

Original Research Article

Association between haemoglobin A1C/albumin ratio and deep postoperative infection after total joint arthroplasty: a single centre study

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ABSTRACT

Background: Till the time in modern practice in a centre where total joint arthroplasty (TJA) including hip and knee mainly is being done in high volume (>100 TJA in a month), there are no guiding parameters to estimate the risk of developing periprosthetic infections in diabetes mellitus. This study aims to compare the risks of periprosthetic infection in patients undergoing total joint arthroplasty with diabetes mellitus (DM) and to investigate the predictive significance of the HbA1c/albumin ratio, so that a guideline can be given to avoid such dreaded complication in diabetic patients.

Methods: Between January 2019 and January 2023, 490 patients who underwent total joint arthroplasty were analysed. 187 diabetic patients were included in the study. 28 of them had periprosthetic infection. Six risk factors (HbA1c/albumin, age, BMI, ASA, length of hospital stay, and surgical duration) were analysed.

Results: The rate of HbA1c/albumin was 13.9 times higher than the patients with ≤ 2.35 cut off value. (HbA1c/albumin ratio (odds ratio (OR)=13.9, 95% CI: 3.18-67.1, p: 0.01). BMI (OR=1.6, 95% CI: 1.168-2.199, p<0.003), DM (OR=0.365, 95% CI: 0.135-0.987, p: 0.04) and glucose (OR=1.016, 95% CI: 1.004-1.029, p: 0.011) were risk factors for periprosthetic infection. Albumin (OR=0.503, 95% CI: 0.109-2.314, p: 0.378) was not found to be a significant risk factor for periprosthetic infection.

Conclusions: In view of our observation in present study we analysed that the HbA1c/albumin ratio has a reliable prognostic indicator than other risk factors in determining the chances of catching the risk of periprosthetic infection after TJA. HbA1c/albumin ratio is a cost effective and easily available parameter to many centres without posing much cost burden. Patients with an HbA1c/albumin cut-off ratio above 2.35 mg/dl in TJA better should avoided from surgery and should be followed more closely for the risk of periprosthetic infection after TJA.

Keywords: HbA1c/albumin ratio, Periprosthetic infection, Risk factors, Total joint arthroplasty, Diabetes mellitus

INTRODUCTION

Diabetes mellitus (DM) is considered as slow poison for multiple system of body if not taken care of properly. People with diabetes mellitus may have pathological conditions that require more surgical intervention than

normal healthy people.¹ Various published literature showed that the risk of surgical complications including intraoperative and postoperative and the average length of hospital stay (ALOS) after surgery increase in patients with diabetes mellitus. Postoperative wound and infectious complications after total knee arthroplasty (TKA) cause

poor overall outcomes and increase health care costs, particularly among patients with diabetes mellitus, who have greater risks of infection.^{2,3} It has also been reported to delay collagen synthesis⁴ and impair phagocytosis.⁵

Total joint arthroplasty (TJA) is an effective surgical procedure applied in patients with advanced osteoarthritis of the knee and hips. Periprosthetic infection (PPI) is a difficult and common complication to treat in total joint arthroplasty. Although measures such as antibiotic prophylaxis and new surgical techniques have increased recently, the number of infections is increasing with increasing surgery rates.⁶

Albumin is a negative phase reactant that decreases during inflammation. An increased incidence of risk of infection after surgical interventions at low albumin values has been reported in the literature.⁷ Patients, those with diabetes with inadequate glycaemic control showed an increased risk rate for PPI and other systemic problems after TJA.⁸

One should target to keep HgbA1c levels below 7% in patients with diabetes mellitus (normally between 4% and 7%).⁹ Haemoglobin A1c (HgbA1c) is a serological marker showing an average systemic glucose concentration in the past 1 to 3 months.⁹ An easily available and cost-effective scoring system may be needed to determine the risk factors in developing PPI in diabetics. We could not find any specific study in the literature investigating the relationship of the HbA1c/albumin marker to PPI risk in patients with DM.

Author's goal is to investigate the risks of periprosthetic infection in TJA patients with DM, and to compare with the HbA1c/albumin ratio, and to investigate the predictive significance of the HbA1c/albumin ratio.

METHODS

Authors retrospectively analysed 490 patients with osteoarthritis who underwent TJA between January 2019 and January 2023. Among these, 187 patients (38.2%) had DM. Twenty-eight patients with DM developed periprosthetic infection (PPI; Group 1), while 159 patients with DM did not (Group 2).

