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Original Research

Suction-Powered Intramedullary Bone Debridement Technology Compared to Conventional Curettage in Infected Revision Total Knee Arthroplasty

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A B S T R A C T

Background: Revision total knee arthroplasty (TKA) in the United States is an increasingly common procedure, often performed in the setting of prosthetic joint infection. Debridement of the intramedullary canals is traditionally performed with surgical curettes and is technically difficult and time-intensive. A suction-powered bone harvester (SPBH) is designed to improve the quality of debridement in a closed-capture system. This study assesses conventional curettage (CC) versus SPBH in debridement mass and time from intramedullary spaces. We hypothesize that SPBH will increase debridement yield more efficiently than conventional curettes.

Methods: Adult patients undergoing revision TKA were enrolled to participate in the study and were divided into 2 groups. Patients in group 1 received tibial debridement with CC followed by SPBH and femoral canals with SPBH alone. Patients in group 2 received femoral debridement with CC followed by SPBH and tibial canals with SPBH alone.

Results: Data were collected from 30 revision TKA cases in the setting of prosthetic joint infection. In total, 14 femora and 16 tibiae were initially debrided with SPBH, while the opposites were debrided with CC. On average, the intramedullary debridement with SPBH yielded 23.1 g compared to 13.2 g with CC (P = .0017). The intramedullary canal required 1 minute 28 seconds for debridement with SPBH compared to 2 minutes for debridement with CC (P = .0347). Culture data from samples obtained from SPBH were noninferior to CC.

Conclusions: SPBH is an effective tool for debridement of intramedullary canal during revision TKA. SPBH led to a significant increase of debrided mass in significantly less time than CC. There was no difference in positive culture yield between the 2 debridement techniques. This debridement technique merits consideration to reduce bioburden in revision TKA.

Introduction

Prosthetic joint infections (PJIs) are a devastating complication in total knee arthroplasty (TKA) which generate substantial societal mortality and disability [1-4]. Despite considerable efforts to reduce the risk of PJI among patients undergoing primary TKA, the risk of PJI has remained constant in recent years [5]. The incidence of PJI is expected to double by 2030, paralleling the exponential demand for TKA observed among an aging population [5-9]. The treatment and management of PJI is nuanced and challenging, often characterized by prolonged, individualized courses of intensive medical and surgical care [10-13]. The mainstay of operative management in patients with PJI is divided between Debridement, Antibiotic, and Implant Retention (DAIR) for acute infections with stable, functional implants or revision arthroplasty, typically performed in the United States as a staged procedure with single-stage or 2-stage techniques [10,11,13]. Effective debridement reduces the burden of infection and is critical to the successful operative management of PJI, as insufficient debridement portends the risk of persistent bioburden presence in infected tissues [13-15]. Therefore, optimizing debridement could play a key role in improving PJI management and outcomes.

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A suction-powered bone harvester (SPBH) system is available for use and indicated for minimally invasive bone graft and marrow harvesting as well as debridement and capture of cancellous bone for infection and tumor applications. The basic design features of the SPBH system are analogous to conventional curettes and include a long, narrow shaft and a sharp, curved tip for debriding cement, bone, and soft tissue. However, this device offers a closed-capture, universal suction-compatible filtration harvester that collects the specimen with debridement (Figs. 1 and 2). The purposes of the present study were to (1) compare the quantity of tissue debrided with conventional curettage (CC) versus SPBH technology in mechanical debridement during revision TKA for PJI, (2) compare the time required for tissue debridement between treatment groups, and (3) to compare rates of positive cultures obtained from specimens collected by CC versus SPBH. Based on their clinical experience with the SPBH prior to study commencement, the authors hypothesized that SPBH use would demonstrate superior quantity and efficiency as measured by debrided tissue mass and time compared to CC debridement.

Figure 2. Demonstration of soft tissue debrided from a femoral intramedullary canal using an SPBH. SPBH, suction-powered bone harvester.

Material and methods

Patient population

This prospective, internally randomized controlled trial included all patients aged more than 18 years undergoing revision TKA for PJI between February 2023 and October 2023. Patients undergoing septic revision procedures were eligible for inclusion. All revision arthroplasty procedures were performed by the senior author, an Adult Reconstruction fellowship-trained surgeon. Institutional review board-approved informed consent was obtained directly from all subjects.

