The Half-Pin and the Pin Tract: A Survey of the Limb Lengthening and Reconstruction Society

Daniel J. Stinner, MD, Jospeh R. Hsu, MD, and Christopher Iobst, MD

Abstract

Although the key principles of external fixation have changed little over the years, there remains a significant amount of variation in fixation methods and postoperative care. In particular, use and management of half-pins intended for prolonged reconstruction are the subject of strong opinions and intense debate.

We conducted a study of common trends in use and management of half-pins and in treatment of pin-tract infections in circular fixation by polling subject matter experts who are members of the Limb Lengthening and Reconstruction Society.

Although the distribution of stainless steel half-pins (52%) and titanium half-pins (48%) was similar, most respondents preferred hydroxyapatite coating (81%). Respondents commonly encouraged use of a shower (60%) and a washing solution (67%) for pin-site care. For pin-tract infections, oral antibiotics were prescribed more often (83%) than parenteral antibiotics (17%) and were given for 8 days on average.

Results from this study helped identify trends in application techniques and in routine management of circular fixators. In addition, they helped identify several areas of clinical equipoise that should be studied, including metallurgy, pin-site care solutions, and antibiotics.

Although the key principles of external fixation have changed little over the years, there remains a significant amount of variation in fixation methods and postoperative care. In particular, use and management of half-pins intended for prolonged reconstruction are the subject of strong opinions and intense debate.

Half-pins are commonly available in stainless steel and titanium. They are also available coated with hydroxyapatite (HA), which has been demonstrated to improve fixation strength and decrease rates of pin loosening.[1,2] Despite this growing body of literature in support of HA-coated half-pins, there remains no standard practice.

Regardless of type of half-pin used, there are many different methods of pin placement, with the main differences in technique being predrilling or no predrilling before half-pin placement and placement of the half-pin by hand or by power. Much of this argument stems from concern about thermal necrosis caused during half-pin placement, which many believe to be associated with subsequent pin loosening and pin-tract infections.[3-5]

Although some studies have reported pin-tract infection rates as high as 100%,[6] there is little standardization in prevention or treatment.[6-8] Surgeons use various methods of pin-site care to prevent infections; this care differs in both frequency (eg, daily, weekly) and procedure (eg, specific cleansing solution).[7,9,10] Treatment ranges from use of parenteral or oral antibiotics to pin removal or, in extreme cases, frame removal.

There is increasing interest in using circular fixation to treat acute and chronic injuries, and in the near future there likely will be an increase in the number of circular fixators being placed. However, there is a lack of consensus regarding both appropriate application and management of these external fixators.

We conducted a study of common trends in use and management of half-pins and in treatment of pin-tract infections in circular fixation by polling subject matter experts, members of the Limb Lengthening and Reconstruction Society (LLRS).

Materials and Methods

After obtaining institutional review board approval, we e-mailed a 9-question survey to the LLRS membership and to participants in the 2009 annual meeting of the organization. LLRS members are committed to clinical excellence in complex fracture management, deformity correction, limb reconstruction, and limb lengthening.

The survey was designed to investigate surgeon preferences regarding type of hardware used, general application tech-

Authors' Disclosure Statement: The authors report no actual or potential conflict of interest in relation to this article.

niques, and routine postoperative management of circular fixators. The survey questions were divided into 3 categories: intraoperative, early postoperative, and late postoperative (**Table I**). Given the wide variety of responses anticipated, all questions were written open-ended to encourage respondents to provide their true treatment preferences.

One question was, "What do you recommend to your patients for pin care?" The answers were categorized as to recommended method and frequency of pin-site care. For frequency, an answer was categorized *limited/no pin care* if the only recommended pin care was daily personal hygiene or a daily shower or bath. An open-ended question was asked at the end of the survey to solicit any comments and tips/tricks not addressed in the responses to the 9 questions. Descriptive statistical analyses were performed on the data from the responses to identify common practices.

Table I. The 9 Survey Questions

Intraoperative
1. Which type of half-pins do you use and why?
2. Do you predrill and place your half-pins by hand, place them with power, or predrill and place them with power?
3. Do you have any tips/tricks regarding pin placement?
4. Do you do anything special to prepare the skin before placing pin/wire?
5. Are you aware of any new technologies or designs that might help improve the pin–bone interface?
Early Postoperative
6. What do you recommend to your patients for pin care?
Late Postoperative
7. How do you treat pin-tract infections?
8. Do you have any special way of dealing with half-pin scars?
9. Do you remove frames in the operating room or clinic?

