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ORIGINAL ARTICLE

Nutritional status as a predictive marker for surgical site infection in total joint arthroplasty

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ABSTRACT

Background: Surgical site infection (SSI) is considered one of the most serious complications in total joint arthroplasty (TJA). This study seeks to analyze the predictive value of preoperative and postoperative nutritional biomarkers for SSI in elective TJA. **Methodology:** Nutritional markers were gathered retrospectively utilizing patient's records from the orthopedics department at Benghazi Medical Center (BMC). The sample spanned cases admitted during the 20-month period between January 2012 and August 2013 and had undergone either elective total hip replacement or total knee replacement. The collected lab results included a complete blood count, total lymphocyte count (TLC), and serum albumin (S. alb.) levels. The patients were then divided into two groups based on the occurrence of an SSI. **Results:** A total of 135 total knee (81.5%, $n = 110/135$) and total hip (18.5%, $n = 25/135$) replacements were performed at BMC during the study period. Among these cases, 57% ($n = 78/135$) had patient records suitable for statistical analysis. The average preoperative TLC was 2.422×10^3 cells/mm^3 (range = 0.8–4.7 $\times 10^3$ cells/mm^3) whereas that number dropped after the surgery to 1.694×10^3 cells/mm^3 (range = 0.6–3.8 $\times 10^3$ cells/mm^3). S. alb. levels showed a mean of 3.973 g/dl (range = 2.9–4.7 g/dl) preoperatively and 3.145 g/dl (range = 1.0–4.1 g/dl) postoperatively. The majority of TJA patients did not suffer any complication (67.4%, $n = 91/135$) while eight cases (5.9%) suffered from a superficial SSI. **Conclusion:** Preoperative S. alb. was identified as the only significant predictor for SSI ($P = 0.011$). Being a preventable cause of postoperative morbidity, it is recommended that the nutritional status (especially preoperative S. alb.) of TJA patients be used as a screening agent and appropriate measures be taken to avoid SSI.

Key words: Libya, nutrition, serum albumin, surgical site infection, total joint arthroplasty, total lymphocyte count

INTRODUCTION

Total joint arthroplasty (TJA) comprises a group of major surgical procedures performed to improve the health and overall quality of life in patients with joint pathologies.[1] Despite the positive goal of the procedure, it is often hindered by malnutrition in patients.[2] Malnutrition increases postoperative morbidity and mortality, prolongs the rehabilitation time,[3] raises the infection rates,[4] and delays wound healing.[5,6] Preoperative and postoperative nutritional status (i.e., serum albumin [S. alb.] and total lymphocyte count [TLC])[7,8] have been suggested as predictive markers for delayed wound healing and undesirable short-term complications.[9-12]

Surgical site infection (SSI) is widely considered one of the most serious complications in TJA.[13] The patient has to endure a tremendous psychological, physical and financial

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burden in order to undergo further treatment (i.e., revision surgery in cases of periprosthetic infections).[14] Many countries are currently facing a surge in the rate of TJA SSI's – leading to an increase in the number of revision surgeries.[15,16]

Despite the potential to prevent this situation, the nutritional status of TJA patients is rarely ever measured on a clinical basis.[17] Developing countries have been slow on the uptake of these procedures, despite having an ever-aging population.[18] This study seeks to analyze the predictive value of preoperative and postoperative nutritional biomarkers for SSI in elective TJA.

METHODOLOGY

Study population

Libya is a North African country situated along the southern coast of the Mediterranean Sea. It is classified under the Eastern Mediterranean Regional Office in the World Health Organization and as part of the MENA region in the World Bank. According to the 2006 Libyan census, the population in the eastern region of Libya exceeded 1.5 million inhabitants – one tenth of whom were above the age of 50 years.[19] This study was based on the Benghazi Medical Center (BMC) located in Benghazi, Libya. Benghazi is the largest city in eastern Libya and is home to nearly one million people. The BMC is a principal medical and surgical center in the region and hosts most major orthopedic operations performed in eastern Libya.