Study groups

Debridement methods were classified as either CC or SPBH debridements. Study participants were divided into 2 groups: (1) tibial CC/femoral SPBH, who underwent tibial intramedullary debridement with CC followed by intramedullary debridement with the SPBH device, and on the femoral side with SPBH alone, and (2) tibial SPBH/femoral CC, who underwent tibial debridement with the SPBH device only and femoral debridement with CC first, followed by debridement with the SPBH (Fig. 3). Patients with even-numbered medical record numbers were assigned to the tibial CC/femoral SPBH group, while patients with odd-numbered medical record numbers were assigned to the tibial SPBH/femoral CC group.

Figure 1. SPBH device within an intramedullary canal during femoral debridement. The closed capture system (*) and standard suction tubing (+) are labeled. SPBH, suction-powered bone harvester.

Debridement devices

SPBH debridement was performed with the Avitus Bone Harvester (Zimmer Biomet), a sterile-packed, single-use, closed-capture suction curettage system that attaches to standard and universal operating room suction tubing and collects debrided tissue in a collection chamber that can hold up to 50 cc of debrided material. The Avitus Bone Harvester is available in 8-mm and 6-mm tip diameters, and the 8 mm was considered standard and used throughout the study. All CC debridement was performed using Moreland reverse curettes (DePuy Johnson & Johnson) considered standard for revision arthroplasty cases at the senior author's institution.

Technique

Following removal of implants, intramedullary debridement was performed by the attending surgeon with either CC or SPBH according to the protocol. Debridement time was measured by an operating room team member using a stopwatch (minute:second). Conventionally curetted material was placed into a sterile collection cup after each pass with the curette. Debrided material from the intramedullary canal was collected in the SPBH closed-capture system and subsequently transferred from the device's collection chamber into a sterile specimen cup (Figs. 4 and 5). The technique for SPBH debridement is similar to standard techniques for conventional canal and involves sequentially passing the debridement device through the canal with the goal to extract intramedullary material. Transfer time in SPBH was only included if the container filled prior to conclusion of the debridement and required interval transfer during the debridement. At the conclusion of debridement, sterile specimen cups were passed off the field and weighed using a matching cup for tare and measured in grams. Following completion of the debridement of specimens that were randomized to undergo CC, a secondary debridement within the same intramedullary space was conducted with the SPBH device to (1)

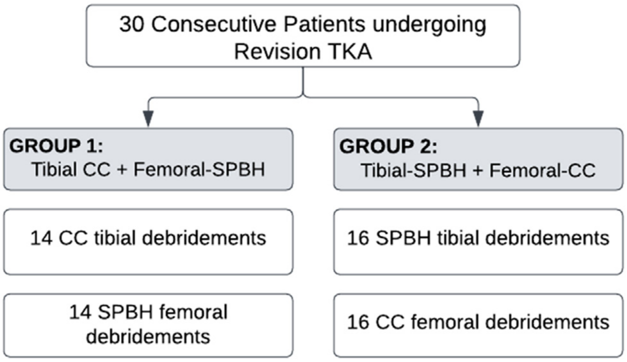

Figure 3. Inclusionary flowchart demonstrating the prospective, internally randomized controlled trial of 30 patients undergoing septic revision TKA. Fourteen patients underwent CC tibial debridement and SPBH femoral debridement (Group 1), while 16 patients underwent SPBH tibial debridement and CC femoral debridement (Group 2). CC, conventional curettage; SPBH, suction-powered bone harvester; TKA, total knee arthroplasty.

achieve a similar standard of care among all patients due to the authors' hypothesis that SPBH enabled more thorough debridement than CC and (2) assess the amount of additional material debrided with the SPBH device. The debrided material was placed into a separate sterile specimen cup and passed off of the sterile field for mass measurement. Three intramedullary tissue specimens were sent for culture per patient: CC only, SPBH only, and SPBH following CC. The surgeon maintained standardized techniques and sought to perform expeditious debridement throughout the study period. Furthermore, the surgeon did not routinely deviate from his standard revision TKA technique, including fixation type, based on the use of a SPBH device. Debridement was concluded based on visual inspection of the canal and diminishing material debrided. An example of intramedullary canal appearance after CC and SPBH debridement as captured by an arthroscopic camera is presented in Figure 6.

Data collection

Patient demographics, type of revision arthroplasty, type of implant removed, and final culture results were collected postoperatively for analysis. Duration of debridement and the masses of debrided contents for CC, SPBH, and excess SPBH after CC were collected intraoperatively.

Figure 4. Demonstration of the technique used to empty the debrided intramedullary material from the SPBH device into the sterile specimen cup. Prior to emptying, the suction-connected cap is removed from the end of the collection chamber and the specimen removed from the chamber via the cartridge. SPBH, suction-powered bone harvester.