Six potential risk factors were evaluated: HbA1c/albumin ratio, age, body mass index (BMI), American Society of Anesthesiologists (ASA) score, hospital stay, and operative time.

Inclusion criteria

Primary osteoarthritis, no history of joint infection or prior primary arthroplasty were included.

Exclusion criteria

Incomplete or unreliable clinical data, secondary osteoarthritis, previous surgery on the index joint for

trauma, infection, inflammatory, neoplastic, or metabolic conditions were excluded.

All patients underwent routine pre- and postoperative blood investigations, urine culture, and nasal swab culture.

Surgical technique

TKA was performed via a standard medial parapatellar approach using a tourniquet. Total hip arthroplasty (THA) was performed using a direct lateral (modified Hardinge) approach. Gentamicin-loaded CMW1-G bone cement was used in all TKA and cemented THA procedures.

Antibiotic prophylaxis

Cefuroxime 1.5 g every 12 hours was administered for 48 hours postoperatively. Clindamycin or linezolid was substituted in patients with a penicillin allergy.

Postoperative care

No drains were used. Physiotherapy and muscle-strengthening exercises began within 24 hours, and patients were mobilized on the first postoperative day.

Clinical and radiographic follow-up was routinely scheduled at 2, 6, and 12 weeks, and extended in cases of infection, restricted range of motion (ROM), or persistent pain.

Definition of periprosthetic infection

PPI was defined according to the International Consensus criteria¹⁰. A definite infection was diagnosed when.

A sinus tract was associated with the prosthesis, or the same pathogen was isolated from at least two separate periprosthetic tissue or fluid cultures, or at least three of the following five findings were present.

Elevated serum ESR and CRP, increased synovial white cell count or positive (++) leukocyte esterase, elevated synovial polymorphonuclear percentage, positive histological analysis of periprosthetic tissue, a single positive culture

Written informed consent was obtained from all participants. Data were anonymized to ensure blinding and eliminate bias.

Statistical analysis

Data analysis was performed using SPSS version 23.0 (IBM Corp., Armonk, NY, USA). Continuous variables are presented as mean \pm standard deviation (SD) and range; categorical variables as frequency and percentage.

Comparisons between groups were performed using the Chi-square test or Student's t-test. Univariate binary logistic regression identified prognostic factors for PPI.

Receiver operating characteristic (ROC) curve analysis determined the diagnostic performance of HbA1c/albumin ratio.¹¹ A p value <0.05 was considered statistically significant (95% confidence interval, 5% margin of error).

RESULTS

Of the 490 patients, 112 (22.9%) were male and 378 (77.1%) were female. Twenty-eight patients (15.1% of those with DM) developed PPI during a mean follow-up of 41.8±1.1 months.

Microbiology

Wound cultures grew *Staphylococcus epidermidis* in 9 cases, 14 cases of methicillin-resistant *Staphylococcus aureus* (MRSA), and 5 cases of methicillin-sensitive *S. aureus* (MSSA) (odds ratio (OR)=2.64; 95% CI: 1.25–5.55; p=0.017).

Univariate analysis

Significant differences between Group 1 and Group 2 were observed for HbA1c/albumin ratio (p<0.001), HbA1c (p=0.02), glucose (p=0.05), BMI (p=0.01), Operation time

(p=0.033). No significant differences were found for ASA score (p=0.036), age (p=0.884), albumin (p=0.502), or hospital stay (p=0.535).

Cut-off analysis

The optimal HbA1c/albumin ratio cut-off predicting PPI was 2.35.

Sensitivity

0.90, specificity: 0.62, area under ROC curve (AUC): 0.868 (p < 0.001)

Multivariate analysis

Independent risk factors for PPI in patients with DM included HbA1c/albumin ratio > 2.35 (OR = 14.6; 95% CI: 3.18–67.1; p=0.01), HbA1c (OR = 2.6; 95% CI: 1.53–4.75; p=0.001), BMI (OR=1.6; 95% CI: 1.17–2.20; p=0.003), glucose (OR=1.016; 95% CI: 1.004–1.029; p=0.011), Diabetes mellitus status (OR = 0.365; 95% CI: 0.135–0.987; p=0.04). Serum albumin alone was not an independent risk factor (OR=0.503; 95% CI: 0.109–2.314; p=0.378).

Table 1: Patient demographics.

