Low Post-Arthroplasty Infection Rate is Possible in Developing Countries: Long-Term Experience of Local Vancomycin Use From A High-Volume Tertiary Knee Center in Iran

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Research article

Keywords: vancomycin, total knee arthroplasty, prosthetic infection, superficial wound infection, antibiotic therapy

Posted Date: June 1st, 2020

DOI: https://doi.org/10.21203/rs.3.rs-31299/v1

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Version of Record: A version of this preprint was published on March 17th, 2021. See the published version at https://doi.org/10.1186/s13018-021-02344-2.
Abstract

**Background:** Significant research has been carried out for prevention and also early detection of post-TKA infections. Regarding prevention, utilizing intrawound vancomycin powder in TKA surgery has yielded rather contrasting results in the pertinent literature. Regarding early detection, CDC criteria, although effective in general, are not specifically designed for post-TKA infections. Here, we present a 7-year experience of primary TKA in a high-volume tertiary knee center in Iran, during which intrawound vancomycin powder was used as a routine practice at the end of TKA surgeries. Also, new criteria are proposed to detect suspected superficial post-TKA infections.

**Methods:** This is a retrospective analysis of primary total knee arthroplasties performed in a tertiary knee center, from March 2011 to December 2018, by a single senior knee surgeon. All patients with follow-up periods of less than one year were excluded from the study. All patient received vancomycin (powder, 1gr) before water-tight closure of the joint capsule.

**Results:** Altogether, 1710 patients were included in the study. Patients were mostly women (male to female ratio: 1 to 4), with a mean age of 64.99 (SD=11.49) years. The overall infection rate was 2.16% (37 of 1710 patients), including 5 periprosthetic deep joint infections and 32 suspected superficial wound infections. Of the 32 suspected superficial infections that were treated with a one-week course of oral antibiotics, all reported disappearance of symptoms, but 2 cases returned with late deep infection. All in all, 7 patients (0.41%) underwent two-stage knee arthroplasty due to deep joint infections.

**Conclusions:** Our experience shows that by utilizing intrawound vancomycin for 7 years as a routine practice along with other measures, we were able to reach relatively low rates of deep post-TKA infections. Howbeit, randomized controlled trials are required to clarify the effect of intrawound vancomycin on post-TKA infection rate.

**Background**

Joint replacement enhances function and alleviates pain in a completely destructed knee, but requires implementing high technical perfection by surgeons or it could result in devastating consequences (1). Deep periprosthetic joint infection (PJI) following total knee arthroplasty (TKA) usually needs treatment by two-stage revision arthroplasty (2, 3). It causes significant bone loss, as well as substantial injury to soft tissue structures and could necessitate higher-constraint prostheses with lower reported survivals (4); ergo, even the lowest infection rate is too high to be accepted by the surgeon or the patient after TKA and reducing infection rate has always been a challenge (3–6). This is especially true in Iran, where heavy economic sanctions have caused revision devices and prostheses less available. Thus, PJI after TKA, is an intolerable complication in Iran.

Much research has been carried out for prevention and also early detection of post-TKA infections (2, 5–10). Regarding prevention, a recent topic is utilizing intrawound vancomycin powder. Separate in vivo rat investigations (11, 12) have demonstrated the effectiveness of intrawound antibiotics in clearing
Staphylococcus aureus from contaminated femoral implants. Intraoperative use of vancomycin powder has also been shown to be effective in reducing the chance of infection in spine surgeries (13–15), but literature on its use in TKA surgery has yielded rather contrasting results (16–18).

Regarding early detection, the latest consensus on PJI has provided some valuable criteria to diagnose a deep infection (19), but literature on the detection of superficial infection after TKA is not clear (20, 21). Some studies (21) have used the US Centers for Disease Control and prevention (CDC) criteria for identifying surgical site infections which were defined by the CDC in 1992 as those occurring within 30 days of surgery (22). CDC criteria although effective in general, are not specifically designed for post-TKA infections. In fact, most TKA patients experience pain, tenderness and swelling at the surgical site. Furthermore, it does not seem logical to wait for wound drainage and positive cultures to intervene.