Statistical analysis

Statistical analyses were conducted using GraphPad Prism, version 10.0.2 (GraphPad Software, Boston, MA). A priori power analysis for sample size was performed for the primary outcome of debrided sample mass before secondary SPBH debridement with an estimated 15 g via CC and 25.4 ± 10 g (standard deviation [SD]) from SPBH based on preliminary data. Fifteen subjects were required in each group to obtain $\alpha = 0.05$ and 80% power with 100% enrollment. Continuous data were described using the calculated mean and SD. Data for femoral, tibial, and mean of combined debridements were further stratified into 4 categories for comparative analysis: conventional, SPBH, excess SPBH after conventional, and additive total of conventional with secondary SPBH. The Shapiro-Wilk test was used to assess normality within the time spent debriding the femur and the tibia overall in each patient, regardless of debridement method, to assess overall balance between groups. Outliers were excluded from normality assessment. Unpaired *t*-tests were used to compare the debridement time and ultimate mass of debrided content between conventional and SPBH debridements, as well as conventional with secondary SPBH and SPBH only. Fisher's exact test was used to compare rates of obtaining positive cultures by the different debridement methods using data from the 9 patients who presented with at least 1 positive culture and odds ratios were calculated. Grubb's test was used to identify outliers among both debridement amount and time values, which were removed from figures and regression analyses. Pearson's correlation coefficients were used to assess trends in debridement mass obtained over time. Statistical significance was defined as $P < .05$.

Results

All 30 sequential septic revision TKAs performed from the initiation of the study period were eligible for inclusion. Mean patient age was 68 years (SD = 6.0) and the majority of patients were males (n = 21, 70%) (Table 1). Post-hoc power analyses performed for combined tibial and femoral debridement mass demonstrated statistical power of 92% with $\alpha = 0.05$. Two patients were found to be outliers in amount of mass debrided: one who underwent CC femoral debridement with 69.2 g of debrided mass in 4:03 and another who underwent SPBH tibial debridement with 52.8 g of debrided mass in 2:56. Two patients were found to be outliers in the amount of time debriding: one who underwent SPBH femoral debridement with 44.3 g of debrided mass in 4:06 and another who underwent tibial CC debridement with 16.2 g of debrided mass in 6:03. After excluding for outliers, internal balance within the femur and tibia debridement groups was achieved as demonstrated by normal data distribution of total time spent debriding with summation of both debridement methods (femur: 2:12 [SD = 1:14], $P = .1912$; tibia: 2:13 [SD = 1:34], $P = .2083$).

Procedures

In total, 36.7% (n = 11) of patients underwent first-stage revision TKA, the majority of which involved the placement of a dynamic spacer (n = 10, 33.3%) (Table 1). Ten percent (n = 3) of patients underwent revision spacer placement, involving explant of a current spacer and placement of a second spacer. The greatest proportion of patients underwent second-stage TKA (n = 15, 50%), the majority of which involved removal of a dynamic spacer and reimplantation (n = 9, 30%). One patient underwent a first-stage

