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The role of drain placement in post-bariatric surgery bleeding and leak detection: Palestinian main center experience (2017–2021)

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Abstract

Introduction Bariatric surgery, such as sleeve gastrectomy (SG) and gastric bypass, is a common option for weight loss in patients with obesity and metabolically ill individuals. However, complications like bleeding and leaks can occur. Surgeons often use intraoperative drains to detect these issues, but their effectiveness is debated due to conflicting evidence. Our study aims to evaluate the benefits of intra-abdominal drains in detecting postoperative bleeding and leaks.

Methods This is a retrospective cross-sectional study, with data from 494 patients who underwent bariatric surgery at the primary bariatric center in Palestine, between 2017 and 2021. Patient demographics, comorbidities, surgical complications, and drain usage were collected, managed, and analyzed using SPSS.

Results The study included 494 patients, predominantly females (69.0%) with a median age of 39.5 years. Sleeve gastrectomy was the most common procedure (78.1%). Postoperative complications occurred in 3.0% of patients, with bleeding being the most prevalent (1.4%). Drain placement was routine (82.0%), but no significant correlation was found between drain output volume and signs of bleeding, such as heart rate and blood pressure. However, a weak inverse correlation was observed between volume for bloody drain character and hemoglobin levels on the first postoperative day.

Conclusion Drains are commonly used in bariatric surgery; however, their effectiveness in detecting complications like bleeding and leaks remains uncertain. There was no association between drain output volume and signs of bleeding and leak complications, and the clinical assessment, especially the vital signs, is the most effective method in identifying postoperative issues.

Clinical trial number Not applicable.

Keywords Bariatric surgery, Drain, Bleeding detection, Leak, Complications, Obesity

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Introduction

Bariatric surgery is an umbrella term under which weight reduction procedures fall. According to the ASMBS/IFSO, bariatric surgery is recommended for individuals with either a BMI of 30–34.9 kg/m^2 and metabolic disease, who did not achieve substantial weight loss or comorbidity improvement by nonsurgical method, or those with a BMI of 35 kg/m^2 or more regardless of absence, presence, or severity of comorbidities [1].

Bariatric surgery is performed using several surgical approaches, including sleeve gastrectomy (SG), Gastric bypass, biliopancreatic diversion with a duodenal switch, and adjustable gastric banding [2–4]. Unfortunately, each approach may have suboptimal outcomes, potentially requiring revision or reoperation [5]. The incidence of reoperation is approximately 7%, and complication rates range from 10–17% [6]. In the last decade, SG has been more popular and is now the predominant bariatric procedure worldwide [7, 8].

The expected complications in the postoperative period can be feasibly categorized into those common to all surgical interventions and those specific to bariatric surgery. Common complications include bleeding, pulmonary complications (e.g., pulmonary embolism and deep vein thrombosis), hepatobiliary complications (e.g., gallstones), neurological complications (e.g., peripheral nerve injury, myopathy, and encephalopathy), and sepsis with a possibility of renal or respiratory failure [9]. Bariatric surgery-specific complications are peritonitis and gastric leak. The latter is a serious complication and one of the primary causes of reoperation in bariatric surgery [10–12].

Postoperative anastomotic leak presents clinically with pain, nausea, tachycardia, fever, raised C-reactive protein level, and leukocytosis, with tachycardia and abdominal pain being the prominent symptoms. These symptoms have been studied and found to be associated with either bleeding or leak, with the following specifications: Tachycardia of more than 120 beats/min, using pain relievers more than expected, and/or inability to mobilize after 2 h of the operation were diagnosed to have bleeding or leak [13].

On the other hand, plays a role in altering leak management, surgical drain placement near the leak orifice was suggested in leak management after one anastomosis gastric bypass (OAGB) conversion to Roux-en-Y gastric bypass (RYGB) where the leak is located at the top of the gastric pouch below the cardia, although conversion to RYGB in this case rarely provides sufficient gastric length to fashion a new gastric pouch [14].

Lab and imaging findings associated with leak and bleeding include a computed tomography (CT) or abdominal ultrasound showing an abdominal abscess in patients with clinical symptoms of anastomotic leak with elevated CRP and/or leukocytes. In published studies, CT scans have also demonstrated contrast leakage in some patients, which was surgically managed. Concluding that a suspected leak based on clinical symptoms in the first 24 h is an indication for surgical exploration [13].

