IJHSR International Journal of Health Sciences and Research
www.ijhsr.org ISSN: 2249-9571

Original Research Article

Role of Controlled Diabetes on Implant Infection - An Institutional Based Study

Dr. Purushothama Sastry[1], Dr. Amithash Rangare Laxmana[2], Dr. Mruthynjaya[3]

[1]Professor, [2]Post Graduate student, [3]Professor and Head,
Department of Orthopaedics, JSS Medical College and Hospital, JSS University, Mysore

Corresponding Author: Dr. Amithash Rangare Laxmana

ABSTRACT

Context: Implant surgery has become one of the most common orthopaedic operations in modern era because of the success of this procedure in restoring function of the affected joint. But orthopaedic implant infections are increasing because of their morbidity and their tendency for serious relapses. Diabetic patients are at high risk for adverse effects following surgery. As the prevalence of diabetes mellitus in people is expected to increase, the number of diabetic patients who undergo orthopaedic surgeries should be expected to increase accordingly. Thus the glycemic control in diabetic individuals has a significant impact on the post-operative outcome. The goal of the present study was to evaluate the role of controlled diabetes on implant infections in orthopaedics. Meanwhile the incidence rate of implant infection was studied as well and as we studied the different micro-organisms isolated from implant infected site.
Aims: To study the role of controlled diabetes on implant infections; to study incidence of infection among patients who have undergone implant surgery. And to study different micro-organisms isolated from the implant infected sites.
Materials and Methods: A total of 40 subjects were included in the study. The study group (n=20) consisted of 20 individuals who were diabetic but their sugar levels were under control with infected implant. The control group (n =20) consisted of healthy individuals who are non-diabetic with infected implant. The HB1AC, Fasting blood sugar (FBS) and post-prandial blood sugar (PPBS) levels were assessed. During surgery, three to five tissue specimens were collected for microbiological and one for histopathological examination. The results were statistically analyzed using Independent t-test.
Results: The data analysis revealed that the control and study group showed significant difference in the HB1AC, FBS, PPBS levels. The range of age in the present study varied from 67 years to 37 years; with the mean age of 50 years in control group and 51years in study group.
In the control group, out of 20 patients, 16 were male and 4 were female. In the study group, out of 20 patients, 13 were male and 7 were female. The incidence rate of implant infection during this study was found to be 3.54%. *Staphylococcus aureus* (25%) was the most common isolate in implant infections followed by *Pseudomonas species* (18%), *Enterobacter* (12%), *Acinetobacter species* (9%).
Conclusion: The present study showed that controlled diabetes had a negative impact on implant infections compared to non- diabetic patients. The incidence rate of implant infection during this study was found to be 3.54%. *Staphylococcus aureus* (25%) was the most common isolate in implant infections followed by *Pseudomonas species* (18%), *Enterobacter* (12%), *Acinetobacter species* (9%).

Keywords: Implant infections, controlled diabetic patients, and Non-diabetic patients.

INTRODUCTION

Diabetes has classically been defined as a group of metabolic diseases characterized by hyperglycemia due to defects in insulin secretion, insulin action, or a combination of both. [1] The vast majority of diabetic cases can be classified as either type 1 or type 2 diabetes. Type 1 diabetes is generally due to β-cell destruction leading to absolute insulin deficiency. This form accounts for roughly 5–10% of diabetic cases, and individuals at increased risk can often be identified by evidence of autoimmune pathologic processes occurring at the pancreatic islets. [1] Type 2 diabetes is characterized by a progressive insulin secretory defect within a setting of insulin resistance. [2] Approximately 90–95% of diabetic cases are type 2. [1] Management of glycemic levels in diabetic patients is critical, as persistent hyperglycemia may lend itself to a number of complications including cardiovascular disease, nephropathy, retinopathy, neuropathy, and various foot pathologies. [2]

Patients with diabetes mellitus have a higher incidence of surgical intervention than patients without diabetes mellitus. [3] Patients with diabetes mellitus have an increased risk for surgical complications, and after surgery, diabetic patients have an increased length of hospital stay when compared with patients who do not have diabetes mellitus. [4] Surgical intervention can disrupt the management of diabetes mellitus, which can lead to hyperglycemia in the postoperative period. [3-5] Optimal management of hyperglycemia has been shown to minimize complications after surgical intervention, whereas suboptimal perioperative glucose control is associated with increased morbidity in the postoperative period. Furthermore, an association between diabetes mellitus and infection after orthopedic operation has been previously described. [6-8]

