

Proper Timing of Prophylactic Antimicrobial Administration in Orthopedic Surgeries

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Original Research Article

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Article History

Received: 15.02.2018

Accepted: 21.02.2018

Published: 30.03.2018

DOI:

10.21276/sajp.2018.7.3.4



Abstract: Correct timing of administration is vital for ensuring the efficacy of prophylactic antimicrobials in preventing surgical site infection (SSI). Insufficient commitment to perioperative antimicrobial prophylaxis guidelines has been observed, but there is a rareness of information on this subject from Jordan. The main aim of this study is to find the appropriateness of administration of the first dose of prophylactic antimicrobials in orthopedic surgeries. An observational study will be performed in the Royal Rehabilitation Centre (RRC) in the Royal Medical Services (RMS); administration of antimicrobials in operations done over a 2-month period was examined. The major outcome measure will be timing of antimicrobial administration in relation to skin incision and tourniquet application. Ideal timing will be defined as prophylactic antimicrobial administration 15-60 min before skin incision or tourniquet application. There were 204 procedures out of which 190 (93.1%) were performed without a tourniquet. Of these 190 procedures, antimicrobials were given before skin incision in 106 (55.8%) procedures and administration was optimal only in 32 (16.8%) procedures. The median induction-incision interval was 19 min (range: 6-41 min). Proper timing schedule of perioperative antimicrobial administration was insufficient. Customary administration at induction of anesthesia may enhance proper timing and might be considered as in any orthopedic procedure where no local or institutional perioperative antimicrobial guidelines are available.

Keywords: Prophylactic, Antimicrobial, Orthopedic Surgery, Incision Interval.

INTRODUCTION

The prevalent use of antibiotics for prophylaxis has changed surgical practice obviously in the previous 20 years and nowadays accounts one of the most common uses of antimicrobials in hospitals, representing for as many as half of all antibiotics prescribed [1]. A surgical site infection (SSI) is well-defined as an infection that arises at or closes a surgical incision in 30 days of the surgery or within one year if an implant is left in place [2]. Patients with SSI need more hospital stay, more nursing attention, and may be readmissions for further surgery [3]. Proper timing of administration is critical to the well-documented effectiveness of prophylactic antimicrobials in avoiding SSI. In actual practice, conversely, it's found that prophylactic antibiotics are frequently not administered at the optimum time to guarantee their existence in effective levels during the operative period [4]. It is commonly suggested that administration of the first dose of prophylactic antimicrobial should begin within 1 hour proceeding to skin incision [5]. Obedience to recommendations is, however, often not satisfactory [6]. In Jordan, there is rareness of data on antimicrobial prophylaxis in orthopedic surgeries. This study was

performed to evaluate the proper timing of administration of the first dose of prophylactic antimicrobials in orthopedic surgical procedures.

MATERIALS AND METHODS

A retrospective observational study was conducted in the Royal Rehabilitation Centre (RRC) at the Royal Medical Services (RMS). Patients who had internal fixation, shoulder arthroscopy, carpal tunnel release, removal of support implant, cruciate ligament reconstruction, repair of femoral neck fracture, hip replacement or spinal operations were considered to be the source population and included in the study. Ethical approval has been obtained from the IRB committees at the JRMS.

The collected data were composed of time and induction kind of anesthesia, time of administration of the initial dose of antimicrobial relative to skin incision and tourniquet placement, time of skin incision, surgery type and forms of implants used. An orthopedic surgeon in the surgery team completed the data arrangement.

The peri-operative antimicrobial was ordered by surgeons. Anesthetist-technicians administered antimicrobials by intravenous bolus route. Cefazolin and gentamicin were the peri-operative antimicrobials. The time of prophylactic antimicrobials administration was the time of completion of administration of the first prophylactic antimicrobial. Cefazolin was the antimicrobial first choice which was administered to all patients; the time of its administration was used in computing time intervals.

