e-ISSN: 0975-1556, p-ISSN:2820-2643

Available online on www.ijpcr.com

International Journal of Pharmaceutical and Clinical Research 2022; 14(7); 309-315

Original Research Article

# Device-related Infections in Orthopaedic and Trauma Surgery

**Soumya Nayak[1], Saroj Kumar Parida[2], Sangram Kishore Sabat[3], Sambit Kumar Panda[4], Gopabandhu Patra[5]**

[1]Assistant Professor, Department of Microbiology, KIIMS, Bhubaneswar, Odisha, India
[2]Assistant Professor, Department of Orthopaedics, S.C.B. Medical College, Cuttack, Odisha, India
[3]Assistant Professor, Department of Orthopaedics, MKCG Medical College, Berhampur, Odisha, India.
[4]Associate Professor, Department of Orthopaedics, B.B Medical College, Balangir , Odisha, India
[5]Assistant Professor, Department of Orthopaedics, B. B. Medical College, Balangir, Odisha, India

**Received: 15-04-2022 / Revised: 18-05-2022 / Accepted: 01-06-2022**
**Corresponding author: Dr Sambit Kumar Panda**
**Conflict of interest: Nil**

**Background:** There are different types of infections that could have a significant impact on the health of the people. The surgical site infection (SSI) is one of the major issues that include deep, implant-associated infection that increase the serious complications in orthopaedic surgery. This is having a significant impact on morbidity and mortality. The outcomes of this are also involving the multiple revisions, poor financial and health related outcomes. There are some guidelines were also made for managing the operational activities and planning of the actions to minimize the infection and improve the health of the patients and staff members

**Aim:** The study aims to analyse device-related infections in orthopaedic and trauma surgery

**Method:** This was a multi-institutional case control study that conducted in SCB Medical College and Hospital,Cuttack between September 2019 to March 2022.The study was approved by the ethical committee and followed the standards. For the study the case were defined considering the health of the patients who have any reinfection demanding any surgical revision in less than 1 year after the index procedure. Apart from this the control were defined as the patients who are not having infection demanding surgical revision.

**Results:** The case patients were more likely involved in smoking especially male with the fracture fixation device. Moreover, the systematic antibodies treated was used for 14 and used for the 22 case and 109 control patients. The Univariate regression analysis has suggested an improvement in risk of recurrent infection with longer antibiotic treatment (OR 1.82, 95% CI 1.00 to 3.28, p = 0.049). The patient's sub-sample with extramedullary fracture device-associated infections. Moreover, the baseline criteria were found well in both case and control and none of them is related to recurrent infection in univariate analysis.

**Conclusion:** From the analysis, it has been considered that exposure of the infection in surgical process is having a significant impact on the health of the patients and affecting the recovery. Moreover, the large-scale confirmatory trails are needed for confirm the issues and developing the systematic process of reducing the reinfection among the surgical patients.

**Keywords:** Infection, Device related infection, Orthopaedic, Trauma Surgery

## Background

There are different types of infections that could have a significant impact on the health of the people [1]. The surgical site infection (SSI) is one of the major issues that include deep, implant-associated infection that increase the serious complications in orthopaedic surgery [2]. This is having a significant impact on morbidity and mortality. The outcomes of this are also involving the multiple revisions, poor financial and health related outcomes [3]. There are various approaches are used for analysing the issues related to the SSI and that involve primary external fixation that followed by open reduction and internal fixation [4]. According to analysis, the deep SSI is specifically implant-related infections that demand aggressive surgical management. There are some decisive factors that play a critical role in managing the infection [5,6].

According to analysis, the particular devices that used for surgery is having a significant impact on the infection rate and mobility. However, systemic antibiotics are used for treating the implant associated orthopaedic infection [7]. There are some guidelines were also made for managing the operational activities and planning of the actions to minimize the infection and improve the health of the patients and staff members [8]. In orthopaedic trauma, adequate timing of definitive fracture fixation after damage-control, if necessary, remains a mainstay of preventing deep infections and other complications [9]. Minimally invasive access routes and biologically designed implants may further decrease the risk of infection because of fewer traumas to surrounding soft tissues, thereby avoiding a surgical second hit [10]. Joint arthroplasty registries have greatly contributed to the knowledge about the risk of infection in high-income countries [11,12]. Various definitions of SSI, follow-up intervals, and effect modifiers like age, co-morbidity, treatment indication, type of components etc. notwithstanding, national benchmarks typically range from 0.5 to 2.0% in primary, elective total hip, and knee replacement [13]. Now, the present study will analyse the influence of the duration of antibiotic treatment on the rate of recurrence after the surgical management of different orthopaedic device-related infection.