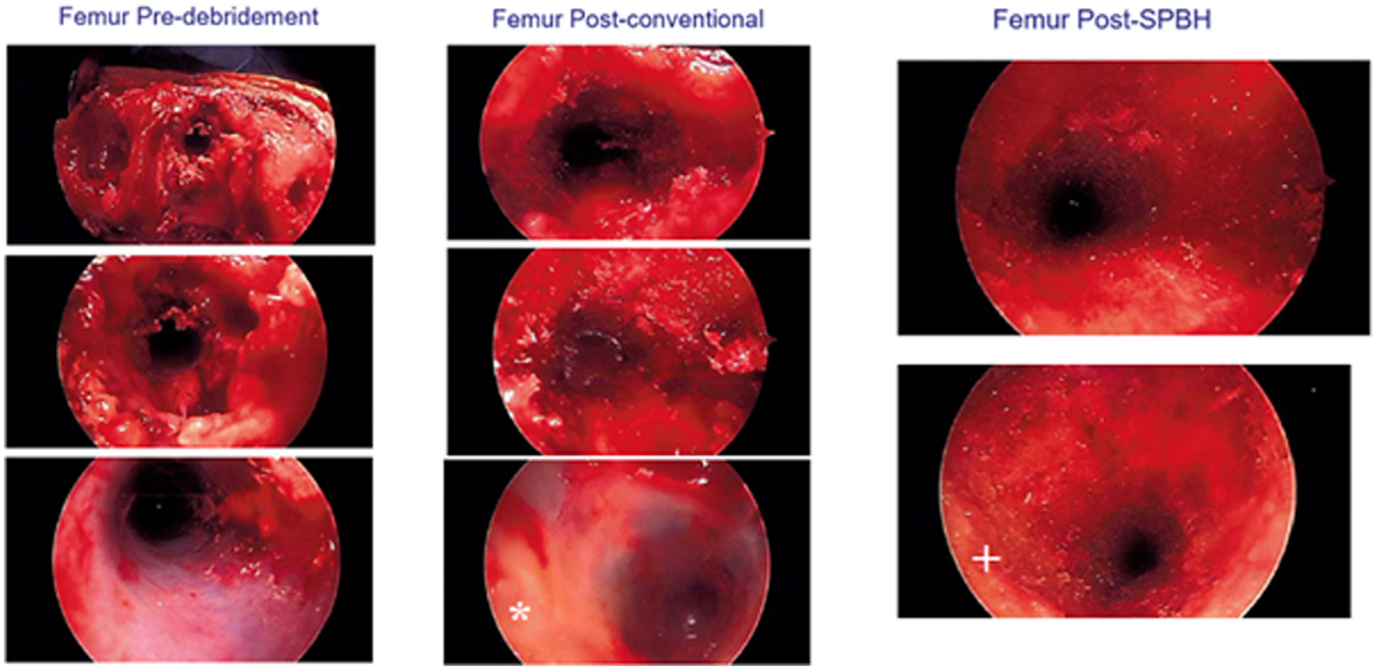

Figure 5. (Color) Femoral intramedullary canal before and after CC and SPBH debridement as captured by an arthroscopic camera placed at the entry of the canal. Note the residual fibrous tissue after conventional debridement (*) and a thoroughly debrided canal with health bleeding cancellous bone, free of fibrous material (+). CC, conventional curettage; SPBH, suction-powered bone harvester.

revision of a revision TKA, in which revision components were explanted and a static spacer placed.

Debridement efficiency

Debridement mass

Comparative debridement mass values are presented in Table 2 and Figure 7. When compared to CC debridement alone, tibial and mean of combined tibial/femoral SPBH debridements yielded significantly greater masses of debrided contents (tibial: 23.2 g [SD = 11.0] vs 10.4 g [SD = 4.7], $P = .0004$; combined tibial/femoral: 23.1 g [SD = 10.4] vs 13.2 g [SD = 12.3], $P = .0017$). There was no difference in mass comparing femoral SPBH to CC or in comparing SPBH to CC with a second pass SPBH debridement (Table 2, Fig. 7).

Debridement time

Comparative debridement time values are presented in Table 2 and Figure 8. When compared to CC debridements alone, SPBH debridements were significantly less time-intensive than CC debridements (tibial: 2:10 [SD = 1:17] vs 1:21 [SD = 0:38], $P = .0322$; combined tibial/femoral: 2:00 [SD = 1:06] vs 1:28 [SD = 0:47], $P = .0347$). Additionally, CC debridement followed by second pass SPBH similarly added more debridement time on average as compared to SPBH alone (femoral: 2:45 [SD = 1:15] vs 1:37 [SD = 0:56], $P = .0096$; tibial: 3:13 [SD = 1:44] vs 1:21 [SD = 0:38], $P = .004$; combined tibial/femoral: 2:58 [SD = 1:29] vs 1:28 [SD = 0:47], $P < .0001$).

Debridement rate

Comparative debridement rates are presented in Table 2. When compared to CC debridements alone, SPBH debridements demonstrated significantly higher rates of mass obtained per unit time as compared to CC debridements (femoral: 17.1 [SD: 9.3] vs 7.3 [SD: 3.8]; tibial: 20.3 [SD: 14.0] vs 5.2 [SD: 1.9]; combined tibial/femoral: 18.8 [SD: 12.0] vs 6.3 [SD: 3.2]). For femoral and tibial debridements, SPBH debridement yielded greater amounts of debrided tissue as compared to CC alone per unit of time. Debridement time was strongly and significantly correlated with debridement mass for CC debridements (femoral: $r(13) = 0.85$, $P < .0001$; tibial: $r(11) = 0.74$, $P = .0045$); however, mass debrided remained stable over debridement time for SPBH debridements (femoral: $r(11) = 0.35$, $P = .2411$; tibial: $r(13) = 0.075$, $P = .7903$).