Postoperative bleeding clinically presents with signs of hypovolemic shock. In previous studies, tachycardia was the most common sign of early bleeding [15, 16]. Collectively, hypotension (systolic blood pressure of 100 mm Hg) and a reduction in hemoglobin are considered effective clinical markers of bleeding [15, 16].However, manifestations of late bleeding are melena and/or hematemesis due to the intraluminal origin, e.g., marginal ulceration [17]. Abdominal drains have been used postoperatively to aid in the detection of bleeding and leakage. Immediate intraoperative leakage or bleeding can be detected by visualization [18].

In recent years, the usefulness of drains in detecting leaks and/or bleeding has been questioned. The American College of Surgeons (ACS) suggested that drains should not be used [19]. This reservation stems from increased drain-associated complications (superficial surgical site infection (SSI), deep incisional, and organ space SSI) with a lack of evidence on detecting leaks and/or bleeding [20]. Even with this sheer evidence against the use of drainage in bariatric surgery, the placement of drains is still routine practice globally [21].

One pending question is whether intraperitoneal drain placement in bariatric surgeries may facilitate the detection of postoperative leakage and bleeding in comparison to known symptoms and signs. With the lack of local Palestinian studies regarding drain use and its effectiveness, it is still a common surgical practice, especially in postoperative. A cross-sectional retrospective study was conducted in our surgical department to assess the effectiveness of drain placement.

Methods

A. Study design

This is a retrospective cross-sectional study, in which preoperative and postoperative outcome variables were collected and analyzed. The study targeted all patients who underwent bariatric surgery at Al-Makassed Hospital between 2017 and 2021. The study was approved by the Ethics Committee at Al-Quds University. Data collection permission was obtained from the Al-Makassed Hospital Ethical Committee.

B. Population and data collection

Our study included 494 patients who underwent either laparoscopic sleeve gastrectomy or laparoscopic gastric bypass at Al-Makassed Hospital between 2017 and 2021. All patients were older than 14. Patients had BMI > 40 without comorbidities or > 35 with comorbidities.

All patients with a known history of coagulopathy, or underwent two operations within the same surgery have been excluded, in addition, those for whom the approach was converted to open from laparoscopic.

Our study uses an intention-to-treat method, the data was collected by reviewing each patient's medical record; accessed by the healthcare information system at Al-Makassed Hospital. We include all patients who underwent bariatric surgery between 2017 and 2021, So selection bias was overcome; however, since our population is inpatients, there remains a risk of berkson's bias. Additionally, measurement bias was overcome with a unified, standardized data collection tool.

The data collected was categorized into sex groups. The first group, biographic information, including sex, date of birth, province, and operation type. The second group, medical and surgical history, encompassed past medical conditions, prior surgeries, drug history, and social history. The third group, laboratory data, was recorded in days according to operation day. The fourth group, vital signs, was collected in the same consequence of days as laboratory data. The fifth group, anticoagulation use, whether pharmacological (enoxaparin) or mechanical and their respective postoperative day of initiation. The final group, surgical complications, including their presence or absence and the method used for detection, such as abdominal drain, NG-tube and medical imaging or testing. Throughout the study period, a passive Jackson-pratt drain was used for all patients.

C. Statistical analysis

Data management was initially done using Excel spreadsheets. Patients with missing data were removed. Daily vital signs were averaged to one reading per day per patient.

We categorized drain output volume into two groups: high (> 50 cc) and low (< 50 cc). Mean arterial pressure(MAP) was calculated using the following equation: ((2*Diastolic BP) + Systolic Blood pressure)/3.

Statistical analysis was performed using SPSS. First, data characteristics were examined using frequency analysis. To assess the correlation between different variables, we used Pearson's correlation, one-way ANOVA, Post-hoc analysis, linear regression, Chi-square, propensity score matching tests. Confounding bias was accounted for by adjusting for confounders in our analysis.

Table 1 Patients' percentages of comorbidities and complications

		Frequency	Percent
Comorbidities	Hypothyroidism	30	6.07%
	Hyperthyroidism	2	0.4%%
	HTN	135	27.30%
	DM1/2	86	17.40%
	Smoking	154	31.20%
	Idiopathic thrombocytopenia	1	0.20%
	Other bleeding disorder	0	0.00%
Complications	Acute Kidney Injury	1	6.70%
	Atrial Fibrillation	1	6.70%
	Bleeding	7	46.70%
	Chest Infection	1	6.70%
	Leak	2	13.30%
	Misfire	1	6.70%
	Misfire / Sutured	1	6.70%
	SMV* injury	1	6.70%

*SMV: superior mesenteric vein

Result

Our sample included 494 patients, of whom 31.0% were male and 69.0% were female, with a median age of 39.5 years old (range: 14–70 years). All patients included in the sample underwent their operation at Al-Makassed Hospital. Among them, 21.9% underwent gastric bypass, while 78.1% underwent gastric sleeve. The average hospital stay was three days. Patients' characteristics and comorbidities are summarized in (Table 1). The percentage of patients who received preoperative anticoagulation medication is shown in (Fig. 1a) while their starting day postoperative is shown in (Fig. 1b).