## Aim

The study aims to analyse device-related infections in orthopaedic and trauma surgery

## Method and Material

This was a multi-institutional case control study that conducted in SCB Medical College and Hospital, Cuttack between September 2019 to March 2022. Thestudy was approved by the ethical committee and followed the standards. For the study the case were defined considering the health of the patients who have any reinfection demanding any surgical revision in less than 1 year after the index procedure. Apart from this the control were defined as the patients who are not having infection demanding surgical revision (or any surgical revision for infection) ≤1 year, being aware the control status is fragile and may change to a case status with longer follow-up intervals.

For completing the study, the researcher has focused on the uni and multivariate regression analysis that hasped to understand the association between the primary and secondary variables. In order to test the possible outcome of the clinical study, the

secondary variables were analysed using the single logistic regression. Days of systemic exposure to fluoroquinolones and rifampicin were clustered in clinically meaningful categories with comparable sample sizes.

## Results

**Table 1:**

| Variable | Cases | Controls |
|---|---|---|
| n | 59 | 210 |
| Median age, years (IQR) | 63 (48–71) | 67 (55–73) |
| Gender, n (%) | | |
| Male | 42 (71) | 106 (50) |
| Female | 17 (29) | 104 (50) |
| Median BMI (IQR) | 28 (25–32) | 28 (25–33) |
| Smoker, n (%) | 20 (34) | 42 (20) |
| Diabetes mellitus, n (%) | 10 (17) | 49 (23) |
| ASA status, n (%) | | |
| 1 | 7 (12) | 18 (9) |
| 2 | 28 (47) | 98 (47) |
| ≥ 3 | 24 (41) | 94 (45) |
| Type of implant | | |
| Total joint arthroplasty | 28 (47) | 157 (75) |
| Fracture fixation device | 31 (53) | 53 (25) |
| Infection site | | |
| Lower extremity | 56 (95) | 200 (95) |
| Upper extremity | 3 (5) | 10 (5) |
| MRSA present, n (%) | 3 (5) | 6 (3) |
| Preferred antibiotics, n (%) | | |
| Cefuroxime | 19 (32) | 106 (50) |
| Moxifloxacin | 13 (22) | 66 (31) |
| Clindamycin | 7 (12) | 38 (18) |

According to the outcome of the table 1, the case patients were more likely involved in smoking especially male with the fracture fixation device. Moreover, the systematic antibodies treated was used for 14 and used for the 22 case and 109 control patients. The Univariate regression analysis has suggested an improvement in risk of recurrent infection with longer antibiotic treatment (OR 1.82, 95% CI 1.00 to 3.28, $p = 0.049$). Male gender (OR 2.42, 95% CI 1.30 to 4.53, $p = 0.005$), smoking (OR 2.05, 95% CI 1.09 to 3.88, $p = 0.027$), and infection of a fracture fixation device (OR 2.25, 95% CI 1.21 to 4.2, $p = 0.032$) were associated with an increased likelihood of developing relapse. Apart from this, the multivariate analysis has suggested male sex (OR 2.06, 95% CI 1.08 to 3.94, $p = 0.029$) and fracture fixation device infections (OR 2.05, 95% CI 1.05 to 4.02, $p = 0.036$) remained predictors of reinfection.