In modern era implant surgery has become one of the commonest orthopaedic operation because of the success of this procedure in restoring function of the affected joint. This is the major procedure to alleviate pain and improve mobility, but post-operative infection is a devastating complication. [9] Orthopaedic implant infections are significant because of their morbidity and their tendency for serious relapses. [10] It can be an economic disaster for hospitals that treat a large number of these patients. Once deep infection is established, rapid, aggressive and definitive treatment must be rendered to the patient. Removal and replacement of prosthesis or implant are usually required to eradicate the infection, antibiotic treatment to reduce the risk of recurrence. [10]

Patients with diabetes are at increased risk for adverse events following surgery. [11] As the prevalence of diabetes mellitus in people is expected to increase, the number of diabetic patients who undergo orthopaedic surgeries should be expected to increase accordingly. [11] Thus the glycemic control in diabetic individuals has a significant impact on the post-operative outcome. The goal of the present study is to evaluate the role of controlled diabetes on implant infections in orthopaedic and to study incidence of infection among patients who have undergone implant surgery and lastly to study different organisms isolated from implant infected sites.

MATERIALS AND METHODS

The Present study was a randomized case control study conducted on patients reporting to the casualty/ OPD and getting admitted under JSS hospital, Mysore under the Department to Orthopaedics during November 2015 to May 2017. A total of 40 subjects were included in the study. The study group (n=20) consisted of 20 individuals who were diabetic but their sugar levels were under control with infected implant. The control group (n =20) consisted of healthy individuals who are non-diabetic with infected implant. The HB1AC, Fasting blood sugar (FBS) and post-prandial blood sugar (PPBS) levels were assessed. During surgery, three to five tissue specimens were collected for microbiological and one for histopathological examination. The results were statistically analyzed using Independent t-test.

Definition of an infected implant:

Infection was confirmed if at least one of the following criteria was present

- Growth of the same micro-organism on two or more cultures of either a pre-operative aspirate or intra-operative tissue specimens
- Purulence of the pre-operative aspirate or intra-operative tissue, as determined by the surgeon
- Acute inflammation on histopathological examination of intra-operative tissue sections.

Ethical committee clearance and prior informed consent of all the subjects was obtained before conducting the study. Independent t-test was applied to statistically determine significant difference between the groups.

RESULTS

TABLE I: Comparison between Control and Study Group

	Groups	N	Mean	Standard Deviation	p-value
HB1AC	Control Group	20	4.52	0.50	< 0.001*
	Study Group	20	7.41	0.56	
FBS	Control Group	20	82.75	7.87	< 0.001*
	Study Group	20	137.90	6.33	
PPBS	Control Group	20	115.95	19.12	< 0.001*
	Study Group	20	225.60	10.62	

p-value based on Independent-t-Test
* = Statistically Significant ($p < 0.05$)

TABLE II: Age statistics in both groups

	Control Group	Study Group
Mean	50.0619	51.8000
Standard Deviation	12.69529	9.21441
Minimum	4.30	37.00
Maximum	62.00	67.00

TABLE III: Control Group Gender Statistics

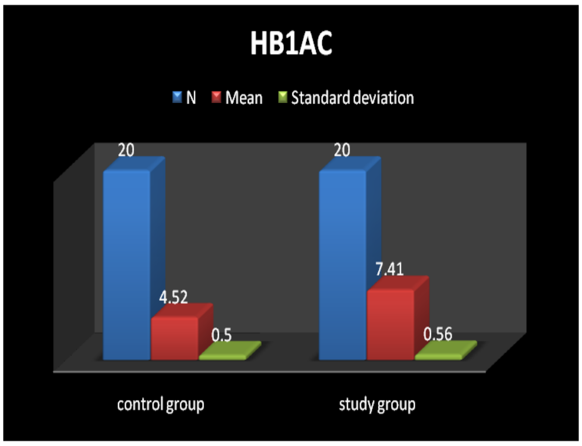
	Frequency	Percent
Male	16	80.0
Female	4	20.0
Total	20	100.0

