary data related to this article can be found at <https://doi.org/10.1016/j.arth.2024.01.047>.

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