The Journal of Foot & Ankle Surgery 58 (2019) 333–336

Contents lists available at ScienceDirect

The Journal of Foot & Ankle Surgery

journal homepage: www.jfas.org

Round Table Discussion

Cannulated Screws

Brian Carpenter, DPM, FACFAS[1], Donald Bohay, MD, FACS[2,3,4], John S. Early, MD[5,6], Meagan Jennings, DPM, FACFAS[7,8], Gregory Pomeroy, MD[9,10], John M. Schuberth, DPM[11], Dane K. Wukich, MD[12,13]

[1] *Professor, Department of Orthopaedic Surgery, The University of North Texas Health Science Center, Fort Worth, TX*
[2] *Clinical Professor, Department of Orthopaedic Surgery, College of Human Medicine, Michigan State University, East Lansing, MI*
[3] *Director, Grand Rapids Orthopaedic Foot and Ankle Fellowship Program., Grand Rapids, MI*
[4] *Adjunct Faculty, Michigan State University College of Osteopathic Medicine, East Lansing, MI*
[5] *Clinical Professor, Orthopaedic Surgery, University of Texas Southwestern Medical Center, Dallas, TX*
[6] *Staff, University of Texas Southwestern Medical Center, Texas Orthopaedic Associates LLP, Dallas, TX*
[7] *Attending Staff, Silicon Valley Foot & Ankle Reconstructive Surgery Fellowship, Mountain View, CA*
[8] *Staff, Sutter Health, Palo Alto Medical Foundation, Mountain View, CA*
[9] *Director, New England Foot & Ankle Specialist, Portland, ME*
[10] *Associate Clinical Professor of Surgery, University of New England, Biddleford, MA*
[11] *Attending Staff, Department of Orthopedic Surgery, Kaiser Foundation Hospital, San Francisco, CA*
[12] *Chairman, Department of Orthopaedic Surgery, UT Southwestern Medical Center, Dallas, TX*
[13] *Professor, Department of Orthopaedic Surgery, UT Southwestern Medical Center, Dallas, TX*

Keywords:
cannulated screws
foot and ankle surgery
expert opinion

The use of cannulated screws in foot and ankle surgery has increased over the years, but remains controversial and largely subject to surgeon preference. A research roundtable of questions has been submitted to 6 invited foot and ankle surgeons relative to their individual use of these cannulated devices. The purpose of this symposium is to explore some of the pertinent controversies between traditional solid screws and cannulated screws. With our current worldwide health care cost concerns, design, and manufacturing there will be a convergence in a quest for value in our implants. I am excited to have such an experienced and well-known group of foot and ankle surgeons participate in this dialogue.

1) **Is there any situation in foot and ankle surgery where a solid screw cannot be used and you must use a cannulated?**

Bohay: Not in the routine day-to-day surgical management in my opinion. The limiting variable in the question is "must use."

Early: NO.

Jennings: Solid core screws with attention to technique and detail can be inserted in any case. However, ease of insertion with cannulated screws especially in percutaneous fixation does make it a viable choice for many surgeons and possibly may allow better adherence to AO principles. For example, a mini-arthrotomy ankle fusion with percutaneous fixation often is easier through the soft tissues than solid core screw insertion.

Pomeroy: 1) Articular fractures with headless screws. 2) Talus fractures fixed from the back.

Schuberth: Although I do not think the described scenario really exists, there are a few instances where they might be preferable. Specifically, when there is a small volume of bone for screw thread purchase, a cannulated guide pin would remove less bone than a drill hole if the drill or pin were directed in a less than optimal anatomic location. Specifically, often when I am trying to capture the talus with the screw threads (ankle or subtalar fusion), I consider a cannulated screw. However, the difference in diameter between a 2.8-mm guide pin and 3.2-mm drill bit is arguably negligible.

Wukich: For me, medial column beaming for Charcot is a good example. You must get the guidewire in precisely the correct spot before drilling and screw placement.

