In Brief

Intraosseous Regional Administration of Vancomycin Prophylaxis for Primary and Revision Total Knee Arthroplasty

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Received: 28 March 2023 *Accepted: 12 November 2023*

Abstract

The advantages of prophylaxis with intraosseous regional administration (IORA) of vancomycin for periprosthetic joint infection (PJI) in primary and revision total knee arthroplasty (TKA) include the ability to deliver antibiotics directly to the surgical bed and avert systemic delivery; the ability to precisely time and quickly administer vancomycin to achieve the highest concentrations at the beginning and throughout the surgical procedure; and the ability to avert several common and potentially serious adverse effects of intravenous vancomycin. Indications for IORA of vancomycin prophylaxis include the following clinical scenarios: revision TKA; obesity; diabetes; beta-lactam allergy; known colonization with methicillin-resistant Staphylococcus aureus (MRSA); individuals coming from institutions with a high MRSA incidence; previous ligamentous surgical procedure or osteotomy; current or recent smokers; in the primary TKA setting if the individual is considered high-risk as defined by the criteria above; and during reimplantation following 2-stage exchange for PJI.

Level of evidence: III

Keywords: Intraosseous regional administration, Periprosthetic joint infection, Primary, Revision, Total knee arthroplasty, Vancomycin prophylaxis

Introduction

Vancomycin has been suggested as an alternate prophylactic antibiotic in total knee arthroplasty (TKA). Intraosseous regional administration (IORA) has been recognized as achieving notably higher antibiotic concentrations than systemic administration and might permit the utilization of a lower vancomycin dose.[1-9]

The purpose of this "in brief" article is to define the current role of prophylactic antibiotic IORA for periprosthetic joint infection (PJI) in primary and revision TKA.

Main body

On March 22, 2023, a literature search was conducted in PubMed. Using "intraosseous antibiotics TKA" as a keyword, 21 articles were found, of which 11 were ultimately analyzed. The inclusion criteria were based on our subjective opinion regarding the relevance of the article content in relation to the title of this article.

According to Arthur et al, an intraosseous needle must be inserted into the proximal medial face of the tibia, just medial and only slightly above the level of the tubercle.[3] A large syringe with the desired antibiotic dose (typically 500 mg vancomycin suspended in normal saline solution) must be connected to the needle, and the solution must be administered over 1 to 2 minutes. The intraosseous needle can then be withdrawn and the surgical procedure continued. These authors preferred employing a power driver (EZ-IO; Teleflex Corp, San Antonio, TX, USA) [Figure 1]; however, manual needles (Cook Medical, Bloomington, IN, USA) can also be used.[3]

Regarding primary TKA, Chin et al stated that IORA optimized the timing of vancomycin administration and resulted in high tissue antibiotic concentrations during TKA in a high-risk patient group.[1] Harper et al found no substantial differences in the complication percentage or creatinine values between the IORA and IV cohorts.[2]

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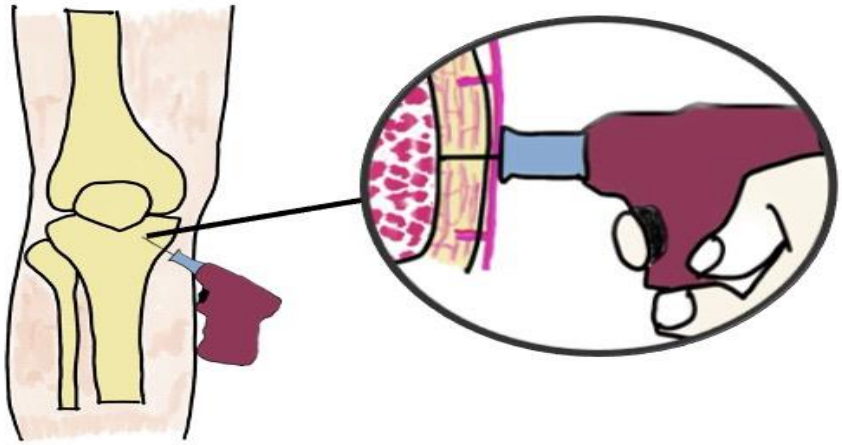

Figure 1. Intraosseous regional administration (IORA) of vancomycin in total knee arthroplasty (TKA) with power driver (EZ-IO,Teleflex Corp, San Antonio, TX, USA)

According to Arthur et al, IORA of vancomycin had several distinct advantages over other methods of antibiotic delivery [Table 1]. [3] Indications for IORA of vancomycin are shown in [Table 2].[3] [Table 3] summarizes IORA studies of vancomycin in primary and revision TKA.[1-11]

Table 1. Advantages of intraosseous regional administration (IORA) of vancomycin prophylaxis over other methods of antibiotic delivery[3]
Capability to deliver antibiotic directly to the surgical bed and avert systemic delivery.
Ability to precisely time and quickly administer antibiotics to accomplish highest concentrations at the beginning of and throughout the surgical procedure.
Capability to avert several common and potentially serious side effects, especially those associated with systemic vancomycin.

Table 2. Indications of intraosseous regional administration (IORA) of vancomycin prophylaxis [3]
Revision TKA.
Obesity (BMI >40 kg/m^2).
Diabetes.
Beta-lactam allergy.
Known colonization with MRSA.
Individuals coming from institutions with a high incidence of MRSA.
Previous ligamentous surgical procedure or osteotomies.
Current or recent smokers.
In the primary TKA setting if the individual is considered high-risk as defined by the criteria above.
During reimplantation following two-stage exchange for PJI.