The Jackson-Pratt drain was placed intraoperatively in 82.0% of patients. The percentages of patients with a drain during each day of the four postoperative days were 79.1% on the first day, 33.8% on the second day, 10.5% on the third, and 3.8% on the fourth day. In contrast, the percentage of patients in whom an intraoperative NG tube was placed was 8.3%, and the percentage of patients with an NG tube during the three postoperative days was 5.2%1.6%, and 0.4%, respectively, where it used based on clinical assessment, due to nausea vomiting or gastric destination rather than routine use. Postoperative complications occurred in 3.0% of patients, with 46.7% of these cases attributed to postoperative bleeding (Table 1).

Our results found a weak correlation between drain volume and heart rate and between drain volume and blood pressure on postoperative days which was statistically insignificant (Table 2).

The linear regression test showed a weak inverse correlation (Pearson Correlation = -0.1), but the.

regression coefficient was statistically significant between drain volume with a spotted bloody character and hemoglobin value on postoperative day 1 (p-value = 0.015). However, there was no relationship between hemoglobin value and drain volume with a spotted bloody character on other days (Table 2).

Another finding from the Pearson correlation test was a significant association between the drain color character and the starting day of postoperative anticoagulant

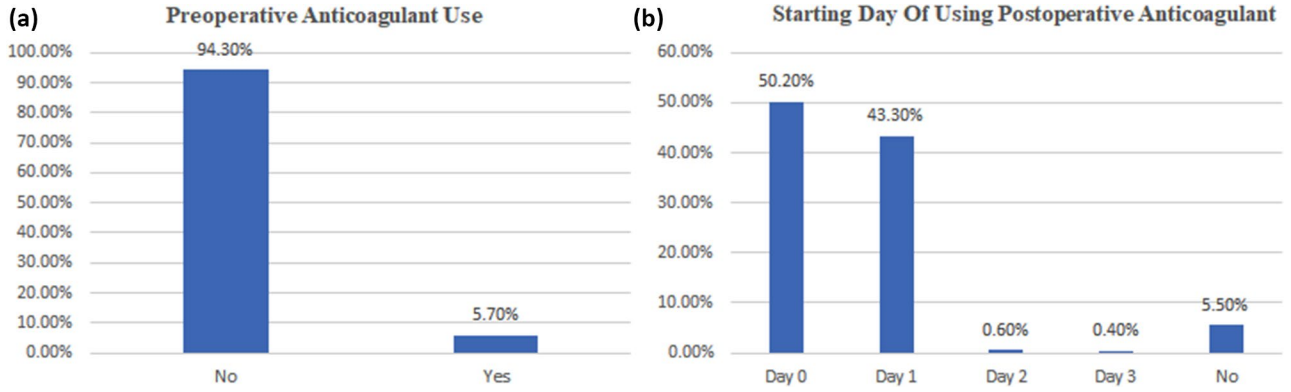

Fig. 1 (**a**) Shows percentages of the patients who utilized preoperative anticoagulation medication (Yes) and who did not utilize preoperative anticoagulation medication (No). (**b**) Shows percentage of the patients who did not use postoperative anticoagulant medication (No) and who used postoperative anticoagulant medication, categorized based on the starting day: operative day (Day 0), one day postoperative (Day 1), two days postoperative (Day 2), three days postoperative (Day 3)

Table 2 P-value and pearson correlation for different associations

	Drain output/Heart rate		Drain output/Blood Pressure		Drain output/Hemoglobin value	
	P- value	Pearson correlation	P- value	Pearson correlation	P- value	Pearson correlation
Day 0	0.092	0.06	0.132	0.068	0.143	0.049
Day 1	0.238	0.032	0.755	-0.014	0.015	-0.1
Day 2	0.076	0.069	0.836	-0.01	0.067	-0.092
Day 3	0.32	0.039	0.193	0.108		
Day 4	0.36	0.054	0.466	0.11		

