Does Postoperative Antibiotic Administration Affect the Infection Rate for Outpatient Orthopaedic Sports Procedures?

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ABSTRACT

Purpose: Perioperative antibiotic administration is a topic of debate, and a varied practice among orthopaedic surgeons. The objective of this study is to compare infection rates after outpatient sports procedures in patients treated with a single preoperative dose of antibiotics versus those given additional postoperative doses.

Methods: This article shows a retrospective chart review of 961 patients undergoing orthopaedic sports medicine surgeries over a 2-year period. A control group of patients that only received preoperative antibiotics was compared to those with additional postoperative antibiotics in the post-anesthesia care unit (PACU) or at discharge (D/C). The primary outcome was the development of a postoperative superficial or deep infection.

Results: The authors found no significant difference in the postoperative infection rate for patients given antibiotics postoperatively compared to the control group. Patients receiving no postoperative antibiotics had a deep infection rate of 2.0% (3/144) and superficial infection rate of 3.5% (5/144). Patients receiving postoperative antibiotics had a deep infection rate of 0.6% (5/817) (P = 0.10), and a superficial infection rate of 1.5% (12/817) (P = 0.16). There was no significant difference in developing deep infections (PACU only (P = 0.14) versus D/C only (P = 0.39)) or superficial infections (PACU only (P = 0.14) versus D/C only (P = 0.76)) in the setting of antibiotic administration.

Conclusions: In this retrospective study of sports procedures, the data indicates that postoperative antibiotic administration did not result in decreased postoperative infections. However, given the low overall infection rate, a larger study with greater power is necessary to confirm findings.

Level of Evidence: III

Keywords: Postoperative complications; Orthopedics; Sports medicine; Surgical wound infections; Anti-bacterial agents

INTRODUCTION

Using perioperative antibiotics to prevent surgical site infections has become routine in most surgical specialties. In orthopaedic surgery, studies have shown that a preoperative single dose of antibiotic prophylaxis reduces infection in prosthetic joints, closed long bone fractures, hip fractures, and arthroscopy as compared to no antibiotics.[1-7] Postoperative infection is one of the most severe complications that can occur after any orthopaedic surgery, and is associated with increased morbidity, mortality, disability, and costs.[8-10] In 1999, the United States Centers for Disease Control and Prevention (CDC) published guidelines in support of perioperative antibiotics. In 2011, working with the United States Centers for Medicare and Medicaid Services (CMS) in the Surgical Care Improvement Project (SCIP), the CDC specified that these antibiotics should be administered within 1 hour of incision for most antibiotics (2 hours for fluoroquinolones and vancomycin).[11,12] Orthopaedic surgeons at the 2013 International Consensus Meeting on Periprosthetic Joint Infection recommended a preoperative dose and continuing antibiotics for 24-hours after surgery.[13]

However, routine use of antibiotics is not benign. Antibiotics have various side effect profiles including clostridium difficile, anaphylaxis, tendinopathy, skin sensitivity, a contribution to the growing body of antibiotic resistant organisms, and adding to the cost of care.[14-17] In 2017, the CDC revised their recommendations against using continued antibiotics in the postoperative period after total joint arthroplasty in all cases.[18] A recent large retrospective study of 20,000 patients who underwent total joint arthroplasty found similar rates of infection in patients treated with a single dose of perioperative antibiotics compared to patients who received multiple doses of postoperative antibiotics, supporting the national guidelines.[6] Other studies have come to similar conclusions for many orthopaedic surgeries – a single dose of perioperative antibiotics is sufficient including with open reduction internal fixation (ORIF) of closed long bone fractures, total hip and total knee arthroplasty, and total shoulder arthroplasty.[19-24] Additionally, a recent study in the spine literature showed no difference in the rate of surgical site infections between patients receiving 24 hours of postoperative antibiotics and those who did not.[25] Studies have shown that guidelines for perioperative antibiotic prophylaxis are not routinely followed in the United States. [26,27] Orthopaedic surgeons were largely unaware of current guidelines.[26,27]

Although antibiotic prophylaxis is shown to be effective for both arthroscopic shoulder and knee cases, to the authors' knowledge, there are no recent studies investigating infection rates after orthopaedic sports procedures in patients treated with a single preoperative dose of antibiotics versus those treated with additional doses postoperatively. This further expands on the previous arthroscopic-only shoulder and knee cases to examine a wider variety of sports cases. The authors hypothesized that postoperative antibiotics did not decrease the risk of a postoperative infection in this population.