Results

Of the 120 surgeons that were sent the survey by e-mail, 63 (53%) responded. Thirty-three (52%) of those respondents were specialists in adult deformity correction and/or trauma, and 30 (48%) were specialists in pediatric deformity correction.

Twenty-nine respondents (46%) commented on which metallic composition they preferred for half-pins; the distribution was almost equal between stainless steel (n = 15, 52%) and titanium (n = 14, 48%). Fifty-seven respondents (90%) commented on coating. Of these, 46 (81%) preferred HA coating, and 11 (19%) preferred non-HA coating.

Fifty-two respondents (83%) commented on pin-placement method. Of these, 48 (92%) predrilled and placed half-pins by hand, 3 (6%) predrilled and placed half-pins by power, and 1 (2%) did not predrill and placed half-pins by power.

Regarding routine circular frame management protocols, there was much more variability among respondents. Recommended methods for pin-site care included shower (60%), washing solution (67%), and chlorinated swimming pool use (10%). The most often recommended washing solutions were soap and water (36%), hydrogen peroxide (36%), saline (33%), and povidone-iodine (21%).

Thirty-eight respondents (60%) commented on pin-care frequency. Most (34) recommended daily care (n = 16, 42%) or limited/no care (n = 18, 47%); 3 (8%) recommended more frequent care (2 or 3 times daily), and 1 (3%) recommended every-other-day care.

Fifty-nine respondents (94%) commented on treatment of pin-tract infections. Of these, 49 (83%) used oral antibiotics, and 10 (17%) used parenteral antibiotics. Although not always mentioned by respondents, the most common first-line oral antibiotic prescribed was cephalexin (n = 23, 47%) followed by clindamycin (n = 7, 14%), and sulfamethoxazole-and-trimethoprim (n = 4, 8%). Mean duration of antibiotic treatment was 8 days (range, 2-10 days). Only 1 respondent (2%) described using a topical antibiotic.

Three respondents (5%) indicated they removed the vast majority (>90%) of frames in clinic. The other 60 respondents used some variation of sedation/anesthesia in, for example, the operating room or the recovery room.

Discussion

The results of this study are similar to other results reported in the literature[6-11,15,16]: There is wide variation in subject matter experts' use and management of half-pins and in treatment of pin-tract infections in circular fixation. However, this study identified several important trends that can help guide surgeons performing circular fixation.

Although use of titanium and stainless steel half-pins was similar, 81% of the respondents who commented on half-pin coating preferred HA over non-HA coating. The main reason for the experts' majority preference on this point is that HA coating improves the strength of the fixation of the bone–pin interface. Moroni and colleagues[1,2,11-14] demonstrated this through comparisons of extraction torques in HA-coated pins and non-HA-coated half-pins. They found that radiographic pin-tract rarefaction, which constitutes radiographic evidence of pin loosening, was significantly ($P<.001$) lower in HA-coated half-pins in a sheep model. In addition, they showed mean extraction torque was higher in the HA-coated group ($P = .0001$). Not surprising, scanning electron microscopy subsequently showed extensive bony coverage of the HA-coated pins without coating delamination or resorption, which was not seen in non-HA-coated pins.[14] In a clinical study, Moroni and colleagues[2] found not only that HA-coated half-pins had higher extraction torque than non-HA-coated half-pins, but also that HA-coated half-pins had extraction torques higher than their corresponding insertion torques ($P<.001$). The evidence in the literature is insufficient to demonstrate a lower infection rate for HA-coated half-pins; however, improved

Table II. Tips and Tricks for Circular Fixation[a]

When drilling, use sharp drill bits, change them frequently if needed, clean the flutes, and lavage/irrigate the drill bits to minimize thermal necrosis.
When placing thin wires, use an alcohol-soaked sponge to help cool the wires and maintain an appropriate trajectory.
There should be no skin tension left on pins or wires at the end of cases. When ending a case, use a No. 11 blade to release any tension.
Once a wire penetrates the far cortex, tap it through the skin to prevent binding of soft tissues and minimize heat generation.
Place all half-pins and wires bicortically, not unicortically.
Instead of repositioning a wire, use a new one.
Round sponges are good for stabilizing the pin–skin interface, but expensive. Store-bought makeup sponges and tissue paper are much less costly alternatives to sterile dressings.
For half-pin placement in tricky locations, use the guide-wire technique: Poke a wire through the soft tissue and tap the bone to ensure a good trajectory for the half-pin.
Use an extra wire or half-pin for additional fixation at each level—in anticipation of needing to remove one wire or half-pin later.