Time was documented with the similar clock for any certain surgical procedure. Antimicrobial incision interval was the time extent between administration of prophylactic antimicrobials and surgical incision and it utilized to surgeries in which antimicrobial administration done before surgical incision. By this technique, the following 4 time

intervals were recorded: antimicrobial incision interval, antimicrobial tourniquet interval, induction-incision interval and induction tourniquet intervals. Administration of antimicrobial agent 15-60 min prior incision or tourniquet application was supposed as ideal timing. Univariate analysis was executed using CDC-Epi Info™ Version 7.1.5 which enables easy data entry form and database construction. Frequencies and percentages were recorded. Measurements of central tendency and spread of time intervals were the median and range respectively.

RESULTS

There were 204 surgeries. Of the remaining 204 surgeries (Table 1), 154 (75.5%) were performed under general anesthesia (GA); 50 (24.5%), under spinal anesthesia. 190 (93.1%) surgeries were done without applying a tourniquet.

Table-1: Surgical Procedures Performed

Surgical Procedure	Frequencies	Percentage
Hemiarthroplasty	14	6.9
Internal fixation of fractures	170	83.3
shoulder arthroscopy	4	2
Cruciate ligament reconstruction	2	1
Repair of femoral neck fracture	2	1
Total hip replacement	4	1.8
Removal of support implant	4	2
Spinal operations	4	1.8

The kinds of implants used are shown in Table 2. The four spinal surgeries were the only procedures with no implants used. Cefazolin was given in all procedures. Gentamicin was a supplementary antimicrobial in 198 (97.1%) surgeries. Cefazolin was the initial antimicrobial administered in all surgeries; therefore, time of its administration was the basic point for calculating antimicrobial-incision and antimicrobial-tourniquet intervals. Antimicrobial were administered prior incision in 106 (55.8%) of the 190 surgeries carried out without applying a tourniquet with median antimicrobial-incision interval of 9 min (range = 1.05-46.00 min) and median induction-incision interval of 23 min (range = 4.00-46.00 min). Only in 32 (16.8%) of these 190 surgeries were antimicrobials given 15-60

min prior skin incision. Figure (1) is a diagram of the antimicrobial-incision interval with groups of size 15 min in the 106 surgeries in which antimicrobials were administered prior skin incision. In 18 (9.5%) and 66 (34.7%) surgeries antimicrobials were given at the time of incision and next to incision correspondingly. The median induction-incision interval for all 190 surgeries was 19.00 min (range = 3.00-45.00 min). In the fourteen surgeries carried out with a thigh tourniquet used the induction-tourniquet intervals were 5 (4 surgeries), 8 (3 surgeries), 10 (2 surgeries), 15, 20 and 25 (3 surgeries) min. In ten surgeries in which antimicrobials were administered prior to using tourniquet, the antimicrobials-tourniquet intervals were 2, 8, 10 (in 6 surgeries) and 20 min.

Table-2: Kinds of Implants Used

Implant	Frequencies	Percentage
Rush rod	12	4.8
Talwalkar rod	10	4
Grosse-Kempf (GK) rod	7	2.8
Inter-locking nail	9	3.6
Broad DCP Plate	34	13.6
Narrow DCP Plate	18	7.2
LC-DCP Plate	21	8.4
Reconstruction Plate	11	4.4
Tubular Plate	13	5.2
T Plate	8	3.2
Proximal femoral prosthesis	3	1.2
Locking Screws	33	13.2
Cortical Screws	24	9.6
Cancellous Screws	19	7.6
Cannulated Screws	27	10.8
Total	249	