METHODS

A retrospective chart review was performed of all patients who had orthopaedic outpatient sports medicine surgeries performed by one of five sports medicine, fellowship-trained surgeons over a 2-year period. All surgeries were performed at a single outpatient surgery center. Cases were identified with a database search of the electronic medical record using current procedural terminology (CPT) codes, which provided all sports procedures performed at the outpatient surgery center for each surgeon during the 2-year period.

The database search yielded a total of 1,358 cases within the selected timeframe. Patients were excluded if they had a known active infection, were younger than 14 years old, older than 79 years old, or had less than 12 weeks of post-operative follow-up. This resulted in 961 cases that were selected for study inclusion.

Of the 961 included procedures, all cases were evaluated for the administration of pre-operative antibiotics alone, versus the administration of additional doses postoperatively in the postoperative antibiotics in the post-anesthesia care unit (PACU) or at discharge. Each of the five surgeons had varied use of antibiotic administration, in that each surgeon's decision for only antibiotics prior to skin incision vs those who preferred additional postoperative antibiotics at discharge was purely their personal practice preference and not preselected for purposes of this study. Preoperative intravenous (IV) antibiotics given prior to skin incision and in cases of repeat dosing of IV antibiotics in the PACU were typically cefazolin, except in the cases of penicillin-allergic patients in which either vancomycin or clindamycin was given. The antibiotics given at discharge were always oral. All patients underwent the preoperative standard sanitary protocol to include hibiclens shower the night before, clipping any body hair over the operative site preoperatively in the operating room, and prepping with chloraprep as the standard. The primary endpoint, which was the development of a postoperative infection, was categorized into superficial infections, deep infections, infections requiring additional antibiotics, and infections that resulted in a subsequent return to the operating room for irrigation and debridement with or without removal of implants. Superficial infections were defined as those of the superficial tissues resulting in cellulitis, versus deep infections defined as infections with deep tissue abscesses, infected implants, or septic arthritis. Additional patient variables included patient age at the time of operation, sex, history of diabetes, surgical time, and use of implants. Although the authors would have liked to include various side effects that could be attributed to antibiotic usage, some of the major side effects such as development of antibiotic resistance could not be determined. Additionally, given the retrospective nature of this study design, there was a scarcity of data regarding antibiotic side effects experienced by patients when performing this chart review. This is related to the fact that not every patient was explicitly questioned about antibiotic side effects, thus leading to very few charts including any discourse related to antibiotic side effects and an underrepresentation of the true burden of antibiotic usage.

Statistical analysis was performed using Fisher's exact test to estimate the odds ratio (OR) of postoperative infection in association with the use of antibiotics and categorical patient demographics (e.g. sex and diabetes). The authors then used a Wilcoxon test to compare differences (with respect to age, surgery time) between patients who developed an infection versus those that did not have a postoperative infection.

RESULTS

After retrospective chart review, a total of 961 patients met the study inclusion criteria. Given that the authors elected to look at all of the sports cases performed at this single site outpatient surgery center, there is a wide variety of cases that were performed. The six most common procedures performed were anterior cruciate ligament (ACL) reconstruction (210 total procedures (21.85%)), knee arthroscopy (including meniscectomy, loose body removal, chondroplasty, lysis of adhesions – 180 total procedures (18.73%)), rotator cuff repair (141 total procedures (14.67%)), open shoulder procedures (including Latarjet, open rotator cuff, open biceps tenodesis, distal clavicle excision, Bankart repair, Remplissage, HAGL Repair – 76 total procedures (7.90%)), Medial patellofemoral ligament (MPFL) reconstruction (67 total procedures (6.97%)), and shoulder arthroscopy (including biceps tenotomy, labral repair, loose body removal, lysis of adhesions, subacromial decompression – 52 total procedures (5.41%)). Table 1 can be referenced for the complete detailed breakdown of the surgical cases that were analyzed.

Of the 961 patients identified, 25 patients were identified who were diagnosed with either a superficial or deep infection. 17 out of 25 (68.0%) of the infections were classified as a superficial infection, and 8 out of 25 (32.0%) were deep infections requiring return to the operating room. 17 out of 25 patients (68.0%) received an additional dose of postoperative antibiotics after the index procedure.