Table IV: Study Group Gender Statistics

	Frequency	Percent
Male	13	65.0
Female	7	35.0
Total	20	100.0

Table V: Different micro-organisms isolated from implant infection sites of present study

Micro-organisms	Number	Percentage
Staphylcoccus aureus	14	25%
Pseudomonas species	10	18%
Enterobacter species	07	12%
Acinetobacter baumannii	05	09%
Enterococci	04	7.27%
Alpha – hemolytic streptococci	03	5.45%
Coagulase negative staphylococcus	03	5.45%
Escherichia coli	03	5.45%
Staphylococcus epidermis	02	3.6%
Beta-hemolytic streptococci	01	1.8%
Klebsiella pneumoniae	01	1.8%
Proteus mirabilis	01	1.8%
Serratia ficaria	01	1.8%

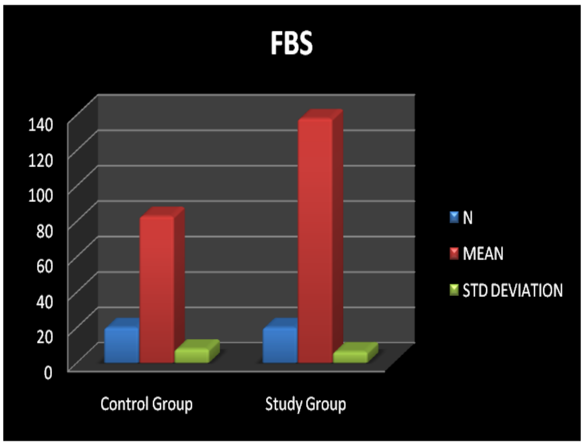


GRAPH 1: Comparison of HB1AC levels between controlled diabetic and non-diabetic patients with infected implants

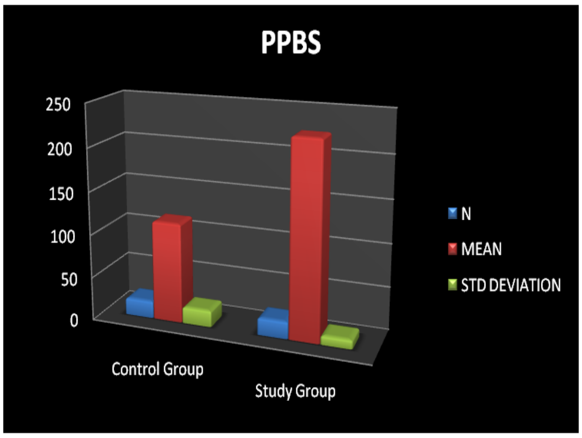
Table VI: Various studies about different micro-organisms isolated from implant infections [20]

	Sonawane *et al* 2010	Goel *et al* 2013	Jain *et al* 2014	Muhammed et al 2014
Common Isolate	*Staphylococcus aureus* (29.26%)	*Staphylococcus aureus* (32.8%)	*Staphylococcus aureus* (26.6%)	*Staphylococcus aureus* (33.3%)
GPC Resistance	Penicillin (75.32%) Cotrimoxazole (69.9%)	Ciprofloxacin (47.5%) Cotrimoxazole (32.5%)	Penicillin (89.1%) Oxacillin (93.75%)	Cefoxitin (64%) Penicillin (60%) Ciprofloxacin (36%)
GNB Resistance	Ampicillin (88%) Ceftriaxone (69.8%) Ceftazidime (69.8%)	Cefuroxime (81.5%) Cefotaxime (78%)	Amoxyclav (80.8%) Ceftriaxone (76%)	Cotrimoxazole (65%) Ciprofloxacin (60%) Ceftriaxone (60%)
Methicillin Resistance	27.85%	30%	40%	64%
ESBL Production	71.72%	-	-	60%