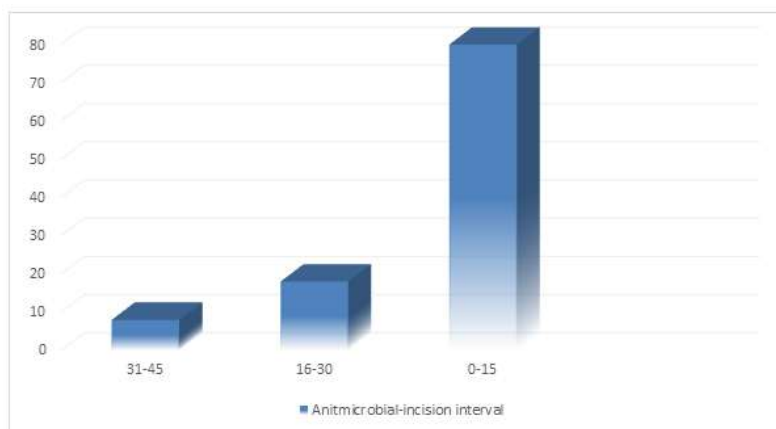


Fig-1: Antimicrobial incision interval in 106 surgeries carried out without applying a tourniquet

DISCUSSION

Prophylactic antimicrobials were administered during 60 min prior incision only in 55.8% of surgeries performed without using a tourniquet. This is insufficient and comparable to the results from other researches [5, 6]. If antimicrobials are given too immediate to the time of skin incision, the serum and tissue level could not have gotten a sufficient concentration for effective prophylaxis. On the other hand, if antimicrobials are administered more than 60 min prior incision, the serum level may drop below the minimum inhibitory concentration (MIC) by the time incision is made, particularly if the half-life ($t_{1/2}$) of the antimicrobials is short. Based on these considerations and the short $t_{1/2}$ of the frequently used antimicrobials (flucloxacillin, clindamycin and cefuroxime) in a study

performed by Stefánsdóttir *et al.* [7] concluded that administration of antimicrobials 15-45 min prior skin incision or tourniquet application is acceptable. The results of this study found that only in 45% of procedures done in their hospital and 57% of randomly selected surgeries were antimicrobials given within 15-45 min before incision. Maintaining the higher level of optimal timing at 60 min since of the relatively longer $t_{1/2}$ of cefazolin (Table 3), we found that antimicrobials were given within 15-60 min before incision in only 16.8% of the surgeries performed without a tourniquet and about 24.5% of the subset in which antimicrobials were administered before skin incision (Figure 1). This reveals the incorrectness of timing of peri-operative antimicrobials prophylaxis in our practice.

Table-3: Elimination $t_{1/2}$ of related antimicrobials in normal adults

Antimicrobial	Half-life (h)
Cefazolin	1.8-2.2
Cefuroxime sodium	1-1.5
Clindamycin	2.4-3.2
flucloxacillin sodium	4-6
Gentamicin	2-3

In evaluating the timing of prophylactic antimicrobials administration in orthopedic procedures, operations done with the applying of tourniquet have to be considered independently due to the fact that antimicrobials should spread in the tissues before tourniquet application. However, in our study, the number of such surgeries is not enough to judge the proper timing of peri-operative antimicrobial administration.

Administration of prophylactic antimicrobials at induction of anesthesia is safe and results in satisfactory tissue levels of antimicrobials [8]. It also warrants that antimicrobials are given prior skin incision. The current study revealed that the median induction-incision interval was more than the median antimicrobial-incision interval for the 106 surgeries done without applying a tourniquet and with antimicrobials administered before incision. Moreover, the median induction-incision interval was 19 min for all 190 surgeries done without using a tourniquet. These results propose that administration of prophylactic antimicrobials usually at induction of anesthesia may result in proper timing.

CONCLUSION

The vital features of prophylactic antimicrobials administration are in selecting an proper antimicrobial, administering a sufficient dose, attaining proper timing before incision, and keeping therapeutic concentrations of antimicrobials all over the procedures. Antimicrobial prophylaxis strategies are not alternatives for clinical decision. Therefore, clinical experts must make their own clinical decision out of their practice in deciding the proper timing of antimicrobial prophylaxis. Nevertheless, the surgical site infections can be abridged by adjusting the timing of prophylactic antimicrobial in surgical procedure as directed in the guidelines.

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