In the current study superficial incisional infections (SII) were suspected, in case of any signs of erythema and/or warmth and/or itching and/or increased local pain on surgical site. We present a 7-year experience in a high-volume tertiary knee center in Iran, during which along with other measures, intrawound vancomycin powder was used as a routine practice at the end of TKA surgeries and we set out to report our findings as well as discuss the reasonable explanations.

**Methods**

This is a retrospective analysis of primary total knee arthroplasties performed in a tertiary knee center, from March 2011 to December 2018. All cases with follow-up periods of less than one year were excluded. Records of each patient’s age, gender, operation time and length of stay in hospital after surgery were collected. Rates of superficial and deep infection are reported along with a detailed report on comorbidities of the infected cases.

We classified all patients with any of the following 5 criteria including erythema and/or warmth and/or itching and/or increased local pain at the surgical wound as suspected cases of SII and treated them with a one-week course of oral Levofloxacina 500mg twice daily. None of them were proved to be infections, as no culture sample was analyzed. We used the proceedings of the Philadelphia consensus as a guide to diagnose deep periprosthetic infections (19).

All patients underwent cemented TKAs without patellar replacement (NexGen, Zimmer Biomet prostheses until July 2017 and Persona Zimmer Biomet prostheses since then). As an infection prevention measure, intrawound vancomycin (powder, 1 gr) was used at the end of all TKA surgeries right before tightly closing the joint capsule. It is worth mentioning that in addition to intrawound vancomycin, intra-articular injection of tranexamic acid was also performed as a routine practice, and its use was previously published from this center (23). Data are reported as means, standard deviations (SD) and percentages. Statistical analysis was performed using SPSS software version 25 (IBM corporation).

**Results**
Amidst a total of 2080 TKAs performed during the study time period, 1710 patients had a minimal documented follow-up period of one year and were included in the study. Demographic data are depicted in Table 1. Patients were mostly women (male to female ratio: 1 to 4), with a mean age of 64.99 (SD = 11.49) years.

| Characteristics                     | Number of patients |
|-------------------------------------|--------------------|
| Female (%)                          | 1393 (81.45)       |
| Mean age (SD)                       | 64.99 (11.49)      |
| Mean Length of hospital stay (SD)   | 3.13 (4.07)        |
| Mean Operation time (SD)            | 60.30 (44.19)      |
| Superficial Incisional Infection (%)| 32 (1.87)          |
| Deep Joint Infection (%)            | 7 (0.41)           |

Table 1
General preoperative characteristics of the patients

Taking both suspected and definite infections into account, the overall infection rate was 2.16% (37 of 1710 patients), including 5 periprosthetic deep joint infections and 32 suspected SIIs. Besides, from the 32 suspected superficial infections that were treated with oral Antibiotics, all reported disappearance of symptoms yet 2 cases returned with late PJI. Except 7 cases, all cases of suspected SII were detected close to one month after surgery. There were no cases of early PJIs defined as those occurring over the first 6 weeks after surgery. Thereupon, no polyethylene exchange was performed over the studied time frame. All in all, 7 patients (0.41%) underwent two-stage knee arthroplasty due to deep joint infections.