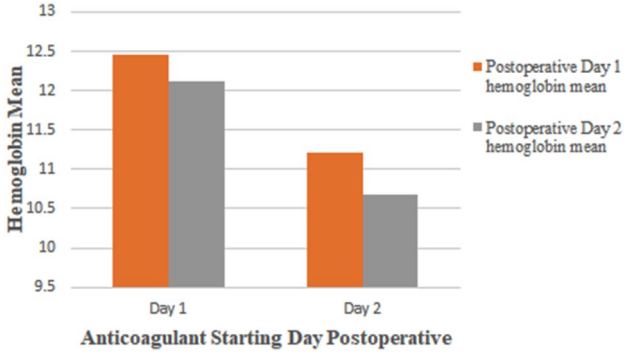

Fig. 2 Shows hemoglobin means postoperative day 1(depicted by orange column) and postoperative day 2 (depicted by gray column) on different anticoagulant starting days: one day postoperative (Day 1) and two days postoperative (Day 2)

use on day 0 (p-value = 0.005) and day 1 (p-value < 0.001), while no association on day 2 (p-value = 0.065) and day 3 (p-value = 0.060).

According to the one-way ANOVA test, there was a significant association between hemoglobin value and the starting day of postoperative anticoagulant on day 0 and day 1 (p-value = 0.000), but no association was found on day 2 (p-value = 0.236). Post-hoc analysis revealed a significant difference in mean hemoglobin across all days. Patients who started postoperative anticoagulation on day 0 experienced the most significant drop from day 0 to day (1) Similarly, patients who started anticoagulation on day 1 had a significant drop between day 1 and 2, while no significant difference in hemoglobin drop was observed in patients who started anticoagulation on day (2) (Fig. 2).

There were no statistical differences in drain volume in both preoperative and postoperative anticoagulant use (Table 3). Only one patient, who was taking aspirin as chronic therapy, experienced bleeding complications.

There were multiple patients who had complications with positive imaging results, including ultrasound, CT scan, gastrografin, methylene blue, and others, but there was no significant association with drain volume (Table 3). Additionally, no association was found between smoking and complications (p-value = 0.855).

We investigated propensity score matching due to the discrepancy between the two patient groups: those with intraoperatively drain placement and those without. After removing the confiding variables (Age, gender, and preoperative anticoagulation use) we ended up with two patient groups, each comprising 101 patients. We then

Table 3 Association between positive imaging and drain output, as well as anticoagulant and drain output

	Ultrasound	CT	Gastrografin	Methylene Blue	Others	Preoperative Anticoagulant	Postoperative Anticoagulant
P-values	0.553	0.59	0.248	0.625	0.331	0.318	0.134

reanalyzed the primary result after matching. The primary results remain consistent both before and after the matching, except for the association between drainage volume with a spotted bloody character and postoperative hemoglobin values which is insignificant on all days after the matching.

Discussion

The main aim of the present study was to investigate the association between drain volume and signs indicative of active bleeding, including tachycardia, hypotension, and reductions in hemoglobin, serving as indicators of hypovolemic shock. Postoperative bleeding was diagnosed based on clinical signs, including tachycardia, hypotension, and altered consciousness, as well as a significant hemoglobin drop of more than 2 g/dL within 24 h. In some cases, imaging modalities such as CT, ultrasound, endoscopy, or laparoscopy were used for confirmation. Drain output was assessed in volume and character (bloody vs. serosanguineous); however, our findings demonstrated no strong correlation between drain volume and clinical bleeding markers. There was no correlation between drain volume and both heart rate and blood pressure; p-values were not statistically significant (all were >0.05) on the four postoperative days. Additionally, we observed a weak inverse correlation between drain volume for bloody character and hemoglobin on the first postoperative day. This association suggests that as bloody drain volume increases, there is a corresponding drop in hemoglobin levels, a phenomenon that can be explained by the expected decrease in hemoglobin due to extra luminal bleeding—a normal physiological response, as discussed in previous literature [22].

Our study revealed that 3% of patients undergoing bariatric surgery encountered complications. Among these, bleeding was the most prevalent, occurring in 1.4% of the total sample, followed by a 0.4% incidence of patients experiencing leaks. Other complications were less frequent, as outlined in (Table 1). Alternatively, the reported bleeding rate aligns with figures found in the literature, where 1.3–1.7% of bariatric surgeries are documented to be complicated by bleeding and hemorrhage [23].