**Table 2:**

| Variable | Cases | Controls | *p* |
|---|---|---|---|
| n | 31 | 53 | |
| Median age, years (IQR) | 55 (45–61) | 51 (37–67) | 0.849 |
| Gender, n (%) | | | 0.706 |
| Male | 20 (65) | 32 (60) | |
| Female | 11 (35) | 21 (40) | |
| Median BMI (IQR) | 26.4 | 26.9 | 0.513 |
| | (24.2–32.4) | (23.8–30.3) | |
| Smoker, n (%) | 12 (39) | 18 (34) | 0.661 |
| Diabetes mellitus, n (%) | 3 (10) | 4 (8) | 0.733 |
| ASA status, n (%) | | | |
| 1 | 6 (19) | 11 (21) | 0.890 |
| 2 | 16 (52) | 28 (53) | |
| ≥ 3 | 7 (23) | 12 (23) | |
| unknown | 2 (6) | 2 (4) | |
| Infection site | | | 0.487 |
| Lower leg | 26 (84) | 41 (77) | |
| Femur | 2 (6) | 8 (15) | |
| Upper extremity | 3 (10) | 4 (8) | |
| Additional IM nail, n (%) | 2 (6) | 7 (13) | 0.334 |
| Microbiology, n (%) | | | |
| MSSA | 21 (68) | 24 (45) | 0.046 |
| MRSA | 3 (10) | 3 (6) | 0.490 |
| CNS | 2 (6) | 11 (21) | 0.080 |
| Enterococci | 3 (10) | 12 (23) | 0.134 |
| Streptococci | 3 (10) | 3 (6) | 0.490 |
| E. coli | 1 | 3 | |
| Enterobacter spec. | 3 | 2 | |
| Corynebacter spec. | 1 | 1 | |
| Proteus spec. | 0 | 1 | |
| Pseudomonas spec. | 2 | 2 | |
| Peptostreptococci | 0 | 3 | |
| Klebsiella spec. | 0 | 2 | |
| Candida spec. | 0 | 1 | |
| Local gentamicin, n (%) | 6 (19) | 10 (19) | 0.956 |
| Systemic antibiotics, n (%) | | | |
| Fluoroquinolones | 13 (42) | 23 (43) | 0.896 |
| Rifampicin | 8 (26) | 15 (28) | 0.805 |
| Cefuroxime | 6 (19) | 14 (26) | 0.463 |
| Aminopenicillins | 9 (29) | 9 (17) | 0.194 |
| Clindamycin | 2 (6) | 5 (9) | 0.633 |
| Linezolid | 1 | 1 | |
| Vancomycin | 0 | 2 | |
| Gentamicin | 0 | 2 | |

| | | | |
|---|---|---|---|
| Imipenem | 1 | 1 | |
| Tazobactam | 1 | 2 | |
| Combined fluoroquinolones and rifampicin | | | |
| None | 29 (55) | 18 (58) | |
| Any | 10 (19) | 5 (16) | |
| Fluoroquinolones and / or rifampicin | 14 (26) | 8 (26) | |

Table 2 has provided the information related to the patient's sub-sample with extramedullary fracture device-associated infections. Moreover, the baseline criteria were found well in both case and control and none of them is related to recurrent infection in univarite analysis.

**Table 3:**

| **Variable** | **Logistic regression, OR (95% CI)** | **p** | **Exact logistic regression, OR (95% CI)** | **P** |
|---|---|---|---|---|
| Age | 1.01 (0.98–1.03) | 0.641 | 1.01 (0.98–1.03) | 0.650 |
| Male gender | 1.19 (0.48–2.99) | 0.706 | 1.19 (0.44–3.35) | 0.889 |
| BMI | 1.02 (0.96–1.08) | 0.598 | 1.02 (0.95–1.08) | 0.601 |
| Smoking | 1.23 (0.49–3.08) | 0.661 | 1.23 (0.44–3.38) | 0.836 |
| Diabetes mellitus | 1.31 (0.27–6.29) | 0.734 | 1.31 (0.18–8.35) | 1.000 |
| ASA class | 1.03 (0.52–2.04) | 0.924 | 1.03 (0.49–2.17) | 1.000 |
| MRSA present | 1.79 (0.34–9.45) | 0.495 | 1.77 (0.22–14.15) | 0.779 |
| Local antibiotics | 1.03 (0.33–3.18) | 0.956 | 1.03 (0.27–3.59) | 1.000 |
| Systemic fluoroquinolones | | | | |
| Any use | 0.94 (0.38–2.31) | 0.896 | 0.94 (0.35–2.53) | 1.000 |
| 1 to 7 days | 1.04 (0.30–3.68) | 0.949 | 1.04 (0.23–4.29) | 1.000 |
| 8 to 31 days | 0.42 (0.08–2.18) | 0.300 | 0.42 (0.04–2.46) | 0.499 |
| > 31 days | 1.43 (0.41–4.92) | 0.572 | 1.42 (0.34–5.85) | 0.796 |
| 1 to 31 days | 0.73 (0.25–2.11) | 0.560 | 0.73 (0.21–2.35) | 0.758 |
| > 31 days | 1.43 (0.41–4.92) | 0.572 | 1.42 (0.34–5.85) | 0.796 |
| Systemic rifampicin | | | | |
| Any use | 0.88 (0.32–2.40) | 0.805 | 0.88 (0.28–2.64) | 1.000 |
| 1 to 31 days | 0.41 (0.08–2.12) | 0.289 | 0.42 (0.04–2.35) | 0.476 |
| > 31 days | 1.42 (0.42–4.74) | 0.572 | 1.41 (0.35–5.60) | 0.790 |
| Fluoroquinolones or rifampicin | 0.95 (0.56–1.59) | 0.838 | | |
| Either | 0.81 (0.24–2.74) | 0.729 | 0.81 (0.19–3.13) | 0.980 |
| Combined | 0.92 (0.32–2.63) | 0.877 | 0.92 (0.28–2.94) | 1.000 |