[a]Responses to an open-ended question soliciting comments and tips/tricks not addressed in the 9-question survey (Table I).

fixation strength may lead to lower infection rates, as many subject matter experts believe frame stability in one form or another has a great impact on development of pin-tract infections.[6,7] Pin loosening has been shown to correlate with pin-tract infection.[15]

Regarding half-pin application, most respondents predrill and place the half-pin by hand, mainly out of concern over thermal necrosis, which can occur in self-drilling pins placed by power without predrilling. Wikenheiser and colleagues[4] placed thermocouple probes 0.5 mm from pins and inside the pins to measure temperatures reached during insertion of pins into bone. Although there was not a significant difference in the microdamage to the surrounding bone between different treatment techniques, there was a difference in insertion torque and thermal responses. Overall, the authors recommended cooling the drill/half-pin before insertion. This pearl was also emphasized by most of our survey respondents (**Table II**).

A recent review of pin-site care for preventing pin-tract infections concluded that there was insufficient evidence to make any clinical recommendations.[10] This was clearly evident in the present study, as the most varied answers from our subject matter experts involved pin care. Sixty percent of the respondents recommended showers, and two thirds recommended one of a variety of washing solutions, most commonly soap and water, hydrogen peroxide, and saline. Of those who specified type and frequency of pin care, 47% recommended limited/no care (only daily personal hygiene or a daily shower or bath) to their patients. This finding is supported by a prospective observational study conducted by Gordon and colleagues,[16] who made almost 4500 clinical observations of pin sites in 27 consecutive pediatric patients who received tibial fixators and were instructed to perform no pin care other than daily showers. The authors noted a total of 178 pin-tract infections (4.0% per observation). Other studies have failed to identify the optimal method and frequency for pin care, or whether pin care should be performed at all.[9,10] This has led investigators to consider other interventions—using antibacterial dressings and coatings over pins—that have had promising results in initial studies.[17,18]

Regarding frame removal, only 3 of 63 the respondents (5%) removed the vast majority of their frames in clinic. Although it may be common practice to remove frames in a setting where anesthesia can be administered, the associated cost must not be ignored. DiCicco and colleagues[19] performed a comparative analysis of patient satisfaction and cost savings for removal of tibial external fixators in clinic versus in the operating room. Eighty percent of patients who had frames removed in clinic rated their pain less than 25% of the maximum on the visual analog scale. In addition, frame removal cost about $250 in clinic and $2160 in the operating room. Ryder and Gorczyca[20] conducted a similar study and found that 90% of patients who had fixators removed without anesthesia indicated they would do so again if given a choice.

This study had the limitations inherent to other studies of the same design. First, as a survey study, it was limited by having preference data only from those surgeons who chose to respond, and therefore it was subject to selection bias. In addition, open-ended questions were used to gather as much information as possible on the topics being evaluated. Although this allowed us to acquire potentially more useful data—the experts were free to respond the way they felt was most appropriate—there was a lack of standardization in the responses.

In conclusion, results from this study helped identify trends in application techniques and in routine management of circular fixators. In addition, they helped identify several areas of clinical equipoise that should be studied, including metallurgy, pin-site care solutions, and antibiotics.

Acknowledgments: The opinions or assertions contained herein are the private views of the authors and are not to be construed as official or as reflecting the views of the US Department of the Army or the US Department of Defense.

Dr. Stinner is Orthopaedic Surgeon, US Army Institute of Surgical Research, Fort Sam Houston, Texas. Dr. Hsu is Orthopaedic Surgeon, US Army Institute of Surgical Research, Fort Sam Houston, Texas, and Chief of Orthopaedic Trauma, Department of Orthopaedics and Rehabilitation, Brooke Army Medical Center, Fort Sam Houston, Texas. Dr. Iobst is Orthopaedic Surgeon, MCH Orthopaedic Surgery, Miami, Florida.