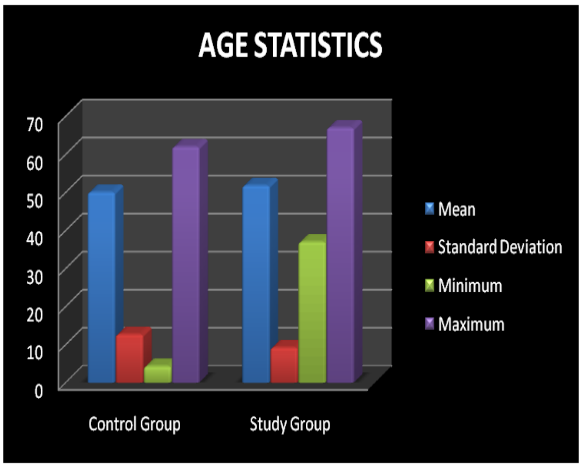
GPC-Gram positive cocci, GNB-Gram negative bacilli, ESBL-Extended spectrum beta lactamase



GRAPH 2: Comparison of FBS levels between controlled diabetic and non-diabetic patients with infected implants

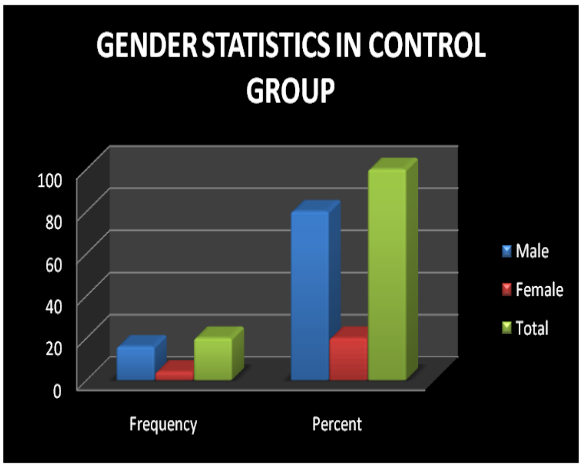


GRAPH 3: Comparison of FBS levels between controlled diabetic and non-diabetic patients with infected implants

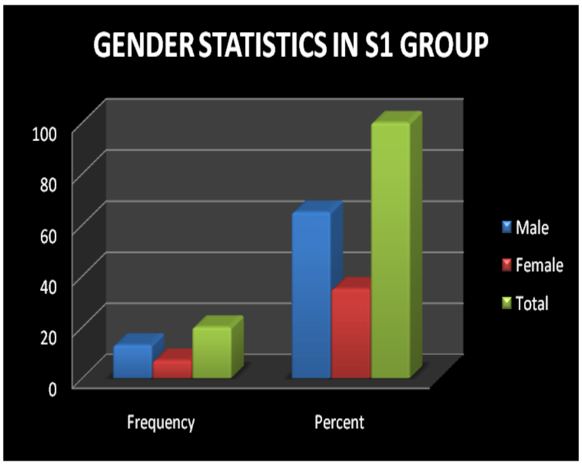


Graph 4: Age statistics in control group and study group

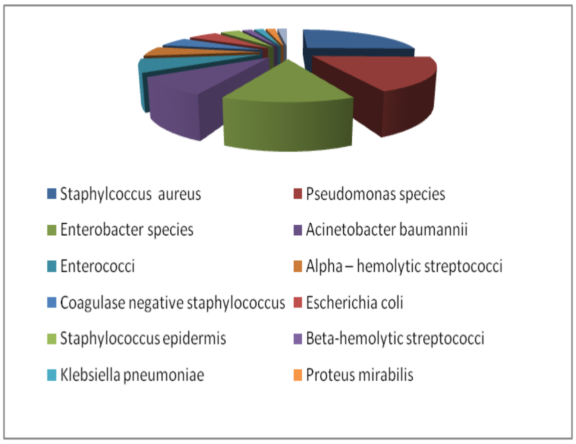
When Independent t-test was used to compare the controlled diabetic patients and non- diabetic patients with infected implants, the values were significant between control group and study group for HB1AC levels, FBS levels and PPBS levels. The values of mean with standard deviation were calculated for the two groups and are given in Table 1 and graph 1, 2 and 3. The range of age in the present study varied from 67 years to 37 years; with the mean age of 50 years in control group and 51years in study group (Table 2 and graph 4). In the control group, out of 20 patients, 16 were male and 4 were female (Table 3 and graph 5). In the study group, out of 20 patients, 13 were male and 7 were female (Table 4 and graph 6).



