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Postoperative Complications in Diabetic type-2 Verses Non-Diabetic Patients Undergoing Appendectomy. A Comparative clinical Study

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ABSTRACT

Background: Diabetes Mellitus (DM) is known to double the risk of postoperative complications because of weak immunity and compromised healing.

Objectives: To analyse the rate of postoperative complications among diabetic and non-diabetic patients who have undergone appendectomy to determine whether the level of diabetes management has an impact on wound healing.

Methodology: A prospective study was done on n=300 patients who were diagnosed with acute appendicitis and were scheduled to undergo appendectomy; of which n=150 patients had diabetes type-2 and n=150 were non-diabetics. Concerning adverse outcomes, the incidence of surgical site infections (SSIs), prolonged healing of the surgical site, and the number of days spent in the hospital after the operation were identified. Diabetes mellitus was defined based on self-reported diagnosis and glycemic control was evaluated using HbA1c level with the cut-off of >7%. Chi-square and t-tests were used in the analysis of data while multivariate logistic regression was used to assess predictors of complications. $p \leq 0.05$ was considered statistically significant.

Results: Diabetic patients had a higher incidence of surgical site infections, 15.3% and 5.3%, p= 0.007 for diabetic and non-diabetic patient respectively and delayed wound healing 10.7% and 3. 3%, p = 0.015 for diabetic and non-diabetic patients respectively. Patients with HbA1c > 7% had a higher rate of SSIs of 21. 8 % and delayed healing of 15.4% compared well-controlled diabetics (p = 0.009 and p=0.02 respectively). It was more prolonged in the diabetic patients (6.1 as against 4. 3 days, p<0.001). Diabetes was found to be an independent risk factor for SSIs and slow wound healing.

Conclusion: Diabetic patients who have undergone appendectomy were more susceptible to SSIs and slow healing of the wound especially if their blood glucose levels were not well controlled. It is possible that enhanced perioperative glycemic control can decrease postoperative adverse effects.

Keywords: Appendectomy, diabetes, postoperative complications, surgical site infections, glycemic control.

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INTRODUCTION

Diabetes mellitus is a long-term condition that is quite common and is marked by high blood sugar levels and it is well understood that patients suffering from the condition are at a great risk of experiencing complications with their surgeries as it has a negative effect on the healing of wounds, immune response and recovery[1, 2]. Literature review has shown that diabetic patients are more prone to postoperative complications such as; SSIs, slow wound healing and longer hospital stays. This is well illustrated in operations that require urgent intervention like appendectomy whereby early intervention is advisable and complications which may be as a result of infections may slow down the rate of healing[3]. Appendectomy is one of the most common performed emergency surgeries around the world with the indication of appendicitis[4]. Despite the fact that appendectomy is considered as a standard surgery, diabetes poses several factors that can affect the patients' results. Hyperglycaemia leads to poor leukocyte function, decreased blood flow to tissues and prolonged the healing process particularly the inflammatory phase, this makes diabetic patients to be at a higher risk to develop postoperative infections and generally take longer time to recover[5, 6]. Diabetes is a complicated metabolic illness that is influenced by both environmental and hereditary factors. It is characterized by persistent low-grade inflammation. An increasing body of research suggests that changes in gut microbiota may play a role in the development of metabolic disorders. It has only been discovered more recently that the human appendix is a vital component of the immune system as well as a microbial reservoir for replenishing the gastrointestinal tract. Therefore, immunological response and microbial ecology may be impacted by appendectomy. This study looked at the relationship between the risk of type 2 diabetes and appendectomy. Due to its enormous variety of vascular consequences and quickly rising prevalence, diabetes is one of the most important public health problems in the world. The International Diabetes Federation estimates that 450 million people worldwide had diabetes in 2023; by 2035, that number is expected to rise to 750 million. Although both diabetes and the appendectomy are common conditions, few studies are available comparing the postoperative results in patients with diabetes as compared to those patients without diabetes who have undergone this surgery. Moreover, the relationship between glycemic control and surgical results has not been investigated in further detail concerning the differences between well-controlled and poorly controlled diabetes[7, 8, 9]. This study will help to fill these gaps through a comparison of postoperative complication rates between diabetic and non-diabetic patients following appendectomy with particular reference to SSIs and wound healing. Further, it aims to examine the effect of glycemic control on the outcomes of diabetic patients, which provides the understanding of the role of diabetes management during the surgery.