There was no statistically significant difference in the rate of postoperative infection for the group of patients given antibiotics postoperatively when compared to the control group. Patients receiving no postoperative antibiotics had a deep infection rate of 2.0% (3 out of 144), and superficial infection rate of 3.5% (5 out of 144). Patients who received postoperative antibiotics had a deep infection rate of 0.6% (5 out of 817) (P = 0.10), and a superficial infection rate of 1.5% (12 out of 817) (P = 0.16). There was no significant difference in the development of deep infections when analyzed by the setting of antibiotic administration: PACU only (P = 0.14) versus D/C only (P = 0.39). Similarly, there was no difference for superficial infections if antibiotics were given in the PACU only (P = 0.14) versus D/C only (P = 0.76). The group that received both PACU and D/C antibiotics had a 0.0% infection rate (0 out of 124) for both deep (P = 0.61) and superficial infections (P =0.15), though this finding was not statistically significant (Table 1).

Table 2 demonstrates the effect of additional patient variables on risk of developing a postoperative infection. When evaluating for patient age at the time of operation, sex, history of diabetes, surgical time, the use of implants, and the use of preoperative antibiotics, the analysis did not reveal any significant disease associations. Patients with a deep infection were older on average (48 years old vs 36 years old, P = 0.18), but this was not significant.

A post hoc power analysis was run using G*Power, version 3.1.9.7 for all the power calculations described below.[28] A sample size of 3,300 would have been necessary to provide a power of at least 0.80 for the three tests considered. This assumes a 6:1 ratio of (postoperative antibiotic: no post-operative antibiotic).

DISCUSSION

Postoperative infections can be catastrophic for patients after outpatient sports medicine procedures. While standards for preoperative antibiotics are clear, there is no clear consensus in this patient population about the use of continued antibiotics postoperatively to prevent infection. In this single center retrospective cohort study, the authors did not find significant decreases in postoperative infection rate in patients treated with additional postoperative antibiotics.

These results coincide with studies of other patient populations that support the use of preoperative antibiotics only. Although classification of the individual infection rates appeared to suggest an overall trend for a reduced infection rate with the use of postoperative antibiotics, this was not statistically significant given the lack of power in this study to decisively advocate for the use of postoperative antibiotics. Tan et al.[6] found a periprosthetic joint infection rate of 0.60% in patients who received preoperative antibiotics only compared with 0.88% of those who received additional postoperative doses (P = 0.064). Recent systematic review with meta-analysis did not find additional benefit to postoperative prophylaxis in total joint arthroplasty, or in the surgical treatment of closed, long-bone fractures.[21,29]

This is contradictory to recommendations from orthopaedic surgeons at the 2013 International Consensus Meeting on Periprosthetic Joint Infection who specifically recommended continuing antibiotics for 24-hours after surgery to prevent periprosthetic joint infection.[13] These recommendations may have been based on personal surgeon experience, and fear of the dreaded septic joint after elective arthroplasty procedures. Rates of septic knee after arthroscopy ranged from 0.009% to 1.1% after routine arthroscopy.[31] In regard to the shoulder, one recent systematic review showed postoperative infection rates of Cutibacterium acnes to be 0.22% following shoulder arthroscopy.[31] Although the authors found no significant difference in infection rates in patients with diabetes in this study, previous literature has shown increased infection rates for many surgical procedures, including following shoulder and knee arthroscopy.[32,33] Cancienne et al.[33] took this further and were able to establish that infection rates significantly increased at Hgb A1C of 8.0 mg/dL or above when performing receiver operating characteristic (ROC) curve analysis for knee arthroscopy.

In outpatient knee and shoulder arthroscopy, the authors were unable to find any studies comparing infection rates with preoperative versus additional postoperative antibiotic administration. Interestingly,