Graph 5: Gender statistics in control group



Graph 6: Gender statistics in study group



Graph 7: Different micro-organisms isolated from the implant infection sites

Figure 1: The infected implant site

DISCUSSION

In the present study, the study group showed increased rate of implant infections compared to the control group who are non-diabetic which was in agreement with study done by Milford H. Marchant Jr. et al, who found that compared to patients with controlled diabetes, those with uncontrolled diabetes had significantly increased risk of post operative haemorrhage, wound infection and death. [11] In a study done by W. J. Choi et al, compared clinical and radiographic results of total ankle replacement of which 25 controlled diabetes and 18 uncontrolled diabetes patients and they concluded that the uncontrolled diabetic group had a significantly poorer outcome and higher rate of delayed wound healing which was in accordance with the present study. [12] Richard et al concluded that patients with diabetes have a higher incidence of infection after total joint arthroplasty (TJA) than patients without diabetes. Hemoglobin A1c levels were examined to evaluate if there was a correlation between the control of HbA1c and infection after TJA and concluded that Hemoglobin A1c (HbA1c) levels are a marker for blood glucose control in diabetic patients. [13] One observational study by Agos et al. demonstrated that implementation of an evidence-based standard to control hyperglycemia reduced the rate of surgical site infection in people undergoing hip and knee replacement surgery. [14] A retrospective study done by Hyuk Soo Han et al consisting of one hundred and sixty-seven TKAs performed in 115 patients with type 2 diabetes mellitus, were reviewed. They concluded that poorly controlled hyperglycemia before surgery may increase the incidence of wound complications among diabetic patients after TKA. [15]

Hyperglycemia impairs leucocyte function causing immunocompromise with consequences for superficial and deep tissue infection as well as overall mortality. In particular, recent evidence suggests that hyperglycemia plays a significant role in the development of postoperative infections, and it has also been reported to delay collagen synthesis and impair phagocytosis. These factors translate into higher risk of various infections and poorer wound healing after any surgical procedure in diabetic patients. [15]

In diabetic patients, the association between hyperglycemia and susceptibility to infection has been well established. [16] Several factors, such as genetic susceptibility to infection, altered cellular and humoral immune defense mechanisms, local factors, including poor blood supply and nerve damage, and the defective regulation of collagen synthesis could predispose diabetic patients to infections. [17,18]

INCIDENCE RATE:

In the present study, the incidence rate of implant infections from November 2015 till May 2017 was 3.54%. A retrospective study done by Hyuk Soo Han et al consisting of one hundred and sixty-seven TKAs performed in 115 patients with type 2 diabetes mellitus showed the overall incidence of wound complications was 6.6% (n = 11) and there were seven cases (4.2%) of early postoperative deep infection. [15]

DIFFERENT ORGANISMS IN IMPLANT INFECTIONS:

In the present study, *Staphylococcus aureus (25%)* was common isolate followed by *Pseudomonas species (18%), Enterobacter (12%), Acinetobacter species*

(9%), Coagulase Negative Staphylococci (CONS) (5.45%), *Escherichia coli (*3%) *Klebsiella sps (1%)*, Proteus species (1%). A prospective study of isolate and to identify organisms from postoperative Orthopaedic implant infections done by Satya Chandrika et al showed that out of 50 samples, 45(90%) were culture positive and 5(10%) were sterile for aerobic bacteria. *Staphylococcus aureus (30%) is common isolate followed by* Coagulase Negative Staphylococci (CONS) (20%), *Escherichia coli (16%), Klebsiella sps (10%), Pseudomonas aeruginosa (6%), Acinetobacter species* (4%), Proteus species (4%). [19] The table VI shows various other studies done about the different micro-organisms seen in implant infections. [20]

The drawbacks of the present study was the smaller sample size and other risk factors affecting the implant infections might cause the bias of this study such as intrinsic factors like aging, patients health condition & extrinsic factors like post surgical sepsis, dirty contaminated wounds, nosocomial infections.

CONCLUSION

To conclude, Controlled diabetes has negative impact on implant infections compared to non- diabetic patients. *Staphylococcus aureus (25%) was the most common isolate in implant infections followed by Pseudomonas species (18%), Enterobacter (12%), Acinetobacter species.*

ACKNOWLEDGEMENT

I am thankful to the Department of Orthopaedics, JSS Medical College and Hospital, JSS University, Mysore for the support and guidance for the study.