MATERIALS AND METHODS

This prospective comparative study was carried out from September, 2023 to June, 2024 in the Department of Surgery of Hameed Latif Teaching Hospital. Total n=300 patients with acute appendicitis were selected for the study and divided into two groups i.e. n=150 diabetic patients and n=150 non-diabetic patients. The study was ethically cleared by Rashid Latif Khan University Medical & Dental College, Institutional Review Board ethical letter ref no. IRB-RLKU-18/09/23/12-A.Patients who had acute appendicitis, and were within the age range of 18-70 years were included in the study and having Type 2 diabetes were categorized as Diabetic group while patients without any

history of diabetes were categorized as non-diabetic group. Diabetice status of patients were identified according to the medical history and HbA1c values; patients with HbA1c > 7 % were considered to have poorly controlled diabetes mellitus. Contraindications to the study were patients with other severe concomitant diseases, including chronic renal failure or cardiovascular disease, those with complicated appendicitis, or with perforation or peritonitis, and patients in whom laparoscopic appendectomy was performed. Patients demographic characteristics (age, gender, BMI), HbA1c, and preoperative glucose levels were obtained from clinical records before surgery. Operations were done by a team of qualified surgeons and all the patients benefited from standard management practices such as antibiotic administration, pre-operative blood glucose level check and post-operative wound care. Data on patients' postoperative outcomes, with specific reference to the complications of SSIs, delayed wound healing, reoperation, and hospital stay were taken. Thirty day postoperative assessment was done to identify any possible complications that may arise after surgery. Raw data were analyzed by using the SPSS Statistical version 26.0 Age and BMI were analyzed using mean and standard deviation while gender and the rates of complications were in terms of frequency percentage. The chi-square tests were used in analyzing categorical data whereas independent t-tests were used in analyzing continuous data. A $p \leq 05$ was considered statistically significant. Furthermore, multivariate logistic regression analysis was also done to measure the following independent risk factors for postoperative complications: diabetes status, BMI and operative time.

RESULTS

This study recruited n=300 patients who were undergoing appendectomy, n=150 of them were diabetic patients and the other n=150 were non-diabetic patients. The diabetic group mean age was 52.3 ± 9.5 years. Five years as compared to forty-eight. 48.1±10.2 years in the non-diabetic group and this difference was not significant (p=0.09). Another comparability was found in gender distribution, 59% of the diabetic patients were male while 55% of non-diabetic patients were of the same gender (p=0.412). The BMI value was marginally higher in diabetic group as compare to non-diabetic group; 29.5±4.1 kg/m² and 28.6±3.9 kg/m² respectively, but difference was insignificant (p<0.001) as shown in table-1.

Table-1 Patients demographic Characteristics

Baseline Characteristics	Diabetic Group (n=150)	Non-Diabetic Group (n=150)	p-value
Age (years)	52.3 ± 9.5	48.1 ± 10.2	0.09
Gender (Male)	88:62	82:68	0.412
BMI (kg/m²)	29.5 ± 4.1	28.6 ± 3.9	0.113

**Age and BMI were analyzed using independent t-tests.*
**Gender was compared using the chi-square test.*

The overall complication rate of 22.7% compared to 10% in the non-diabetic group, postoperative problems were more prevalent in the diabetes group (p=0.003). those with diabetes experienced 15.3% more surgical site infections (SSIs) than those without diabetes (5.3%), and this difference was statistically significant (p=0.007). Additionally, there was a significant difference in the amount of delayed wound healing between the diabetes group (10.7%) and the non-diabetic group (3.3%) (p=0.015). Although the reoperation rate was greater in patients with diabetes (4.7%) compared to patients without diabetes (2%), it

did not achieve statistical significance (p=0.121). Patients with diabetes experienced a significantly longer mean hospital stay (6.1 ± 2.2 days) than non-diabetic patients (4.3 ± 1.8 days) (p<0.001) as shown in table-2.