Table 1. Detailed Procedure Breakdown

Procedure Type	Total Patients	Percentage	Procedure	Total Patients	Percentage
Arthroscopic-Assisted ACL Reconstruction	210	21.85%	Patellar Tendon Repair	4	0.41%
Knee-Arthroscopic Procedures (including meniscectomy, loose body removal, chondroplasty, lysis of adhesions)	180	18.73%	Fasciotomies – Leg	4	0.41%
Arthroscopic-Assisted Rotator Cuff Repair	141	14.67%	Patellar ORIF	3	0.31%
Open Shoulder Procedures (including biceps tenotomy, labral repair, loose body removal, lysis of adhesions, subacromial decompression)	76	7.90%	Ankle ORIF	3	0.31%
MPFL Reconstruction	67	6.97%	Tibial Tunnel Grafting	3	0.31%
Shoulder – Arthroscopic Procedures (including labral repair, loose body removal, lysis of adhesions, subacromial decompression)	52	5.41%	Gluteus Medius Tendon Repair	2	0.21%
Hip – Arthroscopic Procedures (including labral repair, loose body removal, lysis of adhesions, acetabuloplasty)	43	4.47%	Quadriceps Tendon Repair	2	0.21%
Multi-Ligamentous Knee Reconstruction	30	3.12%	Tibial Tubercle ORIF	2	0.21%
Arthroscopic-Assisted Meniscus Repair	22	2.29%	Bursectomy (Patella and Greater Trochanteric Bursas)	2	0.21%
Clavicle ORIF (including clavicle Fx ORIF and AC Joint separation ORIF)	21	2.19%	Ankle Arthroscope	1	0.10%
Combined Arthroscopic-Assisted ACL Reconstruction and Meniscus Repair	19	1.98%	CRPP of SF P1 Fx	1	0.10%
Osteochondral Defect Procedures (including Microfracture, OATS)	18	1.87%	CRPP of Jones-Fracture 5th Metatarsal	1	0.10%
Hardware Removal (including tibial tubercle, tibial nail, external-fixator, clavicle plates, ankle syndesmotic screw and patella plates)	17	1.77%	MCL Repair	1	0.10%
Achilles Tendon Repair	6	0.62%	Meniscus Transplant	1	0.10%
Distal Femur ORIF (due to OCD lesion vs femoral condyle fracture)	6	0.62%	Peroneal Nerve Neurolysis	1	0.10%
Pectoralis Major Repair	6	0.62%	Open Foreign Body Removal (bullet)	1	0.10%
Open Distal Biceps Repair	5	0.52%	Open Partial Patellectomy	1	0.10%
Hamstring Tendon Repair (hamstring avulsion vs tendon rupture)	4	0.41%	Open Ankle ATFL Reconstruction	1	0.10%
PCL Reconstruction	4	0.41%		Total 961	100.00%

three retrospective reviews of outpatient knee arthroscopy found no decreased risk of infection with or without the administration of prophylactic antibiotics given preoperatively.[1,7,34] A recent meta-analysis of 49,682 patients undergoing knee arthroscopy found a decreased rate of infection for patients who received prophylactic antibiotics versus those who did not after simple knee arthroscopy, which included all procedures without graft placement. However, when bony procedures such as microfracture and bone tunnels were excluded from the simple knee arthroscopy group, there was no significant difference with the administration of prophylactic antibiotics.[35] A recent systematic review did not find any strong data in support of preoperative antibiotics in routine shoulder arthroscopy, suggesting that preoperative antibiotics may not be necessary in prevention of infection in simple arthroscopy procedures.[36] This study does show a higher postoperative antibiotic usage rate compared to the current national standard, but this practice has

Table 2 *Association of Antibiotics and Infection*

Deep Infection					
Antibiotics?	**Total Patients**	**Deep Infection**	**Percentage**	**Odds Ratio (95.0% CI)**	**Fisher's Test P-Value**
No Antibiotics	144	3	2.0% (3/144)	Null Value	Null Value
Any Abx (Either PACU or D/C or Both)	817	5	0.6% (5/817)	0.29 (0.07-1.2)	0.1
PACU Abx Only	474	3	0.6% (3/474)	0.30 (0.60-1.50)	0.14
D/C Abx Only	219	2	0.9% (2/219)	0.43 (0.07-2.6)	0.39
PACU Ax and D/C Abx	124	0	0.0% (0/124)	0.39 (0.02-6.83)	0.61

Superficial Infection					
Antibiotics?	**Total Patients**	**Superficial Infection**	**Percentage**	**Odds Ratio (95.0% CI)**	**Fisher's Test P-Value**
No Antibiotics	144	5	3.5% (5/144)	Null Value	Null Value
Any Abx (Either PACU or D/C or Both)	817	12	1.5% (12/817)	0.41 (0.14-1.19)	0.16
PACU Abx Only	474	6	1.3% (6/474)	0.36 (0.11-1.19)	0.14
D/C Abx Only	219	6	2.7% (6/219)	0.78 (0.23-2.62)	0.76
PACU Ax and D/C Abx	124	0	0.0% (0/124)	0.18 (0.01-3.15)	0.15

Key – Abx= Antibiotics; PACU= Antibiotics in the Post-Anesthesia Care Unit; D/C= Discharge Antibiotics; OR= Odds Ratio; CI= Confidence Interval

changed more recently over the past several years. Reasons for decisions on whether a surgeon may elect for antibiotics ultimately came down to surgeon preference, which is often affected by patient factors, including comorbidities such as diabetes, social history, substance use, personal experience of the surgeon based on their clinical experience, or the background of the program where they were trained.