2) **In your clinical setting how do you justify the higher cost of these implants to the third-party payer, the patient, or the hospital?**

Bohay: I do not use cannulated screws as a routine and teach our fellows and residents solid screw technique using AO principles. The cannulated screw itself is 3 to 4 times the price of a solid screw and the cannulated drills are in the range of $75.00 per drill bit. In our institution, this situation is difficult to reconcile financially to any party. However, if

Financial Disclosure: None reported.
Conflict of Interest: Donald Bohay discloses consultant roles with Stryker Corporation, Zimmer-Biomet Corporation, Wright Medical Technologies, and Nextremity, and the receipt of honoraria and other compensation from these companies. Gregory Pomeroy discloses a leadership role with Bespaglobal Consulting Firm.

Address correspondence to: Brian Carpenter, Department of Orthopaedic Surgery, 270 Private Road 3362, The University of North Texas Health Science Center, Paradise, TX 76073.
E-mail address: ankletrauma@gmail.com (B. Carpenter).

https://doi.org/10.1053/j.jfas.2018.08.035

the surgeon's skill set is such that using a cannulated screw system substantially enhances his or her performance, the balance may be neutral (ie, time in the operating room, fewer failures and revision surgeries).

Early: Decreasing the duration of surgery and limiting complications can justify cost.

Jennings: If a solid core screw is not feasible, then cannulated may certainly be preferable and its use outweighs the cost burden. Along with that, ease of use, saved operating room time, and other associated costs to soft tissue or surrounding structures of the patient due to repeated attempts at fixation, may outweigh the financial cost of a cannulated screw when used only in an absolute "as-needed basis." Because I rarely use them, I rarely need to justify cost.

Pomeroy: Only used when solid screws are not feasible.

Schuberth: I do not. Cannulated screws are not my default device and rarely used. It has been at least 15 years since I used a cannulated screw of less than 7.3 mm in diameter.

Wukich: Our operating room time is $90 per minute. Using a cannulated screw in a teaching program decreases operating room time considerably.

3) **In minimally invasive fracture repair techniques do you choose a solid or cannulated screw and why?**

Bohay: As a universal principle, any surgical fracture treatment holds the tenant to obtain anatomic reduction and stable fixation. I am a firm believer in this principle and it should take precedent over any "minimally invasive" fracture treatment. For instance, the percutaneous reduction and cannulated screw fixation of a displaced Lanfranc's injury will more often than not result in a malreduction. The literature supports anatomic reduction of the transverse tarsal joint as a prognostic indicator in the treatment of such fractures. On the other hand, the percutaneous fixation of a Jones fracture (fifth metatarsal metaphyseal/diaphyseal junction) is routinely addressed percutaneously but with the use of a solid screw.

In summary, the issue is anatomic reduction rather than screw type in my opinion.

Early: The type of screw chosen is determined by the situation. I am more likely to use a cannulated screw for large screw fixation 6.5/7.0 because I like the accuracy of first placing a wire before drilling. For smaller diameter screws I prefer noncannulated.

Jennings: Screw selection depends on the procedure. Often, I will do a cannulated preparation with pinning, drill, and then insert a solid core screw. Examples of procedures include medial malleolus fractures and Jones' fractures.

Pomeroy: Solid screws because they are simpler and cheaper.

Schuberth: I really do not think it makes a difference what type of surgery is being done. The principles are the same. I usually substitute the drill bit for the guide pin, and take a fluoroscopic image with the drill bit in place. If the drill is in the desired position, I put a solid screw in, percutaneously or open.

Wukich: Cannulated screw. Precise placement of the guidewire ensures that the screw will be where it is supposed to be. Often you only get 1 or 2 attempts to place a screw.

4) **Do you experience a higher complication rate with cannulated screws versus solid screws such as nonunions or hardware failure?**

Bohay: Anecdotally, the hardware failures we see in consultation are more often cannulated screw devices, but I do not have any data to support that.

Early: No.

Jennings: Because I rarely use cannulated screws, I would say I do not see a higher complication rate. However, depending on the procedure, such as a Lisfranc open reduction with internal fixation with a partially threaded cannulated screw, I have seen a number of those break at the screw runout and the fracture interface. Theoretically, a solid partially threaded screw would be stronger in this instance, but I have seen those break as well.

Pomeroy: Very limited use of cannulated screws.

Schuberth: Although this a global characterization, I have found that cannulated screws fail sooner than solid screws, and the purchase of partially threaded cannulated screws is often less than desired. Yet, I do not expect any screw to escape fatigue failure if the fusion or fracture interface has not united in a timely fashion.