Table-2: postoperative Complications

Postoperative Complications	Diabetic Group (n=150)	Non-Diabetic Group (n=150)	p-value
Overall Complication Rate	34 (22.7%)	15 (10%)	0.003
Surgical Site Infection (SSI)	23 (15.3%)	8 (5.3%)	0.007
Delayed Wound Healing	16 (10.7%)	5 (3.3%)	0.015
Reoperation Rate	7 (4.7%)	3 (2%)	0.121
Length of Hospital Stay (days)	6.1 ± 2.2	4.3 ± 1.8	<0.001

**Categorical variables (complication rate, SSI, wound healing, and reoperation) were analyzed using the chi-square test.*

**Length of hospital stay was analyzed using an independent t-test.*

Subsequent examination of the diabetic cohort according to glycemic control revealed that patients with poorly managed diabetes (HbA1c >7%) experienced a markedly elevated frequency of SSIs (21.8%) in contrast to those with well-managed diabetes (HbA1c ≤7%), who demonstrated an SSI rate of 8.3% (p=0.009). Similarly, patients with poorly managed diabetes had a higher prevalence of delayed wound healing (15.4%) than did patients with well-controlled diabetes (5.5%) (p=0.02). Additionally, hospital stays for poorly managed diabetes patients were substantially longer (7.3 ± 2.5 days) than for well-controlled patients (5.1 ± 2.0 days) (p<0.001) as shown in table-3.

Table-3: Impact of Glycemic Control on Postoperative Outcomes in Diabetic Patients

Impact of Glycemic Control on Postoperative Outcomes in Diabetic Patients	Well-Controlled (n=72)	Poorly Controlled (n=78)	p-value
Surgical Site Infection (SSI)	6 (8.3%)	17 (21.8%)	0.009
Delayed Wound Healing	4 (5.5%)	12 (15.4%)	0.02
Reoperation	2 (2.8%)	5 (6.4%)	0.37
Length of Hospital Stay (days)	5.1 ± 2.0	7.3 ± 2.5	<0.001

**Categorical variables (SSI, wound healing, reoperation) were analyzed using the chi-square test.*

**Length of hospital stay was analyzed using an independent t-test.*

Diabetes was found to be an independent predictor of both delayed wound healing (OR: 2.97, 95% CI: 1.34-5.68, p=0.008) and SSIs (Odds Ratio OR: 3.12, 95% Confidence Interval CI: 1.47-6.25, p=0.002) in a multivariate logistic regression analysis. Significant predictors of postoperative problems were BMI >30 kg/m² (OR: 1.87, p=0.04) and longer surgical duration (>90 minutes) (OR: 1.98, p=0.03) as shown in table-4.

Table-4: Multivariate Logistic Regression Analysis for Risk Factors

Multivariate Logistic Regression Analysis for Risk Factors	Odds Ratio (95% CI)	p-value
Diabetes (HbA1c >7%)	3.12 (1.47-6.25)	0.002
BMI >30 kg/m²	1.87 (1.06-3.25)	0.04
Prolonged Operative Time (>90 minutes)	1.98 (1.12-3.50)	0.03