Data

Nutritional biomarkers were gathered retrospectively utilizing patient records from the orthopedics department at BMC. The sample spanned cases admitted during the 20-month period between January 2012 and August 2013 and had undergone either elective total hip replacement or total knee replacement (n = 135). All proper surgical techniques were followed during these operations.

The marker results were divided into two main categories – preoperative and postoperative. The preoperative samples were obtained on the 1st day of admission whereas the postoperative samples were collected on the 1st day after the arthroplasty (i.e., first postoperative day). The collected lab results included a complete blood count, TLC, and S. alb. levels. The same laboratory was used in the preoperative and postoperative tests. TLCs <1500 cells/mm^3 and S. alb. readings <3.5 g/dl were considered clinical indicators of protein energy malnutrition.[12,20] Anemia was defined as a hemoglobin reading below 12 g/dl in males and 10 g/dl in females.

In addition to the lab results, other anthropometric (weight, height, body mass indexes [BMI]) and demographic variables (age, length of stay, primary pathology, presence of co-morbidities, postoperative complications etc.) were collected.

Surgical procedure

The arthroplasties were performed under spinal anesthesia by two teams – each lead by a consultant orthopedic surgeon. All patients were given antibiotic prophylaxis (intravenous ceftriaxone) intraoperatively and for 24 h postoperatively.[21]

The Watson-Jones anterolateral approach was used for THR while a medical parapatellar incision was used for TKR. All the arthroplasties were performed using cemented fixation and drainage systems were removed 48 h after surgery.

The patients were followed-up on an outpatient basis at regular time intervals (1-week, 1-month, 3 months and 6 months after the TJA) and any complications were documented.

All cases with identified complications were further investigated by reviewing hospital charts and clinical medical records. The surgical sites were considered infected when bacteria cultures were positive. Only superficial SSI's (i.e., superficial to the fascia)[22] were observed in our sample.

Statistical methods

Statistical analysis was carried out to evaluate the significance of nutritional status as a predictive parameter for postoperative SSI. Descriptive statistics (means, standard deviation, range, and frequencies) were carried out, and ANOVA was used to compare means. All statistical analysis was performed using SPSS/PASW (version 18, IBM, Chicago).

RESULTS

A total of 135 total knee (81.5%, n = 110/135) and total hip (18.5%, n = 25/135) replacements were performed at BMC during the study period. Among these cases, 57% (n = 78/135) had patient records suitable for statistical analysis. The remaining cases were excluded [Figure 1].

Blood samples were taken from the patients before and after the arthroplasty, and nutritional biomarkers were measured. The average preoperative TLC was 2.422×10^3 cells/mm^3 (range = 0.8–4.7 $\times 10^3$ cells/mm^3) whereas that number dropped after the surgery to 1.694×10^3 cells/mm^3 (range = 0.6–3.8 $\times 10^3$ cells/mm^3). S. alb. levels showed a mean of 3.973 g/dl (range = 2.9–4.7 g/dl) preoperatively and 3.145 g/dl (range = 1.0–4.1 g/dl) postoperatively.