Wukich: Yes, cannulated screws do fail more often. However, I believe that is not clinically significant. The only areas where I think solid screws are more beneficial are fifth metatarsal proximal fractures in elite athletes. In this case, I use a cannulated screw technique but insert a solid screw

5) **Do you think it is faster to put in a solid or a cannulated screw for fixation?**

Bohay: Faster? Well, that depends solely on the surgeon. If the skill set allows, the surgeon should be able to target a drill and follow with a screw as quickly as putting in a guide pin, overdrilling, and placing the screw. I guess because there is 1 less step putting in a solid screw

Early: As surgeons, we strive for accuracy and with that in mind placing a cannulated screw is faster with less potential for bone or adjacent joint injury. With the use of large screws placing a wire first ensures appropriate placement of the final screw without significant bone removal or destruction.

Jennings: Time for screw placement varies. Often with cannulated screws, the guide pin cold-welds to the drill and then you lose provisional fixation, which creates a 'fiddle factor' with cannulated systems. For solid core fixation, you have to plan ahead and place your provisional fixation so as to not interfere with your permanent fixation. The remaining steps are the same, however, so one does not save time. When working through deep tissue planes such as in tripod screw fixation for an ankle fusion, in my opinion, cannulated fixation is easier to keep the trajectory and place the screws.

Pomeroy: Solid.

Schuberth: With accurate target areas for the screw threads, there is no difference in time. I rarely use a tap in foot and ankle surgery, which can take additional time for solid screws.

Wukich: I think that the cannulated screw initially may take a minute or 2 longer; however, changing the position is much easier and ultimately saves time in a teaching program.

6) **With a fully threaded screw preventing shear at the fracture site and a partially threaded screw producing less compression at the fracture site, why do those who use cannulated screws primarily use partially threaded screws and should they switch to fully threaded?**

Bohay: Again, without using these systems it is difficult to comment. In my practice, I prefer to use solid core, fully threaded screws in the midfoot and forefoot and 6.5 mm/16 mm partially threaded solid screws for fusion procedures in the hindfoot and ankle using AO interfragmentary screw compression.

Early: My opinion is that surgeon's use partially threaded because they are easier and readily available. Most cannulated screws do not come fully threaded. To properly make a fully threaded screw act as a lag screw, there must be a large diameter drill present to oversize the proximal hole. That drill size is not available in many of the sets.

Jennings: I think a fully threaded cannulated screw (such as some of the headless fully threaded cannulated screws) makes more sense in this scenario. At least with a fully threaded cannulated screw, there is no runout on the screw midshaft as a weakness.

Pomeroy: I am not sure why and yes they should.

Schuberth: Good question. Except in ankle and subtalar fusions as described elsewhere, I do not use any partially threaded screws, cannulated or not! If I want compression, I overdrill. If I need purchase in both fragments for stability, I do not overdrill, particularly if the bone is softer.

Wukich: If you have an anatomic reduction, the use of a fully threaded screw increases your purchase and I agree they should switch.

7) **With cannulated screws now being used for bicortical fixation and being self-tapping/self-drilling with sharp protruding tips, do you worry about damage to nerves, vessels, or tendons?**

Bohay: This should not be a problem when a technically sound surgeon is using the devices.

Early: No. These are no different than their solid counterparts. You still have to get the length correct.

Jennings: I think with good techniques with drilling and screw placement, this should not be a huge issue.

Pomeroy: No.

Schuberth: Categorically, no, because I really try to measure the length accurately, cannulated or not. However, if I am later surprised that my screw is inadvertently too long, and in the anatomic locale of vital structures, I would worry a bit. Most often the patient will let you know if the screw is encroaching these structures.

Wukich: I do not. My technique it to place the guidewire to the far cortex and measure. I add 2 mm and then insert the guidewire through the far cortex.

8) **In removing partially threaded cannulated screws, have you experienced the screw head breaking off due to the ingrown bone in the cutting flutes and what is your technique to remove them if they do break?**

Bohay: I have not had that experience.

Early: Yes, I have, or the head becomes completely striped. The fact that the screws are cannulated can be helpful. In some of the available broken screw removal sets, there are tapered, reverse-threaded screw bits that can be inserted in the central hole to engage the screw shaft and aid in extraction. Failing that, appropriately sized trephine to drill over the screw shaft is the surest way to remove these screws.