**Multivariate analysis was performed using logistic regression to determine the odds ratios for various risk factors.*

DISCUSSION

The results of this study showed that the diabetic patients who underwent appendectomy had increased postoperative risk with additional complications such as SSIs and delayed wound healing as compared with non-diabetic patients[10]. These findings are in agreement with the current literature, where diabetes affects the wound healing process and the ability of the body's immune system to fight infections, and there is also poor blood flow to the affected tissues. The overall complication rate in diabetic patients was 22 percent. 7% which is more than double of what is found in non-diabetic patients, 10%, this is a significant finding which points to the need for adequate perioperative management in diabetic patients[11, 12]. The SSIs in the diabetic patients were 15. 3% while in the non-diabetic patients it was 5. 3%. This might have been due to hyperglycaemia, which alters the leukocytes function and hence increases bacterial proliferation at the surgical site[13]. Further, higher HbA1c levels, which point towards a poor glycaemic control, was also a predictor of increased SSIs and delayed wound healing. Patients with HbA1c greater than 7% were 21 percent likely to develop SSI as opposed to patients without diabetes. 8 % and in the case of 'Disabled persons', 8 % only. While, CINR is significantly higher in patients with diabetes mellitus, it is 3% in well-controlled diabetic patients. This has further stressed the need to maintain glycaemic control in order to reduce postoperative complications. Sivrikoz et al. (2015) have also done some previous research work which shows that the HbA1c level is directly related to post-operative infections[14]. Regarding the delayed wound healing, the studies unveiled that 10. 7% of diabetic patient developed complications with regards to wound closure while in the control group, only 3. 3% of non-diabetic patients. This is in line with the knowledge that diabetes has an unfavourable impact on collagen synthesis and new blood vessel formation, which results in prolonged inflammation and slow tissue healing. Postoperative stay was also longer for the diabetic patients (6. 1 ± 2. 2) as compared to the non-diabetic patients (4. 3 ± 1. 8) mainly due to the reason of wound care and infection control[15]. For instance, reoperation rates were slightly higher in diabetic patients, 4. 7%, as compared to non-diabetic patients, 2%, but the difference was not significant. This may suggest that although diabetic patients are more susceptible to infections and compromised wound healing, such complications are more likely to be medically than surgically treatable. However, the greater length of stay in hospital and the higher incidence of wound infections contributes a significant cost to health care especially in areas with high incidence of diabetes[16, 17]. Multivariate analysis for SSIs showed that diabetes was an independent predictor of SSIs and delay in wound healing. A few other characteristics that were also considered to be independent predictors of postoperative complications included obesity defined as a BMI of greater than 30 kg/m² and long operative duration. These studies imply that obesity and longer length of surgery also affect poor postoperative outcomes apart from diabetes[18]. Therefore, diabetic patients who are undergoing appendectomy are likely to develop postoperative complications especially the surgical site infections and delayed wound healing. Various complications arise from diabetes and their risks should be reduced especially during the perioperative period, a factor that calls for proper glycaemic control among diabetic patients. Furthermore, fine-tuning the preoperative and postoperative management of the diabetic patient such as glucose control and wound care may decrease the rate of complications. More studies are required to determine the effects of individual glycaemic management approaches on the

surgical outcomes of people with diabetes[4, 19].

CONCLUSION

The patients diagnosed with diabetes who are subjected to appendectomy were three times more likely to develop a postoperative surgical site infections and slow wound healing than patients without diabetes. To reduce a number of complications, it is necessary to maintain the blood serum level of glucose in the operative period.

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None declared.

Authors' Contributions:
N.U.H. and **M.Z.** conceived the study and designed the methodology. **H.A.**, **Z.N.M.**, **M.I.**, and **M.T.** contributed to data collection, analysis, and manuscript revision.

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REFERENCES

1. Panahi A, Bangla VG, Divino CM. Diabetes as a Risk Factor for Perforated Appendicitis: A National Analysis. The American Surgeon™. 2023;89(2):204-9.doi: 10.1177/00031348221124334
2. Maqsood KM, Pahwani R, Avinash F, Shabbir MR, Basham MA, Khalid A, et al. Association Between Levels of Pre-operative Glycosylated Hemoglobin and Post-operative Surgical Site Infections After Elective Surgery in a Low-Income Country. Cureus. 2022;14(7):e27397.doi: 10.7759/cureus.27397
3. Liu S, Shi L, Wang B, Lou J, Sun M, Yang H, et al. Preoperative hyperglycemia is associated with elevated risk of perioperative ischemic stroke in type 2 diabetic patients undergoing non-cardiovascular surgery: A retrospective cohort study. Frontiers in Aging Neuroscience. 2022;14.doi: 10.3389/fnagi.2022.990567
4. Wu C-C, Lee C-H, Hsu T-W, Yeh C-C, Lin M-C, Chang C-M, et al. Is Colectomy Associated with the Risk of Type 2 Diabetes in Patients without Colorectal Cancer? A Population-Based Cohort Study. Journal of Clinical Medicine. 2021;10(22):5313.doi: 10.3390/jcm10225313
5. Park B-S, Cho SH, Lee SH, Son GM, Kim HS. Role of C-Reactive Protein, White Blood Cell Counts, and Serum Glucose Levels as Early Predictors of Infectious Complications After Laparoscopic Colorectal Surgery for Colorectal Cancer. The American Surgeon™. 2023;89(12):5821-8.doi: 10.1177/00031348221135786
6. Tansawet A, Siribumrungwong B, Techapongsatorn S, Numthavaj P, Poprom N, McKay GJ, et al. Delayed versus primary closure to minimize risk of surgical-site infection for complicated appendicitis: A secondary analysis of a randomized trial using counterfactual prediction modeling. Infection Control & Hospital Epidemiology.2024;45(3):322-8.doi:10.1017/ice.2023.214
7. Li X, Liu L, Liang X-Q, Li Y-T, Wang D-X. Preoperative carbohydrate loading with individualized supplemental insulin in diabetic patients undergoing gastrointestinal surgery: A randomized trial. International Journal of Surgery. 2022;98:106215.doi: 10.1016/j.ijsu.2021.106215
8. Ghazisaeedi M, Shahmoradi L, Garavand A, Maleki M, Abhari S, Ladan M, et al. Developing a Clinical Decision Support System for Prediction Postoperative Coronary Artery Bypass Grafting Infection in Diabetic Patients. J Biomed Phys Eng. 2022;12(6):583-90.doi: 10.31661/jbpe.v0i0.2011-1235
9. Usman A, Akbar E, Mukhtar A, Nasir I, Rehman U, Iqbal A, et al. Comparative Outcomes of Immediate and Delayed Wound Closure Techniques in Appendectomies for Gangrenous Appendicitis: Postoperative Recovery in Gangrenous Appendicitis. DEVELOPMENTAL MEDICO-LIFE-SCIENCES. 2024;1(3):35-40.doi: 10.69750/dmls. 01.03.030