TKA, total knee arthroplasty; BMI, Body mass index; MRSA, methicillin-resistant Staphylococcus aureus; PJI, periprosthetic joint infection

Table 3. Studies on intraosseous regional administration (IORA) vancomycin prophylaxis in primary and revision total knee arthroplasty (TKA)

AUTHORS [REFERENCE]	YEAR	TYPE OF STUDY	RESULTS	CONCLUSIONS
Chin et al [1]	2018	PRIMARY TKA: Randomized clinical trial.	Low-dose IORA was efficacious in the high-BMI population cohort, rendering tissue concentrations of vancomycin 5-9 times higher than systemic administration.	IORA optimized timing of vancomycin administration and rendered high tissue antibiotic concentrations during TKA in a high-risk patient cohort.
Young et al [8]	2018	REVISION TKA: Randomized controlled clinical trial	IORA administration of vancomycin in individuals experiencing revision TKA led to tissue concentrations of vancomycin five to 20 times higher than systemic IV administration in spite of the lower dose. High tissue concentrations were kept throughout the procedure despite a period of tourniquet deflation.	The preliminary results of this study justified prospective cohort studies, which might focus on broader safety endpoints in more diverse patient populations.
Harper et al [2]	2020	PRIMARY AND REVISION TKA: Retrospective review of patients.	There were 100 primary and 29 revision TKA cases in the control (IV) arm and 100 primary and 19 revision TKA cases in the intervention (IORA) arm. There were fifteen 30-day adverse events and eighteen 90-day adverse events.	IORA of vancomycin had an appropriate safety profile in primary and revision TKA, eliminating the logistical challenge of timely prophylactic antibiotic administration.
Arthur et al [3]	2020	PRIMARY AND REVISION TKA: Clinical study.	IORA (500-mg dose of vancomycin suspended in a solution of 140 mL of normal saline solution) can be used even in the primary TKA setting if the individual is considered high-risk.	These authors utilized IORA during reimplantation following two-stage exchange for PJI.
Klasan et al [4]	2021	PRIMARY TKA: Retrospective review.	All individuals received 500 mg of IORA of vancomycin after tourniquet inflation and 3 × 1 g IV cefazolin in 24 hours.	IORA of vancomycin in addition to standard IV systemic cefazolin prophylaxis in TKA was safe without significant adverse effects of vancomycin.
Park et al [5]	2021	PRIMARY TKA: Retrospective review of primary TKAs: IV versus IORA vancomycin at 30-day, 90-day, and one-year follow-up.	Incidence of PJI with minimum 90-day follow-up was 1.4% (eight knees) in the IV cohort and 0.22% (one knee) in IORA cohort. This study showed a decrease in the prevalence of infection in TKA utilizing IORA vancomycin combined with a first-generation cephalosporin.	IORA delivery of vancomycin after tourniquet inflation was a safe and efficacious alternative to IV administration, eliminating the logistical challenges of timely dosing.
Parkinson et al [6]	2021	PRIMARY TKA: Retrospective comparative study (level 3 of evidence).	Although BMI, diabetes, and renal failure were identified as infection risk factors, the utilization of IORA antibiotics did not result in a lower PJI risk compared with IV antibiotics.	Surgeons should consider IORA in primary TKA to diminish the risk of early PJI.
Wells et al [10]	2022	PRIMARY TKA: Review article.	Recently, large-scale retrospective studies have shown lower PJI rates following TKA when IORA was utilized when compared to routine IV prophylaxis.	These authors proposed an evidence-based method for IORA in TKA.
Spangehl et al [7]	2022	PRIMARY TKA: Randomized clinical trial (level 1 of evidence).	Median vancomycin concentrations in tissue were significantly higher (5-15 times) at all time points in the IORA cohort. There were no adverse events related to IORA.	Low-dose vancomycin IORA accomplisheD tissue concentrations 5-15 times higher than those accomplished by IV administration.
Miltenberg et al [11]	2023	PRIMARY TKA: Systematic review.	Perioperative IORA of antibiotics in TKA rendered local tissue concentrations of antibiotics that WERE on average 10 times higher than IV administration alone.	IORA should be considered in high-risk individuals where elevated tissue antibiotic concentrations would be of a maximum benefit.
Lachiewicz [9]	2023	REVISION TKA: Prospective single-surgeon consecutive series.	In 20 patients having aseptic revision TKA, 500 mg of vancomycin in 120 mL of saline were infused into the tibia prior to incision, in addition to IV cefazolin. The knees were aspirated in the operating room prior to IV and IORA antibiotics.	In this study, there was no added benefit of IORA vancomycin infusion, but there were no infections with MRSA.

TKA, total knee arthroplasty; IV, intravenous; BMI, body mass index; PJI, periprosthetic joint infection; MRSA, methicillin-resistant Staphylococcus aureus

Conclusion

Low-dose (500 mg) IORA of vancomycin prophylaxis should be considered in high-risk patients undergoing primary TKA. However, additional studies are required before this technique should be routinely advised in revision TKA.

Acknowledgement

Not applicable

Conflict of interest: None

Funding: None

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