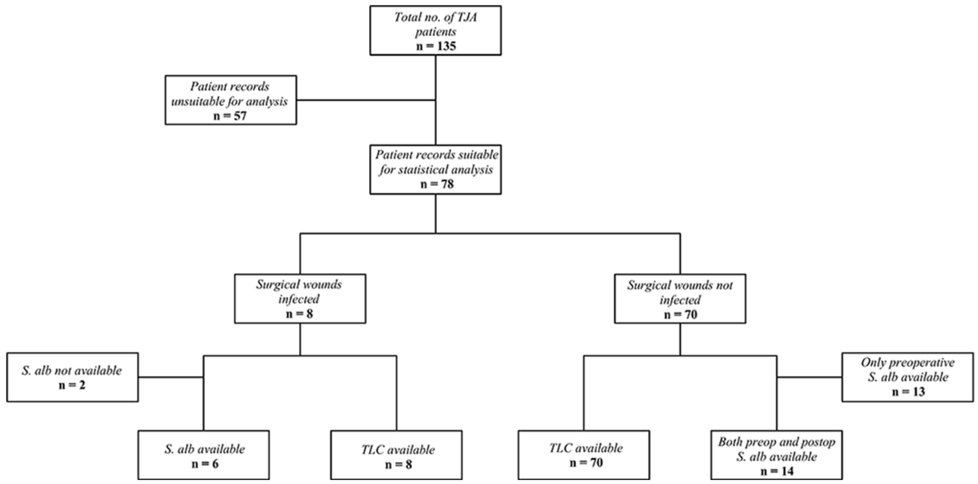

Figure 1: Flowchart depicting the inclusion and exclusion of cases from the study

Nearly one-tenth of our patients had low lymphocytic counts (6.7%, n = 5/78) and 4% (n = 3/78) had low S. alb. levels upon admission – 2 patients had both. The preoperative malnutrition rate was determined to be 12.8% (n = 10/78). Postoperatively, those figures rose to 44% (n = 34) with low lymphocyte counts and 64% (n = 13/20) with low S. alb. Naturally, a considerable proportion (77%, n = 47/78) of the TJA patients had to receive nutritional support in one form or another (i.e., specialized diets or oral supplements) as shown in Table 1.

The main primary pathology (i.e., indication for surgery) was degenerative osteoarthritis (OA) (79.5%, n = 62/78) followed by post-traumatic OA (9%, n = 7/78), avascular necrosis (7.7%, n = 6/78), rheumatoid arthritis (RA) (2.6%, n = 2/78), and developmental displacement of the hip (1.3%, n = 1/78). More than one-third (39.7%, n = 31/78) of our patients had no medical co-morbidity. Hypertension (50.1%, n = 39/78) and diabetes mellitus (30.9%, n = 24/78) were the two most common conditions that our patients suffered.

Using the anthropometric readings, the BMI of 36 patients were calculated. The average preoperative BMI was found to be 33.26 kg/m^2 (range 19–46 kg/m^2). More than three-quarters of the patients (80.5%, n = 29/36) suffered from obesity. Table 1 displays key nutritional parameters for the patients who underwent TJA.

The mean preoperative hemoglobin was 12.9 g/dl (range = 7.5–16.8), with 7.7% (n = 6) presenting with anemia. Postoperatively, the average hemoglobin decreased to 10.8 g/dl (range = 7.6–15.2) and the anemia rate spiked to 44.8% (n = 35/78). In fact, 8 patients required blood transfusion due to the severity of the anemia.

Table 1: Key nutritional parameters for patients who underwent TJA

	n	Percentage
BMI		
Underweight (<18.5 kg/m^2)	0	0
Normal weight (18.5-24.9 kg/m^2)	5	13.9
Overweight (25-29.9 kg/m^2)	2	5.6
Obese class I (30-34.9 kg/m^2)	14	38.9
Obese class II (35-39.9 kg/m^2)	12	33.3
Extreme obesity (≥40 kg/m^2)	3	8.3
Total (excluding missing)	36	100
Missing	99	
Total (including missing)	135	
Nutritional support given		
No nutritional support	14	23
High protein diet	8	13.1
High iron diet	6	9.8
Iron supplements	11	18
High protein and iron diet	4	6.6
Iron supplement and protein diet combination	18	29.5
Total (excluding missing)	61	100
Missing	74	
Total (including missing)	135	
Postoperative complications		
No complication	91	67.4
Superficial wound infection	8	5.9
Anemia	35	25.9
Hematoma	1	0.8
Total	135	100

TJA: Total joint arthroplasty, BMI: Body mass index

Following surgery, our patients attended long-term follow-up at the outpatient clinic for periods lasting up to 18 months. The majority of TJA patients did not suffer any complication (67.4%, n = 91/135).

Of the 135 patients who underwent TJA, 8 (5.9%) were complicated by a superficial SSI. Two of these cases were managed on an outpatient basis with oral antibiotics while the remaining six had to be readmitted to the orthopedic ward to received intravenous antibiotics (vancomycin).