According to the outcome of table 3, univariate analysis has suggested that 60% reduced odds of re-infection with systemic fluoroquinolones (OR 0.42, 95% CI 0.04 to 2.46) or rifampicin treatment (OR 0.41, 95% CI 0.08 to 2.12) for up to 31 days.

## Discussion

According to analysis, the deep SSI is specifically implant-related infections that demand aggressive surgical management. There are some decisive factors that play a critical role in managing the infection. The particular devices that used for surgery is having a significant impact on the infection rate and mobility. However, systemic antibiotics are used for treating the implant associated orthopaedic infection. There are some guidelines were also made for managing the operational activities and planning of the actions to minimize the infection and improve the health of the patients and staff members. As per the outcome of the current study, the case patients were more likely involved in smoking especially male with the fracture fixation device.

Moreover, the systematic antibodies treated was used for 14 and used for the 22 case and 109 control patients. The Univariate regression analysis has suggested an improvement in risk of recurrent infection with longer antibiotic treatment (OR 1.82, 95% CI 1.00 to 3.28, $p = 0.049$). Male gender (OR 2.42, 95% CI 1.30 to 4.53, $p = 0.005$), smoking (OR 2.05, 95% CI 1.09 to 3.88, $p = 0.027$), and infection of a fracture fixation device (OR 2.25, 95% CI 1.21 to 4.2, $p = 0.032$) were associated with an increased likelihood of developing relapse.

As per the study of Burch et al., (2019) [14], in orthopaedic trauma, adequate timing of definitive fracture fixation after damage-control, if necessary, remains a mainstay of preventing deep infections and other complications. Minimally invasive access routes and biologically designed implants may further decrease the risk of infection because of fewer traumas to surrounding soft tissues, thereby avoiding a surgical second hit. The information related to the patient's sub-sample with extramedullary fracture device-associated infections [15]. Moreover, the baseline criteria were found well in both case and control and none of them is related to recurrent infection in univariate analysis. [16 ]

## Conclusion

From the analysis, it has been considered that exposure of the infection in surgical process is having a significant impact on the health of the patients and affecting the recovery. Moreover, the large-scale confirmatory trails are needed for confirm the issues and developing the systematic process of reducing the reinfection among the surgical patients. The shorter treatment trails are not sufficient for maintaining the hygiene level and influencing the health of the patients.

## References

1. Onsea J, Wagemans J, Pirnay JP, Di Lucas M, Gonzalez-Moreno M, Lavigne R, Trampuz A, Moriarty TF, Metsemakers WJ. Bacteriophage therapy as a treatment strategy for orthopaedic-device-related infections: where do we stand?. European Cells & Materials. 2020;39:193-210.
2. Goh GS, Tornetta III P, Parvizi J. Facilitating the Approval Process of Anti-Infective Technologies and Advancing Them to the Market: Insights from an FDA Workshop on Orthopaedic Device-Related Infections. JBJS. 2021 Aug 4;103(15):e57.
3. Sumrall ET, Hofstee MI, Arens D, Röhrig C, Baertl S, Gehweiler D, Schmelcher M, Loessner MJ, Zeiter S, Richards RG, Moriarty TF. An Enzybiotic Regimen for the Treatment of Methicillin-Resistant Staphylococcus aureus Orthopaedic Device-Related Infection. Antibiotics. 2021 Oct;10(10):1186.
4. Burch MA, Keshishian A, Wittmann C, Nehrbass D, Styger U, Muthukrishnan G, Arens D, Stadelmann V, Richards R, Moriarty T, Thompson K. The non-steroidal anti-inflammatory drug carprofen negatively impacts new bone formation and antibiotic efficacy in a rat model of orthopaedic-device-related infection. Eur. Cells Mater. 2021 Jun 17;41:739-55.