A detailed report on comorbidities for the patients who developed superficial infection, is provided in Table 2. The most common characteristics among this group of patients were age > 60 years, followed by obesity and diabetes mellitus in order. Except one, every one of them had at least one comorbidity. All PJI cases were females.
| Case No. | DM | RA | KD | Obesity | Age>60 y |
|---------|----|----|----|---------|---------|
| 1       | +  | -  | +  | +       | +       |
| 2       | +  | -  | +  | +       | +       |
| 3       | +  | -  | -  | +       | +       |
| 4       | +  | -  | -  | +       | +       |
| 5       | +  | -  | -  | +       | +       |
| 6*      | -  | +  | -  | +       | +       |
| 7       | -  | -  | -  | +       | +       |
| 8       | +  | -  | -  | -       | -       |
| 9       | -  | -  | -  | +       | +       |
| 10      | +  | -  | -  | +       | +       |
| 11      | +  | -  | -  | +       | +       |
| 12      | +  | -  | -  | +       | +       |
| 13      | -  | +  | -  | -       | +       |
| 14      | +  | -  | -  | +       | +       |
| 15      | +  | -  | -  | +       | +       |
| 16      | -  | -  | -  | +       | +       |
| 17      | +  | -  | -  | -       | +       |
| 18      | +  | -  | -  | +       | +       |
| 19      | +  | -  | -  | +       | +       |
| 20      | +  | -  | -  | +       | +       |
| 21      | +  | -  | -  | +       | +       |
| 22      | -  | +  | -  | +       | +       |
| 23      | +  | -  | -  | +       | +       |
| 24*     | +  | -  | -  | +       | +       |
| 25      | +  | -  | -  | +       | +       |
| 26      | -  | -  | -  | -       | +       |
| 27      | -  | -  | -  | +       | +       |
| 28      | -  | -  | -  | -       | +       |
Table 2
Comorbidities of the 32 patients with SII. Cases who finally developed deep infection are marked with a star.

**Discussion**

This is a retrospective analysis of a 7-year experience of a single knee surgeon from a tertiary knee center, during which a total of 1710 knees underwent primary total joint replacement. Patients include those from all over Iran. The mean age, mean duration of surgery and mean Length of stay for all of them with more detailed data on comorbidities and final outcome of those who were diagnosed to have superficial or deep infections are presented.

The mean length of stay in our study was 3.13 days (SD = 2.12), which is somewhat higher than recent reports (24, 25). In our center, preoperative planning and paraclinical work-ups of patients were performed on an outpatient basis. Only after determining precise surgical plans, having prepared required devices, and optimizing their medical states, were TKA candidates scheduled for surgery. Patients were admitted to the hospital early in the morning and then underwent surgery the same day and if alert and well, patients were discharged the next morning. The only exceptions were those patients coming from distant cities or rural places of the country who neither had a place to stay in Tehran nor could come back any sooner than 2 months after surgery. These patients sometimes were discharged after a week or two, until knee range of motion was secured and the surgical wound completely healed. Of our TKAs, 90% were discharged in less than 6 days and 60% were discharged in less than 3 days after surgery.

Mean age in our study population was 64.99 years (SD = 11.49), which is somewhat younger than that of similar studies (21), despite the fact that people here refer for surgery at the latest stages of knee joint destruction. This obvious lower age of TKA candidates in Iran could be due to the Middle-eastern lifestyle which is characterized by high-flexion activities such as praying, sitting on the ground and using Iranian toilets which needs squatting.

Previously it has been proved that increased operative time could result in higher complication rate especially infection, venous thromboembolism (VTE) and patient dissatisfaction (24, 26–31). Each TKA
surgery in this study took an average of 60.30 minutes (SD = 44.19) from incision to wound dressing, which is comparable to other reports (27, 32).

There were 32 cases (1.87%) of suspected superficial infections and no cases of early PJI. Seven cases of late PJI (0.41%) were diagnosed and underwent two-stage revision arthroplasties, among whom 2 patients had a history of being treated for suspected SII. Our rate of PJI is in concert with recent reported rates (21). Multiple factors affect post-TKA infection rates.

A discussion needs to be made on how to diagnose superficial incisional infections after TKA. To the best of our knowledge, there is no unified approach in the literature on this matter and CDC criteria are not designed, specifically for post-TKA infections. Our approach was to detect all cases suspected of having a superficial incisional infection and treating them with a short course of antibiotics. We can’t be sure if these 32 cases were in fact, infections, or solely inflammations or hypersensitivity reactions to Monocryl stitches. There was a 6-month period of time from April 2016 to September 2016, when an increase in these cases was observed (10 cases). After intense scrutiny, we found similar reports from other centers in Tehran using the same brand of Monocryl as ours. After switching to rapid Vicryl, the SII rate declined. The role of stitches in TKA wound complications has been reported before (33). We cannot still be sure how many suspected SIIIs were actually stitch reactions. Howbeit, the fact that most cases happened close to one month after surgery (the time that Vicryl starts to resorb) makes this explanation more convincing. Indeed, it seems that even the quality of stitches we used has been seriously affected by tight economic sanctions. There were no records of SII over the last year of the study time.