These patients were ultimately discharged after a resolution of the infection and were given an oral antibiotic (amoxicillin with clavulanic acid) in addition to nutritional supplements. One of the infected cases was originally a THR patient while the other seven were TKR patients. Each of the SSI patients had specific risk factors such as DM, HTN, SLE or immunosuppressant use. Table 2 compares certain key demographic parameters in patients according to outcome (i.e., SSI vs. non-SSI).

None of the SSI patients suffered from anemia before the surgery. After the arthroplasty however 62.5% (n = 5/8) had anemia, the mean hemoglobin was 9.9 g/dl (range 8–11.7). Most of the SSI patients (75%, n = 6/8) had normal lymphocyte counts before their surgery (mean = 2.064 × 10^3 cells/mm^3, range = 0.8–2.9 cells/mm^3); however, that proportion was later reversed with the majority (62.5%, n = 5/8) having low TLC (mean 1.481 × 10^3 cells/mm^3, range = 0.8–2.7 cells/mm^3).

Serum albumin was also found to have decreased postoperatively (mean = 2.800 g/dl, range = 1–3.7 g/dl) when compared to the average from before the surgery (mean = 3.600 g/dl, range = 2.9–4.3 g/dl). It should be noted here that 2 patients had missing documents relating to albumin levels and were therefore not included in these calculations. Moreover, while only half (50%, n = 3/6) had low albumin levels preoperatively that figure jumped to 83.3% (n = 5/6) after the surgery. Table 3 compares the biochemical nutritional markers between patients who had SSIs and those who did not. Preoperative S. alb. was found to be the only nutritional biomarker that was statistically different between the SSI group and the non-SSI group (P = 0.011).

Table 2: Comparison of key demographic parameters in patients according to outcome (infected wound vs. wound not infected)

	Mean	*P*
Age		
Infected wound	58.5	0.463
Wound not infected	61.5	
Primary diagnosis		
Infected wound	1.88	0.196
Wound not infected	1.37	
Co morbidity		
Infected wound	2.1	0.523
Wound not infected	1.6	
Preoperative BMI		
Infected wound	32.7	0.818
Wound not infected	33.3	
Length of hospital stay (days)		
Infected wound	7.7	0.197
Wound not infected	6.9	

BMI: Body mass index

Table 3: Preoperative and postoperative values of TLC (10^3 cells/mm^3) and serum albumin (g/dL) in patients undergoing TJA

	n	Mean (95% CI)	SD	*P*
Preoperative TLC				
SSI	8	2.1 (1.5-2.7)	0.7	0.167
Non-SSI	70	2.5 (2.3-2.7)	0.8	
Total	78	2.422 (2.247-2.597)	0.8	
Preoperative serum albumin				
SSI	6	3.6 (3.0-4.2)	0.6	0.011
Non-SSI	27	4.1 (3.9-4.2)	0.3	
Total	33	3.973 (3.828-4.118)	0.4	
Postoperative TLC				
SSI	8	1.5 (1.0-2.0)	0.6	0.413
Non-SSI	70	1.7 (1.5-1.9)	0.8	
Total	78	1.694 (1.516-1.872)	0.8	
Postoperative serum albumin				
SSI	6	2.8 (1.8-3.8)	0.9	0.152
Non-SSI	14	3.3 (3.0-3.6)	0.5	
Total	20	3.145 (2.819-3.471)	0.7	

TLC: Total lymphocyte count, TJA: Total joint arthroplasty, SSI: Surgical site infection, CI: Confidence interval, SD: Standard deviation

DISCUSSION

Malnourishment negatively affects normal immune function and often results in poor wound healing, placing the patient at risk for SSI's and poor postoperative outcomes.[23-25] This study focused primarily on the ability of nutritional biomarkers to function as indicators of future SSI in TJA patients. The only reliable predictor of an SSI in elective TJA was the preoperative S. alb. level (P = 0.011). This corroborates well with previous literature,[8,9,11,26] despite one study reporting that only preoperative TLC could predict delayed wound healing[27] – a major risk factor for SSI.[28,29]