5. Spitzmüller R, Gümbel D, Güthoff C, Zaatreh S, Klinder A, Napp M, Bader R, Mittelmeier W, Ekkernkamp A, Kramer A, Stengel D. Duration of antibiotic treatment and risk of recurrence after surgical management of orthopaedic device infections: a multicenter case-control study. BMC Musculoskeletal Disorders. 2019 Dec;20(1):1-0.
6. Foster AL, Boot W, Stenger V, D'Este M, Jaiprakash A, Eglin D, Zeiter S, Richards RG, Moriarty TF. Single-stage revision of MRSA orthopedic device-related infection in sheep with an antibiotic-loaded hydrogel. Journal of Orthopaedic Research®. 2021 Feb;39(2):438-48.
7. Plate A, Weichselbaumer V, Schüpbach R, Fucentese SF, Berli M, Hüllner M, Achermann Y. Diagnostic accuracy of 99mTc-antigranulocyte SPECT/CT in patients with osteomyelitis and orthopaedic device-related infections: A retrospective analysis. International Journal of Infectious Diseases. 2020 Feb 1;91:79-86.
8. Li P, Gao Z, Tan Z, Xiao J, Wei L, Chen Y. New developments in anti-biofilm intervention towards effective management of orthopedic device related infections (ODRI's). Biofouling. 2020 Dec 30;37(1):1-35.
9. Dudareva M, Barrett L, Figtree M, Scarborough M, Watanabe M, Newnham R, Wallis R, Oakley S, Kendrick B, Stubbs D, McNally MA. Sonication versus tissue sampling for diagnosis of prosthetic joint and other orthopedic device-related infections. Journal of clinical microbiology. 2018 Nov 27;56(12):e00688-18.
10. Richards RG, Moriarty TF, D'Este M. Novel antimicrobial approaches to prevent orthopaedic device-related infection. InOrthopaedic Proceedings 2021 Nov. The British Editorial Society of Bone & Joint Surgery. 2021:103(13): 97-97.
11. Pirisi L, Pennestrì F, Viganò M, Banfi G. Prevalence and burden of orthopaedic implantable-device infections in Italy: a hospital-based national study. BMC infectious diseases. 2020 Dec; 20(1):1-1.
12. Stučinskas J, Bakutis P, Smailys A. Suortopediniaistraumatologiniaisimplantaiss usijusiinfekcija: šiuolaikinėsprevencijosirgydymogairės= Orthopaedic and trauma device-related implant infection: current guidelines for improved diagnostics and treatment. Lietuvosbendrosiospraktikosgydytojas. Kaunas: Vitae Litera, 2019, t. 23, Nr. 6. 2019.
13. Onsea J, Post V, Buchholz T, Schwegler H, Zeiter S, Wagemans J, Pirnay JP, Merabishvili M, D'Este M, Rotman SG, Trampuz A. Bacteriophage Therapy for the Prevention and Treatment of Fracture-Related Infection Caused by Staphylococcus aureus: a Preclinical Study. Microbiology spectrum. 2021 Dec 15;9(3):e01736-21.
14. Margute, T. G., Ferreira , P. C., Almeida , I. M. M., Denardin, C., Silva , T. Q. M. da, Margute, T. G., Maione, M. S., Rossato, A. R., & Santos, I. F. dos. Use of tricyclic antidepressants in trigeminal neuralgia. Journal of Medical Research and Health Sciences, 2022:5(5), 2008–2012.
15. Burch MA, Thompson K, Eberli U, Arens D, Milstrey A, Stadelmann V, Richards G, Moriarty F. Non-steroidal anti-inflammatory drug administration impairs antibiotic treatment of orthopaedic device-related infection in a rat model. InOrthopaedic Proceedings 2019 Dec. The British Editorial Society of Bone & Joint Surgery. 2019:101:(14):87-87.
16. Depypere M, Morgenstern M, Kuehl R, Senneville E, Moriarty TF, Obremskey WT, Zimmerli W, Trampuz A, Lagrou K, Metsemakers WJ. Pathogenesis and management of fracture-related infection. Clinical Microbiology and Infection. 2020 May 1;26(5):572-8.