Culture outcomes

Of the 3 cultures collected per patient during intramedullary debridement in accordance with the study protocol, final culture speciation data were available for 29 patients (1 patient's cultures were collected but lost in transport to the laboratory). In total, 9 patients were found to have 1 or more positive intramedullary culture samples, with the remaining 20 demonstrating negative intramedullary culture samples. Of the 9 patients with positive cultures, 2 underwent explant of primary TKA and placement of a static spacer, while 7 underwent placement of a dynamic spacer. All 15 patients undergoing second-stage revision TKA were found to have negative cultures.

Of the 27 culture samples obtained from the 9 positive culture patients, 22 samples were found to be positive, 3 were found to be negative, and 2 were collected but lost in transport to the laboratory. Culture strains reported included *Coccidioides immitis*, diptheroids, *Enterococcus faecalis*, *Staphylococcus aureus*, and methicillin-resistant *Staphylococcus aureus*.

Of the 22 positive culture samples, 4 were obtained by femoral CC, 3 by tibial CC, 3 by femoral SPBH, 4 by tibial SPBH, 5 by femoral SPBH after CC, and 3 by tibial SPBH after CC.

In total, incidence of positive cultures was not different between conventional and SPBH debridements (n = 7/28, 25% vs n = 15/57, 26.3%; confidence interval = 16%-40%, $P = .756$). Assuming that all patients who had at least 1 positive culture would be expected to have all positive cultures, sensitivities were not different between

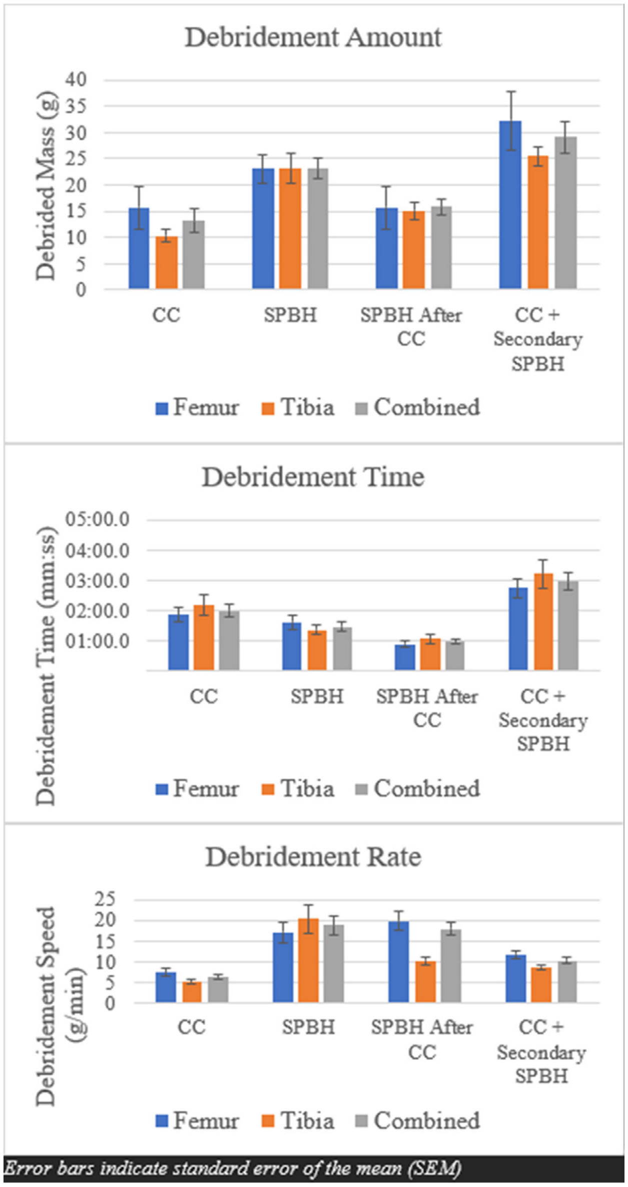

Figure 6. (Color) Graphical representation of the debridement mass, time, and rate between the studied techniques.

conventional and SPBH debridements (n = 7/8, 87.5% vs n = 15/17, 88.2%%; confidence interval = 64%-99%, P = .931). Of note, in 1 patient, the CC femoral debridement cultures were negative while the secondary femoral SPBH debridement and the tibial SPBH debridement cultures were both found to be positive. In the one patient where 2 of 3 samples were lost in transport to the laboratory, the sample that made it to the laboratory was from the secondary femoral SPBH debridement and was found to be positive.