Jennings: With any screw removal, I do my best to clear the surrounding bone with an osteotome before attempted removal. The advantage cannulated screws do have is that, if you need to remove them, the central hole allows guidewire placement or screw removal tools such as an easy out device.

Pomeroy: I have not experienced this. Would have to bore out.

Schuberth: A good reason not to use them! If they do break, the commercially available screw removal sets will enable retrieval. I try to plan every fixation construct with the "next operation" in mind, such that removal of offending hardware will not be a misadventure.

Wukich: Yes, I over-ream and remove that way. If lucky enough to have access to the far cortex, then it can be retrieved that way.

9) **Would using cannulated screws for an arthrodesis versus a solid screw affect your postoperative course?**

Bohay: Again, that is not my standard and I am unable to comment. However, the technical elements and results are primarily in patient selection, joint preparation, fusion position, and screw position. Regardless of implant selection, if these factors are not meticulously attended to, failure may become imminent.

Early: No. I do not see there being an appreciable difference between cannulated and solid screws in their resistance to micro motion. The important factor is the placement of fixation and joint preparation. Fixation will not make up for mistakes there.

Jennings: No. My postoperative course is the same and depends more on the patient's body mass index, bone quality, vitamin D levels, intraoperative fixation, meticulous joint preparation, and stability achieved; it does not depend on cannulated or solid screw fixation.

Pomeroy: No.

Schuberth: No. If I am concerned about the purchase in the operating room, I take the time to make it stable if possible, such that my postoperative course is not altered. Even if I did use cannulated screws, bony union depends more on the preparation and construct rather than the actual screw. "It's not what you use, but where you put it."

Wukich: It does not.

10) **If a surgeon thinks cannulated screws are faster and more accurate in their insertion does the additional cost of them justify their usage?**

Bohay: As I mentioned, this could be a determining factor on the financial side. However, the care of the patient and a technically correct operation should always outweigh the price of a screw in my opinion. If the surgeon cannot examine the patient, select an appropriate surgical option if indicated and perform the operation technically well in an efficient fashion, the selection of hardware is moot.

Early: NO. Not if it truly shortens his operating room time and decreases complications.

Jennings: I would need to see the data on this to truly make a recommendation. Complications, return to operating room, and operating room time—all would need to be reviewed to make a recommendation. Some surgeons may not be as technically savvy or skilled, and thus, ultimately, to get a comparable patient outcome, which is the highest priority, it may make sense to spend the money.

Pomeroy: No.

Schuberth: Surgeons are great rationalizers, but in some surgeons' hands the use of the cannulated screw probably is faster. The argument of the cost of running an operating room per minute is a weak one but frequently used by hospital accountants and the same surgeons who believe that the overall time savings translate into decreased overall costs.

Wukich: Yes.

11) **With the possibility of bundled payment arrangements for procedures affecting the physician's payments, do you think there will be a decrease in cannulated screw use?**

Bohay: This is again the argument of finances over patient care. However, it is a reality in the current medical environment. As I have mentioned, if the surgeon can perform the surgery better and more efficiently with better results using a cannulated screw system, then that is what he or she should use. Perhaps the bundle can be reassessed for savings in other areas to balance the cost of the implants. Certainly, in situations where a less expensive implant can be used and not change in anyway the result afforded to the patient, it should be considered.

Early: Surgeon response to bundled payments will probably depend on whether or not they are participating in the cost or savings. Without "skin" in the game, there is no incentive to change. Either the companies will lower their cost to gain equivalency or surgeons with an incentive to contain costs will use less.

Jennings: I believe the people that use them, use them out of necessity, and thus will continue to need to use them for whatever their reason(s) may be.

Pomeroy: I think the cost of cannulated screws will come down.

Schuberth: It should, but it probably will not. Some surgeons just will not let go and may feel paralyzed without cannulation. Only a substantial cost differential directly to the surgeon is likely to effect a change in use.

Wukich: It is possible that this will occur. However, the difference in the cost of a screw is much less than the difference in the cost of an implant. Bundling targets high-volume procedures like spine or joint arthroplasty. I suspect that focusing on the cost of screws in the foot and ankle will be negligible compared to a pedicle screw for the spine or a total joint implant. A primary total hip replacement or total knee replacement is about $3900 to $4000. Why is a total ankle $10,000 to $12,000?

