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QUESTION 3: When performing intramedullary (IM) fixation, what is the evidence regarding reaming versus non-reaming and the association with infection?

RECOMMENDATION: Based on the current evidence, there is no difference in infection rates following IM fixation of long bone fractures using a reamed or non-reamed technique.

LEVEL OF EVIDENCE: Moderate

DELEGATE VOTE: Agree: 100%, Disagree: 0%, Abstain: 0% (Unanimous, Strongest Consensus)

RATIONALE

Using an IM fixation technique has become the accepted standard in treating long bone fractures. Tibial fractures are the most common type of long bone fracture encountered and therefore are the most studied in the current literature [1,2]. Evidence has supported that IM nailing is superior to external fixation with regards to patient outcomes [3–5]; however, there has not been a consensus with regard to reamed versus non-reamed IM nailing technique.

Classically, the arguments against the use of reaming point to the risk of fat embolization from the marrow-generated from the increased intramedullary pressure created during the technique, and development of acute respiratory distress syndrome (ARDS) [6,7]. Also, long bone fractures are often the result of high-energy injuries and are accompanied with varying degrees of periosteal stripping [4]. This inherent soft tissue damage can predispose patients to complications, such as infections, especially in open fractures. In addition to the soft tissue compromise secondary to the trauma, reaming has also been shown to disrupt endosteal blood flow and to cause thermal necrosis of the bone [4,7]. This is thought to have the potential to further increase the risk of infection due to added insult to the soft tissue [4]. To avoid such adverse effects and complications, a non-reamed IM nailing technique was developed.

Despite the described adverse results of reaming, current literature has not convincingly proven an association between reaming and infection rates. Finkemeier et al. conducted a prospective, randomized study analyzing 94 patients with closed and open tibial fractures treated with either reamed or non-reamed IM nailing [8]. There was no statistically significant difference in the infection rate between the two study groups. When comparing infection rates of only closed fractures treated with reamed and non-reamed techniques (4% vs. 4%, p = 0.945), no statistical difference was observed [8]. Open fractures also had no significant difference in infection rates when treated with the studied techniques (5% reamed vs. 4% non-reamed, p = 0.851) [8]. Similarly, Blachut et al. conducted a prospective study of 141 fractures randomized into reamed and non-reamed groups and found no increased rate of infection [9]. Both of these studies noted that their smaller sample sizes could limit the quality of the evidence they presented [8,9].

A much larger prospective, blinded randomized trial was conducted by the Study to Prospectively Evaluate Reamed Intramedullary Nails in Patients with Tibial Fractures (SPRINT) investigators [1]. This study randomized 1,319 tibial shaft fractures into reamed or non-reamed cohorts and did not allow re-operations for nonunion to occur before six months in order to effectively evaluate the outcomes of the techniques [1]. The results of their study found a statistical difference in the relative risk (RR) of a primary event when a reamed technique was used in a closed tibial fracture (RR = 0.67 confidence interval (CI), 0.47-0.96, p = 0.03) [1]. The RR of an infection in a closed fracture, however was not statistically significant when comparing the reamed and unreamed groups (RR = 1.37, CI 0.48-3.93, p = 0.56) [1]. The same was seen in open fractures when comparing the infection rates of the two techniques (RR = 1.27, CI 0.67-2.40, p = 0.46) [1]. The SPRINT trial was unable to draw any conclusions about risks of infections between reamed and non-reamed techniques due to disparity between the study groups. The authors of the study noted that there was potential bias in their study, for their surgeons had more expertise with the reamed technique [1]. This could have biased their data against the non-reamed group.

A systematic review and meta-analysis of a pooled group of 646 patients conducted by Bhandari et al. found a RR of reamed versus nonreamed IM nails of 0.98 (CI 0.21-4.76, p = 0.86) for rate of infection [10]. They did note trends in favor of reamed IM nailing with closed fractures and nonreamed IM nails in open fractures. Due to the lack of significance in the results, however, they were unable to draw definitive conclusions pertaining to infection rates between the studied techniques [10]. Foote et al. conducted a network meta-analysis to analyze all treatment options for open tibial shaft fractures [2]. Similar to Bhandari et al., they were unable to find a difference between reamed and non-reamed IM techniques (direct evidence non-reamed vs. reamed odds ratio (OR) = 0.74, CI 0.45-1.24) [2].

A third systematic review was also unable to establish a statistically significant difference between infection rates when using a reamed technique as opposed to a non-reamed technique (RR = 1.19, CI 0.71-2.00) of the 1,545 patients included in this analysis [11]. Of note, the Duan et al. systematic review was heavily dominated by the inclusion of the SPRINT trial which contributed the majority of the patients to the overall analysis and was cited as a potential weakness of their study [11].

Despite concern of an increased rate of infection when a reamed technique is used for IM nailing, current evidence has been unable to elucidate a difference between reamed and non-reamed IM nails in this regard. There are several studies addressing the issue, however smaller sample sizes in all of these studies prevents one from drawing a definitive conclusion [8,9,11]. In addition, the current literature focuses primarily on outcomes aside from infection. The high-energy nature of fractures treated with these techniques as well as the open/closed nature of the injury can also be confounding factors limiting many authors' ability to draw definitive conclusions. Therefore, there is no conclusive evidence linking

IM reaming with increased rates of infection when compared to non-reamed techniques.

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QUESTION 4: Are antibiotic coated rods (ACRs) and antibiotic coated plates (ACPs) an acceptable alternative to cement only implants?

RECOMMENDATION: Antibiotic-loaded polymethyl methacrylate (AL-PMMA) spacers can be considered an established treatment concept for local antibiotic delivery in osteomyelitis and implant-associated infections.

ACRs and ACPs can also be of value in specific indications, mainly infected non-unions, in order to address both local delivery of antibiotics and biomechanically stable fixation of the non-union site to allow for possible spontaneous bone consolidation.

LEVEL OF EVIDENCE: Limited

DELEGATE VOTE: Agree: 91%, Disagree: 5%, Abstain: 4% (Super Majority, Strong Consensus)

RATIONALE

Biomechanically stable ACRs, such as antibiotic coated interlocking nails, and ACPs exhibit the advantage of additionally providing sufficient biomechanical stability to allow for bone healing in infected non-unions compared to antibiotic delivery only by biomechanically unstable drug carriers. There are only a few limited case series available on biomechanically stable ACRs [1–4] and ACPs with the study of Conway et al. being the largest with 110 patients on locked ACRs that were retrospectively analyzed [1]. A good overall clinical outcome could be accomplished with an overall limb salvage rate of 95% (105/110 patients) in infected non-union and infected arthrodesis.

For ACPs, there is only one case report and one case series with four patients all of whom showed healing of the formerly infected fracture by the use of the ACPs [5,6].

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