Discussion

The use of SPBH technology for surgical and mechanical debridement in revision TKA enables improved debridement rate with higher mass in less time. Additionally, most cultures found to be positive were obtained from samples collected with SPBH, which suggests that the utilization of a closed-capture collection system is a noninferior technique to the use of traditional curettes

Table 1
Demographics.

Demographics	
Age, mean (SD)	68 (6.0)
Male, N (%)	21 (70%)
Right, N (%)	11 (36.7%)
Debridement tool distribution	
Group 1: CC tibia/SPBH femur	14 (47%)
Group 2: SPBH tibia/CC femur	16 (53%)
Procedures	
First-stage revision with dynamic spacer	10 (33.3%)
First-stage revision with static spacer	1 (3.3%)
Revision spacer	3 (10%)
Second-stage removal of dynamic spacer and reimplantation	9 (30%)
Second-stage removal of static spacer and reimplantation	6 (20%)
Other	1 (3.3%)

CC, conventional curettage; SD, standard deviation; SPBH, suction-powered bone harvester.

in obtaining culture samples from intramedullary debridements. Further research is necessary to determine whether SPBH offers benefits in debridement efficacy or sample collection over curettage.

Intraoperative debridement is intensive in technique and includes surgical, mechanical, and chemical components. Surgical debridement involves appropriate exposure, explanation of cement and hardware, and radical excision of synovium and visible biomembrane. Mechanical debridement includes curettage, reaming, and lavage. Chemical debridement encompasses the use of solutions that destroy pathogens and create an environment that prevents their propagation [15]. For PJI, aggressive mechanical debridement is critical and enables simultaneous reduction in pathogen bioburden and improves the exposure of the surviving pathogens to antibiotics and autoimmune response mechanisms [14,16]. The rigor of debridement has been described as an important factor in PJI management. Suboptimal debridement potentially leaves residual bioburden, negatively influences outcomes, and contributes to the variation in response to debridement observed in current literature [13,14]. In their discussion of debridement principles for patients undergoing implant retention, Deckey et al. [14] identify mechanical debridement as one of the most important factors in the success of DAIR. While 2-staged revision arthroplasty remains the gold standard of treatment for PJI, there is evidence that up to 20% of patients ultimately do not undergo the second stage of revision for a variety of reasons [17], further emphasizing the importance of comprehensive debridement of infected tissues in the first stage of revision arthroplasty. Subsequently, identifying mechanisms by which to promote the most effective, reproducible, high-quality debridement offers value in PJI management.

Given the increasingly recognized importance of mechanical debridement on reducing bioburden, the impetus for the present study emerged to compare the standard at the senior author's institution, CC, to an existing technology designed to facilitate easy autograft harvest and limit seeding risk in infectious and oncologic procedures [18]. In addition to the improved debridement rate and higher mass of debrided contents from SPBH, the authors recognized several other subjective benefits. For example, CC frequently requires the use of an assistant to aid in promoting efficiency while capturing debrided contents, which similarly diverted the attention of an additional person in the operating room and required an additional person to handle a contaminated sample. Additionally, debrided contents not stored in a closed-capture system can inadvertently fall back into the canal being debrided. SPBH requires only the surgeon to operate, and the contents are easily captured into the device and stored there for easy sampling access, which may help reduce the risk of surgical field contamination.

Table 2
Debridement comparison.

Debridement site	Debridement method				% change with secondary SPBH	*P* values	
	CC	SPBH	SPBH after CC	CC + secondary SPBH		SPBH versus CC	SPBH versus CC with secondary SPBH
Mean debrided mass (g)							
Femur	15.8 (16.1)	23.0 (10.1)	16.5 (9.1)	32.2 (22.3)	+104%	.161	.167
Tibia	10.4 (4.7)	23.2 (11.0)	15.1 (5.8)	25.4 (7.1)	+145%	.0004[a]	.527
Combined[b]	13.2 (12.3)	23.1 (10.4)	15.8 (7.6)	29.1 (17.1)	+120%	.0017[a]	.106
Mean debridement time (SD)							
Femur	1:51 (0:57)	1:37 (0:56)	0:54 (0:23)	2:45 (1:15)	+49%	.504	.0096[a]
Tibia	2:10 (1:17)	1:21 (0:38)	1:04 (0:31)	3:13 (1:44)	+49%	.0322[a]	.004[a]
Combined[b]	2:00 (1:06)	1:28 (0:47)	0:58 (0:27)	2:58 (1:29)	+48%	.0347[a]	< .0001[a]
Debridement rate (g/min)							
Femur	7.3 (3.8)	17.1 (9.3)	19.8 (9.5)	11.8 (3.4)	+62%	.0006[a]	.0423[a]
Tibia	5.2 (1.9)	20.3 (14.0)	10.2 (3.5)	8.7 (2.5)	+67%	.0004[a]	.0049[a]
Combined[b]	6.3 (3.2)	18.8 (12.0)	17.9 (8.6)	10.3 (3.4)	+63%	.0001[a]	.0004[a]

CC, conventional curettage; SD, standard deviation; SPBH, suction-powered bone harvester.
[a] Statistically significant ($P < .05$).
[b] Mean of femur and tibia.