There were some key routine practices that possibly prevented higher infection rates in our study.

First and foremost, it is the oriented and highly trained operating room (OR) personnel who understood the importance of infection control and strict infection prevention standards. The second probable factor, could be the use of intrawound vancomycin powder before water-tight closure of the joint capsule. We routinely used vancomycin powder in the wound at the end of all TKA surgeries and this could have helped lower the infection rate. The effect of vancomycin powder on infection rate has not been proved in TKA (16–18), in contrast to spine surgery where it has been well established (13–15). This effect cannot be proved based on the current study either, as we had no control groups to compare our results. Large prospective randomized trials are required to evaluate the effect of intrawound vancomycin in post-TKA infection rate. In the current study, despite the inability to claim its effectiveness, we do report low infection rates in a 7-year experience we have had using intrawound vancomycin as a routine practice.

Third is our approach to early wound infection. During postop follow-up examinations, if the surgical wound showed signs of erythema and/or warmth and/or itching and/or increased local pain at the surgical wound, superficial incisional infection was suspected and a one-week course of oral Levofloxacin 500mg twice daily was prescribed. This might have been a factor in the low rate of PJI among our recorded cases of SIIIs. We do not use CDC criteriae for surgical site infection, as it is not specifically designed for knee arthroplasty. Pain, tenderness and/or swelling which are mentioned in CDC criteria, occur in the early postoperative period of most TKAs and do not seem specific enough to
diagnose a superficial infection. In fact, in knee arthroplasty, due to cumbersome management and poor outcomes of PJI, we need early diagnosis of any superficial infection and wound drainage or positive culture mentioned in the CDC criteria would procrastinate diagnosis and prevent early intervention.

This study has serious limitations. It is a retrospective analysis, with no control group. Thus, no claim can be made as to the effectiveness of intrawound vancomycin in TKA surgery from this study. Nonetheless, it shows a successful experience to reach low rates of infection in developing countries by using intrawound vancomycin along with other measures especially water-tight repair of joint capsule, intrawound injection of tranexamic acid at the end of the operation and implementing highly sensitive criteria to detect postop SII. That being said, deciding on the effectiveness of intrawound vancomycin still needs randomized controlled trials specific to its use in knee arthroplasty surgery.

**Conclusion**

Our experience shows that by utilizing intrawound Vancomycin for 7 years as a routine practice along with other measures, we were able to reach relatively low rates of superficial and deep post-TKA infections.

**Abbreviations**

TKA: Total Knee Arthroplasty  
SII: Superficial Incisional site Infection  
PJI: Periprosthetic Joint Infection  
CDC: US Centers for Disease Control and Prevention  
OR: Operating Room  
VTE: venous thromboembolism  
SD: Standard Deviation

**Declarations**

**Consent for publication:**

Not Applicable.

All authors declare that there were no competing interests for this study.

Institutional Review Board confirmed the current study.
Availability of data and materials:

The datasets used and/or analyzed during the current study are available from the corresponding author on reasonable request.

Funding:

No funding was received for the current study.

Acknowledgements:

Authors of this paper wish to acknowledge the valuable comments of the reviewers who add valuable insight to papers despite their busy schedule.

Authors' contributions and information:

MNT was the senior Orthopaedic surgeon who performed all the analyzed TKAs and also helped in data gathering as well as writing the manuscript. FV helped in study design, statistical analysis, and writing the manuscript. ASV was assistant surgeon and helped in Study design, data gathering and preparing the manuscript. MT was assistant surgeon and also helped in writing the manuscript. MK was assistant surgeon and helped in Data gathering and preparing the manuscript and submission. HR helped in data gathering and manuscript preparation.

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