REFERENCES

1. American Diabetes Association, “Diagnosis and classification of diabetes mellitus,” *Diabetes Care*, vol. 33, supplement 1, pp.S62–S69, 2010.
2. American Diabetes Association, “Standards of medical care in diabetes—2014,” *Diabetes Care*, vol. 37, supplement 1, pp. S14–S80, 2014.
3. Golden SH, Peart-Vigilance C, Kao WH, et al. Preoperative glycemic control and risk of infectious complications in a cohort of adults with diabetes. Diabetes Care 1999;22:1408.
4. Krinsley JS. Association between hyperglycemic and increased hospitalization in a heterogeneous population of critically ill patients. Mayo Clinic Proceedings 2003; 78:1471.
5. Rizvi AA, Chiloag SA, Chiloag KJ. Peri-operative management of diabetes in hyperglycemia in patients undergoing orthopaedic surgery. J AAOS 2010; 18:426.
6. Fang A, Hu SS, Enres N, et al. Risk factors for infection after spinal surgery. Spine 2005;30:1460.
7. Marchant Jr MH, Viens NA, Cook C, et al. The impact of glycemic control in diabetes mellitus on per-operative outcomes after total joint arthroplasty. J Bone Joint Surg, Am 2009;91:1621.
8. Wimmar C, Gulch H, Franzrab M, et al. Predisposing factors for infection in spine surgery: a survey of 850 spinal procedures. J Spinal Disorders 1998;11:124.
9. S.C. Goel. Infection following implant surgery. Indian Journal of Orthopaedics 2006;40:133-137.
10. John J. Anderson, Myron Hansen, Gregory Paul Rowe, Zflan Swayzee. Complication rates in diabetics with first metatarsophalangeal joint arthrodesis. Diabetic Foot and Ankle 2014;5:24649.
11. Milford H Marchant Jr., Nicholas A Veins, Chad Cook, Thomas Parkar Vail. The Impact of Glycemic Control and Diabetes Mellitus on Perioperative Outcomes After Total Joint Arthroplasty . The Journal of Bone and Joint surgery 2009;91:1621-9.
12. W. C. Choi, J. S. Lee, M. Lee, J. H. Park, et al. The impact of diabetes on the short- to mid-term outcome of total ankle replacement. The Bone and Joint Journal 2014;96-B:1674–80.
13. Richard Iorio, Kelly M. Williams, Andrew J. Marcantonio, Lawrence M. Specht et al. Diabetes Mellitus, Hemoglobin A1C, and the Incidence of Total Joint Arthroplasty Infection. The

Journal of Arthroplasty 2017 doi:10.1016/j.arth.2011.09.013.
14. Agos F, Shoda C, Bransford D, et al. Part II: managing perioperative hyperglycemia in total hip and knee replacement surgeries. Nurs Clin North Am. 2014;49(3):299–308.
15. Han et al. Relations between Glycemic Control and Complications of Total Knee Arthroplasty in Diabetes. Clinics in Orthopedic Surgery 2013;5(2):118-123.
16. Pozzilli P, Leslie RD. Infections and diabetes: mechanisms and prospects for prevention. Diabet Med. 1994;11(10):935- 41.
17. Brenner RE, Riemenschneider B, Blum W, et al. Defective stimulation of proliferation and collagen biosynthesis of human bone cells by serum from diabetic patients. Acta Endocrinol (Copenh). 1992;127(6):509-14.
18. Robertson HD, Polk HC, Jr. The mechanism of infection in patients with diabetes mellitus: a review of leukocyte malfunction. Surgery. 1974;75(1):123-8.
19. Satya Chandrika and Surya Kirani KRL. Bacteriological Spectrum of Post Operative Orthopedic Implant Infections and Their Antibiogram. JKIMSU 2016; 1 (5): 20-26.
20. Muhammad Qaisar shah et al. Surgical site infection in orthopaedic implants and its common bacteria with their sensitivities to antibiotics, in open reduction internal fixation. J Ayub Med Coll Abbottabad 2017;29(1):50-3.

How to cite this article: Sastry P, Laxmana AR, Mruthynjaya. Role of controlled diabetes on implant infection – an institutional based study. Int J Health Sci Res. 2017; 7(8):65-71.

****