In 2017, CDC guidelines were revised to recommend the administration of preoperative antibiotics only without continuation of 24-hours of postoperative antibiotics for routine surgical cases.[11] Continued antibiotic administration is not benign and can contribute to antibiotic-resistant organisms.[14-17] It can also cause side effects, ranging from clostridium difficile infection, anaphylaxis, red man syndrome, tendinopathy, and skin sensitivity.[14-17]

While the authors believe that this study contributes to the scientific literature, there were significant limitations. The first major limitation is that this study was underpowered. However, given that the infection rate was similar to other studies, the authors believe this may indicate that this study can be generalized to similar studies with similar results. The authors hypothesize that the lack of statistical significance, especially within the deep infection group, was likely due to limited statistical power as a result of a relatively small number of cases of infections among the available patients meeting exclusion and inclusion criteria. Post hoc power analysis revealed that a sample size of 3,300 should provide a power of at least 0.80 for any infection, deep infection, and superficial infection; assuming a 6:1 ratio of post-operative antibiotic: no post-operative antibiotics. For future studies, either a multicenter study or a large public database would be required to obtain a sufficient number of patients to achieve significant power. These large numbers were unable to be obtained at a single outpatient surgery center in this study. In addition, this study is a retrospective study with its own inherent limitations. These limitations include selection bias, as more patients received postoperative antibiotics than those who did not. This was a result of surgeon preference and was not randomized, leading to unequal patient distributions in the control and treatment groups. Another limitation is the fact that, given the retrospective nature of this study design, patients were not specifically asked about all possible side effects they may have experienced while taking the antibiotics. Only major side effects were reported back to the prescribing surgeon, leading to a gross under representation of the true burden of the antibiotics, and leading to its lack of inclusion in this current study. The final limitation is patients lost to follow-up, as the authors excluded patients with less than 12-weeks of post-operative follow-up. As a result, their long-term post-operative course is unknown. A future large, randomized control trial may lead to stronger results and recommendations.

CONCLUSION

To the authors' knowledge, while postoperative infections after routine sports procedures are rare, literature on infection rates after various timing regimens of antibiotic administration has not been published. This single-center retrospective review of

Table 3

Variable		n	Super-Infection n (%)	OR (95% CI)	P-Value	Deep-Infection	OR (95% CI)	P-Value
Gender	Male	524	10 (1.9%)	1.19 (0.41, 3.73)	0.81	5 (1.0%)	1.39 (0.27, 9.02)	73
	Female	437	7 (1.6%)			3 (0.7%)		
Implant	Yes	712	13 (1.8%)	1.14 (0.35, 4.84)	1	5 (0.7%)	0.58 (0.11, 3.76)	0.43
	No	249	4 (1.6%)			3 (1.2%)		
DM	Yes	56	0 (0.0%)	0 (0, 3.72)	0.62	0 (0.0%)	0 (0, 9.63)	1
	No	905	17 (1.9%)			8 (0.8%)		
Pre-Op Abx	Yes	953	16 (1.7%)	0.12 (0.01, 5.72)	0.13	8 (0.7%)	NA	1
	No	8	1 (12.5%)			0 (0.0%)		
Variable (Mean, SD)	Super-Infection		Wilcox-Test P-Value	Deep Infection		Wilcox-Test P-Value		
	Yes	No		Yes	No			
Age	33.6 (17.5)	35.6 (16.3)	0.80	47.9 (16.5)	35.6 (16.3)	0.18		
Surgery Time	89.6 (31.6)	84.4 (38.9)	0.39	75.0 (44.5)	84.6 (38.8)	0.59		

Key: OR= Odds Ratio; Abx= Antibiotics; DM= Diabetes Mellitus; SD= Standard Deviation

patients undergoing outpatient sports procedures found that postoperative antibiotic administration did not result in decreased infection rates compared to preoperative antibiotic administration alone. Due to the limited number of postoperative infections, this present study was underpowered, and a larger study might find utility in postoperative antibiotics or confirm the findings in this study group.

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