Address correspondence to: Daniel J. Stinner, MD, Department of Orthopaedics and Rehabilitation, Brooke Army Medical Center, 3851 Roger Brooke Dr, Fort Sam Houston, TX 78234 (tel, 210-916-5666; fax, 210-916-0559; e-mail, daniel.stinner@us.army.mil).

Am J Orthop. 2013;42(9):E68-E71.

References

1. Moroni A, Toksvig-Larsen S, Maltarello MC, Orienti L, Stea S, Giannini S. A comparison of hydroxyapatite coated, titanium coated, and uncoated tapered external fixation pins. *J Bone Joint Surg Am.* 1998;80(4):547-554.

2. Moroni A, Heikkila J, Magyar G, Toksvig-Larsen S, Giannini S. Fixation strength and pin tract infection of hydroxyapatite-coated tapered pins. *Clin Orthop*. 2001;(388):209-217.
3. Chao EY, Hein TJ. Mechanical performance of standard Orthofix external fixator. *Orthopedics*. 1988;11(7):1057-1069.
4. Wikenheiser MA, Markel MD, Lewallen DG, Chao EY. Thermal response and torque resistance of five cortical half-pins under simulated insertion technique. *J Orthop Res*. 1995;13(4):615-619.
5. Matthews LS, Hirsch C. Temperatures measured in human cortical bone when drilling. *J Bone Joint Surg Am*. 1972;54(2):297-308.
6. Green SA. Complications of external fixation. *Clin Orthop*. 1983;(180):109-116.
7. Paley D. Problems, obstacles, and complications of limb lengthening by the Ilizarov technique. *Clin Orthop*. 1990;(250):81-104.
8. Checkets RG, Otterburn M. Pin tract infection: definition, prevalence, incidence. Abstracts of the 2nd Riva Congress, Riva di Garda (Italy) University of Verona, University of Montpellier. I:98-99; 1992.
9. W-Dahl A, Toksvig-Larsen S, Lindstrand A. No difference between daily and weekly pin site care: a randomized study of 50 patients with external fixation. *Acta Orthop Scand*. 2003;74(6):704-708.
10. Lethaby A, Temple J, Santy J. Pin site care for preventing infections associated with external bone fixators and pins. *Cochrane Database Syst Rev*. 2008;8(4):CD004551.
11. Moroni A, Vannini F, Mosca M, Giannini S. State of the art review: techniques to avoid pin loosening and infection in external fixation. *J Orthop Trauma*. 2002;16(3):189-195.
12. Moroni A, Aspenberg P, Toksvig-Larsen S, Falzarano G, Giannini S. Enhanced fixation with hydroxyapatite coated pins. *Clin Orthop*. 1998;(346):171-177.
13. Magyar G, Toksvig-Larsen S, Moroni A. Hydroxyapatite coating of threaded pins enhances fixation. *J Bone Joint Surg Br*. 1997;79(3):487-489.
14. Moroni A, Caja VL, Maltarello MC, et al. Biomechanical, scanning electron microscopy, and microhardness analyses of the bone–pin interface in hydroxyapatite coated versus uncoated pins. *J Orthop Trauma*. 1997;11(3):154-161.
15. Mahan J, Seligson D, Henry SL, Hynes P, Dobbins J. Factors in pin tract infections. *Orthopedics*. 1991;14(3):305-308.
16. Gordon JE, Kelly-Hahn J, Carpenter CJ, Schoenecker PL. Pin site care during external fixation in children: results of a nihilistic approach. *J Pediatr Orthop*. 2000;20(2):163-165.
17. Holt J, Hertzberg B, Weinhold P, Storm W, Schoenfisch M, Dahners L. Decreasing bacterial colonization of external fixation pins through nitric oxide release coatings. *J Orthop Trauma*. 2011;25(7):432-437.
18. Collinge CA, Goll G, Seligson D, Easley KJ. Pin tract infections: silver vs uncoated pins. *Orthopedics*. 1994;17(5):445-448.
19. DiCicco JD, Ostrum RF, Martin B. Office removal of tibial external fixators: an evaluation of cost savings and patient satisfaction. *J Orthop Trauma*. 1998;12(8):569-571.
20. Ryder S, Gorczyca JT. Routine removal of external fixators without anesthesia. *J Orthop Trauma*. 2007;21(8):571-573.

This paper will be judged for the Resident Writer's Award.