Quality of debridement is critical to PJI management; however, a comprehensive debridement requires substantial time investment. With each minute in the operating room estimated to cost $30-38 in 2018 [19], seemingly small adjustments in operating room practices to save minutes in operative duration can generate substantial savings [20-22]. Additionally, there is increasing evidence to suggest that overall procedural efficiency sustains clinical improvements in PJI management. Prolonged operative times have been linked to negative outcomes, such as PJI incidence among primary TKAs and length of stay in revision TKAs, suggesting that surgical efficiency and reducing operative time should be of escalating importance in optimizing outcomes [23-28]. In their analysis of 14,769 revision TKAs from the American College of Surgeons National Surgical Quality Improvement Program database, Chen et al. [24] observed an increase in rates of surgical site complications, postoperative blood transfusion, and prolonged hospitalizations that occurred concurrently with a 15-minute increase in surgical time. With rising rates of revision TKA, the financial ramifications of these procedures cannot be ignored. The overall perioperative management of revision TKA has been estimated as high as 5 times the cost of primary uncomplicated TKA, and TKA PJI is projected to account for $1.1 billion of annual hospital costs by 2030 [29-31]. Even when compared to aseptic revision procedures, operating room and anesthesia costs for revision TKA for PJI are reported at twice as high as those for aseptic procedures [32]. Subsequently, surgeons balance thorough debridement with operative efficiency to optimize PJI management.

Along with surgical and mechanical debridement, sufficient collection of intraoperative cultures from a variety of sources is vital to perioperative PJI management [33-35]. Culture-negative (CN) PJI, initially defined in 2007 by Berbari et al. [36] as the presence of periprosthetic purulence, acute histopathologic inflammation, or a sinus tract in the setting of negative aerobic and anaerobic cultures, incur a specific challenge in identifying pathogen etiologies of infection and resultant treatment plans [36,37]. However, there is evidence to suggest that CN-PJI do not remain CN: among patients undergoing DAIR for TKA CN-PJI, 53.3% of the patients who failed treatment were found to be culture-positive [38]. While withholding preoperative antibiotics and obtaining sufficient samples can improve the sensitivity and specificity of cultures [35], the ability of the SPBH to harvest deep endosteal material in a closed-capture collection system assists in deep specimen sampling while minimizing the potential for tissue seeding [18]. In the present study, many patients already had identified pathogens and had been on antibiotic therapy; however, a greater percentage of cultures found to be positive came from specimens collected by the SPBH. Furthermore, of the 9 found to have positive culture results, culture specimens in 1 patient were found to be positive from both the primary SPBH tibial

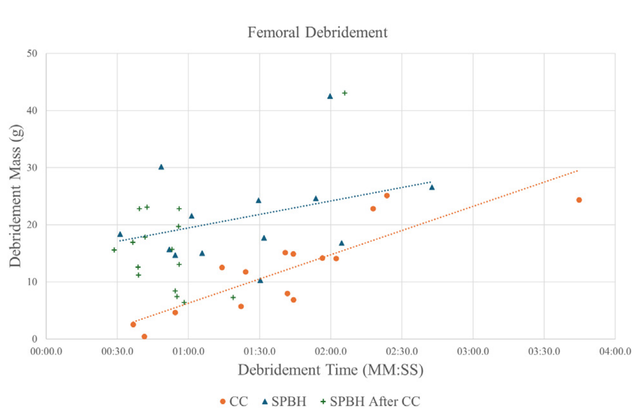

Figure 7. (Color) Graphical representation of femoral debridement efficiency between the studied techniques in the femur.