Preoperative nutritional depletion occurs in an estimated 86% of trauma-related surgery and 30% of elective surgery.[30] In our sample, 12.8% (n = 10/78) showed signs of preoperative malnutrition, with that figure increasing significantly after surgery. Low lymphocytic counts were observed in 44% (n = 34/78) of patients and 65% (n = 13/20) had low S. alb. levels. A similar study showed that in their TJA practice, 27% of their cases had signs of preoperative nutritional depletion (i.e., 57 patients with low TLC's, 4 patients had low S. alb. levels, and 2 patients with both).[9]

Malnutrition is a common occurrence in TJA patients >55 years.[2] Age did not play a significant role in wound infection (P = 0.463) and studies have shown that it does not affect the outcome of TJA.[31]

Surgical site infection rates among TJA cases are dependent on intrinsic patient factors.[32] Different studies have reported different findings regarding the relevance of indication of TJA and its impact on the postoperative outcome. Secondary OA has been the subject of heated debate – with studies suggesting an association with wound infection[33] and others refuting that statement.[34] Our study did not find a relationship between the indication (i.e., OA, RA or AVN) and the incidence of SSI (P = 0.196).

Poorly controlled diabetic patients have a higher risk of infected TKR.[35-37] Other co-morbidities (i.e., hypertension)[38] were also implicated in increased rates of SSI.[36] Such an association was not found in our studied sample of TJA patients. Patients with a BMI >50 kg/m^2 reportedly have an 18.3 times higher odds of infection compared with those whose BMI <50 kg/m^2.[32] As an independent factor, obesity has not been found to have an effect on the clinical outcome of total knee replacement.[39] Our study did not find a significant association between either the BMI or the presence of co-morbidities and the rate of SSI.

In a larger study, 12.8% (n = 662) of THR and TKR patients had preoperative anemia, which was ultimately associated with increased postoperative morbidity.[40] Different studies have shown various patient characteristics that influence the length of stay[3] and others have discussed hospital-related factors as well.[41] We found no significant difference in the length of stay between patients who suffered from an SSI and those who did not (P = 0.197). No significant differences were found between the demographic variables of TJA patients and the risk of SSI.

Matar *et al*. have suggested the use of nutritional biomarkers as screening tests and any patient found to suffer from malnourishment would have their surgery postponed and receive nutritional support.[14] Prevention strategies are essential to reduce the rate of SSI in TJA patients. Nutritional support has been demonstrated to decrease the incidence of SSI.[42] In a US trauma center, the implementation of new protocols (including nutritional screening and support) successfully decreased the infection rate from 12.9% to 1.9%.[4] Achieving optimum preoperative nutrition status and controlling any medical co-morbidities decreases postoperative wound complications.[28]

Being a case series, certain caveats must be covered. As in all medical record reviews, lack of documentation can be a confounding factor.[32] This is especially true in the Libyan scenario where a number of factors played contributed toward the incomplete patient files.[43,44] The conflict situation complicated the problem of documentation, with a large number of patient records having been damaged during armed clashes. Occasionally, certain medical documents were missing for a number of cases files and as such were not included in the statistical analysis. One reason for this is that the patients' families would take documents from the file in order to travel abroad. This leads to the missing lab results (particularly S. alb.) for a number of cases. These missing cases have been referred in Tables and Figure 1. Libya has only recently started performing TJA's and as such the sample size was low. However, it should be noted that obtaining significant statistical results (i.e., $P < 0.05$) would be harder with lower patient numbers. The fact that preoperative S. alb. showed a significant difference (P = 0.011) even with a low sample size supports its assertion of being a good predictor of subsequent SSI in TJA patients.

CONCLUSION

The nutritional status of Libyan TJA patients was determined before and after surgery. Preoperative S. alb. was identified as the only significant predictor for SSI (P = 0.011). Being a preventable cause of postoperative morbidity, it is recommended that the nutritional status (especially preoperative S. alb.) of TJA patients be used as a screening agent and appropriate measures be taken to avoid SSI.

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Conflicts of interest

There are no conflicts of interest.

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