Discussion

Although the opinions of these experienced surgeons vary somewhat, there is some consistency in the overall philosophy of indications and principles. The seminal issues of the cost of the hardware, ease of use, strength of fixation, and time for insertion all have bearing on the specific indications.

The cost of hardware is a major determinant in many health care markets. Cannulated screws are between 6 and 10 times more expensive than their solid counterparts. The manufacturing costs of both the cannulated screws and cannulated instrumentation largely contribute to this disparity, but it is also driven by the need for higher margins for the manufacturers to offset the cost of research and development.

The discussion of time saved in the operating room with cannulated screws is a polarizing one. In part, it is complicated by the many different billing methods that hospital systems have relative to operating room time (1). Moreover, disparate accounting methods among hospitals decrease the opportunity for meaningful comparative cost analyses. A recent study of operating room costs revealed an average of $62 per minute for operating room fee (2). The 2013 Becker's Hospital Review on operating room efficiency demonstrated a cost of $15 to $20 per minute for a basic surgical procedure (3). Regardless of the accounting or billing methods that are used, it is difficult to fully embrace the concept that cannulated screws may be faster (cheaper), because the time to insert these screws represents a small finite portion of the overall time in the operating room. Meaningful analysis of cost effectiveness is further confounded when multiple screws are used. With the increasing cost of health care and recent policy changes to decrease spending, requiring surgeons to disclose the costs of products they are using may be an effective way to control operating room spending henceforth (4).

In training situations or with inexperienced surgeons unaccustomed to precise targeting of screws, a hybrid technique has been described whereby a guide pin and cannulated drill are used to prepare the screw channel, but a solid core screw is used instead. (5) Ostensibly, this technique will save time and reduce costs.

Although one cannot dispute that solid core screws have more mechanical strength than a cannulated one of equal caliber, the impact of strength on the ultimate outcome of the surgical procedure is obtuse. One would expect cannulated screws to fail with cyclical load earlier than the solid core counterpart. However, it most likely would not matter if biologically induced nonunion was evolving. Although it is intuitive that a solid core screw would better resist bending forces early in the bony consolidation phase, definitive thresholds for any surgical procedure have not been established that would compel the use of certain screws in certain situations.

Although one cannot dispute that fully threaded screws prevent shear and strain (6), using a fully threaded versus a partially threaded screw takes longer to put in. This is due to 1 more step of overdrilling, so you have a glide hole for compression and not all cannulated screw sets have the over drill bit. Not all companies that make cannulated screws have a fully threaded version and only manufacture a partially threaded one as well.

This roundtable discussion has captured the most contemporary issues regarding the use of cannulated screws. It is clear that sophisticated technology is more expensive. Although we did not resolve the dilemma of cost effectiveness herein, we have identified that scientifically sound data are necessary before we can make firm recommendations for or against cannulated screws. Perhaps the use of cannulated screws would change if surgeons, patients, and payers were more vulnerable to absorbing all or a share of the increased cost.

References

1. Patterson P. How surgery departments charge for OR time. OR Manager Web Site November 2011;27(11). Available at: http://www.ormanager.com/wp-content/uploads/pdfx/ORMVol27No11ORCharging.pdf. Accessed October 7, 2017.
2. Macario A. What does one minute of operating room time cost? J Clin Anesth 2010;22(4):233–236.
3. Gamble M. 6 Cornerstones of operating room efficiency: best practices for each Becker's Hospital Review Web SiteAvailable at: https://www.beckershospitalreview.com/or-efficiencies/6-cornerstones-of-operating-room-efficiency-best-practices-for-each.html. January 18, 2013. Accessed November 2, 2017.
4. Austin LS, Tjoumakaris FP, Ong AC, Lombardi NJ, Wowkanech CD, Mehnert MJ. Surgical cost disclosure may reduce operating room expenditures. Orthopedics 2017;40(2):269–274.
5. Wukich DK, Dial DM. Rigid stabilization of partial incongruous Lisfranc dislocations: a cannulated solid screw technique. Foot Ankle Online J 2009;2(6):4.
6. Downey MD, Kosmopoulos V, Carpenter BB. Fully threaded versus partially threaded screws: determining shear in cancellous bone fixation. J Foot Ankle Surg 2015;54(6):1021–1024.