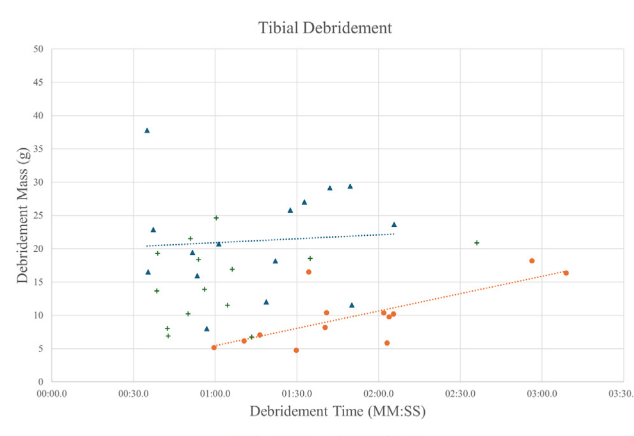

Figure 8. (Color) Graphical representation of femoral debridement efficiency between the studied techniques in the tibia.

debridement and the secondary SPBH femoral debridement, while negative from the primary conventional femoral curettage. In this particular case, the presence of a positive culture directly determined organism-specific antibiotic therapy. Overall, the distribution of positive cultures among both the CC and SPBH groups suggests that SPBH offers a viable method for obtaining intramedullary debridement samples; ultimately, further research is necessary to determine whether the deep specimen collection and closed-captured system of the SPBH offers benefits in sample collection and possibly pathogen identification.

Based on the results of the present study, the SPBH appears to offer benefits over CC in terms of debridement time required and debrided mass, with 73% of the debridement time requirement and 75% more debrided mass (1:28 vs 2:00 minutes, $P = .0347$; 23.1 vs 13.2 g, $P = .0017$). Even when used as a secondary augment following CC in the same bone, the SPBH debrided over 100% more mass in less than half of the time spent on the initial CC. When comparing the overall rate of debridement, SPBH demonstrated consistently significantly higher rates of debridement as compared to CC alone across femoral, tibial, and combined femoral/tibial intramedullary canals. Similarly, the quantity of mass debrided correlated significantly with increases in debridement time for CC debridements; however, rates of debridement among debridements performed with SPBH devices remained stable, suggesting a steadier debridement rate across all time points. The results of the present study suggest that the SPBH may offer benefits in minimizing debridement time while maximizing debrided contents. Additionally, SPBH appears to be a noninferior debridement tool for obtaining culture specimens. Future research will be necessary to establish overall debridement efficacy as well as sampling efficacy for culture specimens.

Limitations

This study is not without limitations. First, while this study demonstrates an appropriately powered study population, a combination of small sample size along with a single surgeon performing SPBH and CC debridements limits the generalizability of these results. Second, while the use of a single manufacturer helped to standardize SPBH throughout the study, it may limit the generalizability of these findings to a particular instrument. Similarly, the specific selection of an angled curette to be used in CC varied between patients according to surgeon judgment in promoting an efficacious debridement. Technique and extent of mechanical debridement is surgeon-dependent with these results demonstrating that mass debrided was not different when SPBH followed CC. Third, despite internal control, differences among infection severity, bioburdens, and bone involvement within the same patient may affect debridement patterns and requirements. Fourth, the study was not designed or powered to determine whether SPBH improved the sensitivity of intraoperative samples to yield positive culture results with identified organisms. Furthermore, this study included different stages of revision TKA as well as different expected bioburden of pathogens present; for example, all 15 patients who underwent stage 2 revision TKA were found to have negative cultures.

Conclusions

In the treatment of PJI, SPBH is an effective tool for the surgical debridement of intramedullary canals during revision TKA and debridements performed with SPBH technology produced significantly more tissue mass in significantly less time than CC alone. Additionally, there was no significant difference in positive culture yield between the 2 debridement techniques. Based on these findings, the SPBH appears to offer an effective tool for debridement in revision TKA that appears noninferior in yielding positive culture results as compared to CC. Future research will elucidate whether the SPBH improves culture precision and accuracy and whether there exist improvements in debridement efficacy with the potential to imbue clinical benefits.

Conflicts of interest

Richard Purcell is a paid consultant for Bone Support, OrthAlign, and Zimmer Biomet. All other authors declare no potential conflicts of interest.

For full disclosure statements refer to https://doi.org/10.1016/j.artd.2025.101648.

CRediT authorship contribution statement

Joshua Hansen: Writing – review & editing, Writing – original draft, Project administration, Methodology, Investigation, Formal analysis, Data curation. **Alexis Sandler:** Writing – review & editing, Writing – original draft, Methodology, Formal analysis, Data curation. **Michael Polmear:** Writing – review & editing, Data curation, Conceptualization. **Richard Purcell:** Writing – review & editing, Investigation, Data curation, Conceptualization.

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