Variable	Total knee arthroplasty (TKA)	Total hip arthroplasty (THA)
Gender (F/M)	253/47	116/74
Mean age (years)	62.5±5.2	46.3±12.0
BMI (kg/m ²)	29.8±3.7	28.1±3.6
Diabetes mellitus (n)	128	59
Follow-up (months)	45±21.4	39±19.3
Operation time (minutes)	76±24.9	95±15.5
Hospital stay (days)	4.2±1.7	5.5±3.9
Periprosthetic infection (n)	51	23

Table 2: Comparison of risk factors.

Variable	Group 1	Group 2	P value
HbA1c/Albumin ratio	3.13±0.7	2.06±0.6	<0.001
Albumin (g/dl)	3.27±0.3	4.43±5.3	0.502
HbA1c (%)	10.2±2.4	7.05±1.2	0.02
Age (in years)	60.9±11.5	61.4±6.1	0.884
BMI (kg/m ²)	33.6±2.5	30.1±3.0	0.01
Hospital stays (days)	4±2.3	4.8±4.2	0.535
Operation time (minutes)	76±24.9	95±15.5	0.03
ASA score (≤2 / >3)	2/8	34 /0	0.036

Table 3: Evaluation of independent predictors of PPI by ROC curve analysis.

Variable	Area (AUC)	Std. Error	Asymptotic Sig. (P)	95% confidence interval
HbA1c/albumin ratio	0.818	0.063	0.000	0.739–0.991
HbA1c	0.851	0.066	0.000	0.732–1.000
BMI	0.764	0.067	0.003	0.661–0.927
Albumin	0.616	0.077	0.252	0.463–0.766
Glucose	0.767	0.079	0.007	0.609–0.921

DISCUSSION

The primary finding of this study is that the HbA1c/albumin ratio serves as a prognostic marker for PPI following TJA in patients with diabetes mellitus. This ratio showed positive correlations with other important prognostic indicators, including BMI, age, operation time, hospital stay, serum glucose, HbA1c, and albumin levels. Periprosthetic infection, defined as infection involving the prosthesis and surrounding tissues, has been reported to occur in 3–8% of arthroplasty cases in the general population.^{1,9,12} The cohort demonstrated a higher rate of 15.15%, which can be attributed to the exclusive inclusion of diabetic patients—a group known to have a 3- to 6-fold higher risk of PPI compared with non-diabetics.¹³ Preventing PPI requires careful identification and management of pre-, intra-, and postoperative risk factors.

Previous studies have highlighted the role of glycaemic control in reducing surgical site infections. Jasmen et al reported a significant association between HbA1c >6.5 mg/dl and PPI after total knee and hip arthroplasty, while Han et al and Kang et al observed increased early wound complications at HbA1c >8 mg/dl.^{14,15} In our study, high HbA1c levels increased the risk of PPI by 2.6-fold, but the HbA1c/albumin ratio was an even stronger predictor, elevating risk 14.6-fold with 90% sensitivity and 62% specificity.

Hypoalbuminemia is another known contributor to postoperative infection and wound complications. Greene et al demonstrated a seven-fold increase in PPI risk when preoperative albumin was <3.5 g/d.^{16,17} However, consistent with some recent reports¹⁸, our analysis did not find a significant association between absolute albumin levels and PPI. The HbA1c/albumin ratio therefore appears to integrate information from both markers, offering a composite index of glycaemic status and nutritional reserve that correlates with inflammatory risk.

Obesity also emerged as an important factor. Si et al showed higher PPI rates in patients with BMI >30 kg/m² and even greater risk above 40 kg/m², partly due to prolonged surgery and delayed mobilization.¹⁹ Our study similarly found that each unit increase in BMI raised PPI risk 1.6-fold.²⁰ Although high ASA grade has been linked to infection in other series, Authors did not observe a significant association between ASA score and PPI in this diabetic cohort.²¹

Limitations

This investigation has several limitations: retrospective design and small sample size (n=187) may reduce statistical power. Being a single-center study limits generalizability. The observed infection rate was higher than most published data, which may partly explain discrepancies with established BMI and diabetes risk estimates. Additional prospective, multicenter studies are

needed to confirm the prognostic utility of the HbA1c/albumin ratio.

CONCLUSION

The HbA1c/albumin ratio is a simple, inexpensive, and effective prognostic marker for predicting periprosthetic infection in diabetic patients undergoing total joint arthroplasty. Patients with a ratio ≥ 2.35 mg/dl should be monitored closely and considered for intensified perioperative optimization to reduce infection risk.

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Ethical approval: The study was approved by the Institutional Ethics Committee

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