10. Gagen B, Hall C. Preventing Surgical Site Infections in Emergency General Surgery: Current Strategies and Recommendations. Current Surgery Reports. 2024;12(8):227-37.doi: 10.1007/s40137-024-00405-z
11. Beattie J, Neufeld S, Yang D, Chukwuma C, Gul A, Desai N, et al. Utilizing Large Language Models for Enhanced Clinical Trial Matching: A Study on Automation in Patient Screening. Cureus. 2024;16(5):e60044.doi: 10.7759/cureus.60044
12. Chang H-H, Chang C-H, Hsiao C-Y, Kao S-Y, Chen J-Y, Chen T-H, et al. Diabetes Is the Most Critical Risk Factor of Adverse Complications After Peritoneal Dialysis Catheter Placement. Frontiers in Medicine. 2021;8.doi: 10.3389/ fmed.2021.719345
13. Sankhuu Y, Altaisaikhan O, Battsogt M-O, Byambasukh O, Khasag A. Diabetes-Related Mortality in a Developing Country: An Exploration of Tertiary Hospital Data. Journal of Clinical Medicine. 2023;12(20):6687.doi: 10.3390/jcm12206687
14. Foghsgaard S, Vedtofte L, Andersen ES, Bahne E, Andreasen C, Sørensen AL, et al. Liraglutide treatment for the prevention of glucose tolerance deterioration in women with prior gestational diabetes mellitus: A 52-week randomized controlled clinical trial. Diabetes, Obesity and Metabolism. 2024;26(1):201-14.doi: 10.1111/dom.15306
15. Rüggeberg A, Meybohm P, Nickel EA. Preoperative fasting and the risk of pulmonary aspiration—a narrative review of historical concepts, physiological effects, and new perspectives. BJA Open. 2024;10:100282.doi:10.1016/j.bjao.2024.100282
16. Qurashi FA, Keegan AC, D'Adamo CR, Wolf JH. Post-operative day zero discharge after laparoscopic appendectomy does not worsen high-yield outcomes: a NSQIP database observational study. Journal of Investigative Surgery. 2022;35(10):1767-71.
17. Bernard L, Chen I, Le T. Appendectomy at the time of ovarian cancer staging increases infectious complications: a National Surgical Quality Improvement Program (NSQIP) propensity score-stratified analysis. International Journal of Gynecologic Cancer. 2020;30(10):1542-7.doi: 10.1136/ijgc-2020-001702
18. Shogan BD, Vogel JD, Davis BR, Keller D, Ayscue JM, Goldstein LE, et al. The American Society of Colon and Rectal Surgeons Clinical Practice Guidelines for Preventing Surgical Site Infection. Diseases of the Colon & Rectum. 9900:10.1097/DCR.0000000000003450.doi: 10.1097/dcr.0000000000003450
19. Atef Abdelsattar Ibrahim H, Kaddah S, Elkhateeb SM, Aboalazayem A, Amin AA, Marei MM. Glucose indices as inflammatory markers in children with acute surgical abdomen: a cross-sectional study. Annals of Medicine. 2023;55(2):2248454.

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