Despite the mounting evidence against drains in bariatric surgeries, their utilization persists in numerous surgical departments worldwide [21]. At our facility, drain usage was standard during the years covered in the data collection, with the data indicating a rate of 82.0% for drain use in bariatric surgeries. With the absence of comparable studies in Palestine, this finding suggests that the placement of drains in bariatric surgery was a prevalent surgical practice in Palestine between 2017 and 2021.

A comparable overall decline in the use of drains is evident in studies conducted by Newcomb et al., Pacilli et al., and Gundogan et al. In the first study conducted in 2017, depending on the MBSAQIP database with a sample size of 148,260 patients undergoing laparoscopic REYGB and SG surgeries, drains were utilized in only 23,190 cases (15.6%) [20], The second study, also based on the same database but covering a longer period from 2015 to 2017, revealed that among patients undergoing primary LRYGB and SG, drains were used in 36.4% of patients in 2015, 33.6% in 2016, and only 30.0% in 2017, indicating a noticeable reduction in drain placement [19]. The last study, retrospective and conducted on patients undergoing gastric sleeve (SG) or Roux-en-Y gastric bypass (RYGB) between January 2010 and June 2016, demonstrated that drains were utilized in 166 out of 361 patients [21].

Our results align with the findings of Curro et al. and Albanopoulos et al., whose previous studies indicated no significant impact of drain placement in post-bariatric bleeding and leak detection [18]. However, conflicting results are observed when compared with several other studies.

The study by Curro et al. involved 100 patients undergoing sleeve-gastrectomy surgery with intra-abdominal and nasogastric drainage, showing no difference between the groups [22]. Although limited by a small sample size, our study addresses this limitation with a sample size of 494 patients. Similarly, Albanopoulos et al.'s study on primary and revisional SG concluded that drains may be beneficial for patients undergoing lap band to SG conversion but did not contribute to the detection of leaks, abscesses, or bleeding in primary SG [18].

On the contrary, the results of Benjamin Clapp et al.'s study indicate that patients without drains after bariatric surgery faced a (1.11%) risk of developing leaks, a (1.13%) risk of readmission, and a (1.18%) risk of reoperation, all of which were higher than those observed in patients with drains. However, the study also states that patients with drains had a higher risk of mortality (1.25%) and morbidity (1.35%). It's important to note that this study was limited by selection bias [19].

The data of this study reveal that postoperative anticoagulation was primarily administered on the day of the operation, constituting 50.2% of cases, followed by 43.3% of patients who commenced anticoagulants on the first postoperative day. It also shows a significant association between hemoglobin levels and the timing of postoperative anticoagulation. Specifically, patients who began anticoagulation on **Day 0** (the day of surgery) experienced the most significant drop in hemoglobin between **Day 0 and Day 1**. Similarly, patients who started anticoagulation on **Day 1** had a notable decrease in hemoglobin between **Day 1 and Day 2**. These findings suggest that initiating anticoagulants immediately after surgery may increase the risk of bleeding and other blood-related complications in the early postoperative period. The

observed drop in hemoglobin could be indicative of acute blood loss or a physiological response to the anticoagulant's effects on coagulation.

In contrast, patients who started anticoagulation on **Day 2** did not show a significant drop in hemoglobin levels, implying that delaying anticoagulation by one or two days may allow the body time to stabilize after surgery. This delay may reduce the risk of bleeding complications, as it provides a window for initial clot formation and hemostasis. The absence of significant hemoglobin drop in this group suggests that anticoagulation administered at this later stage does not contribute as heavily to bleeding or blood loss, as the body is better able to manage the effects of the medication at this point.

Interestingly, no significant changes in the color characteristics of the surgical drain were observed at the time points as previously mentioned, despite the drop in hemoglobin levels associated with the use of anticoagulants on Days 0 and 1. A reduction in hemoglobin would be expected to correlate with changes in the volume for bloody drain character, which would indicate ongoing bleeding. However, the lack of such changes in the volume for bloody drain character suggests that the observed drop in hemoglobin was not significantly reflected in the drain. This implies that the drain may not have been an effective indicator of bleeding in this context.

These findings align with existing literature on postoperative anticoagulation. It is well-documented that restarting anticoagulant therapy too early can increase the risk of bleeding complications while delaying it too long can increase the risk of thromboembolism. For example, warfarin, which has a slow onset of action, should generally be restarted as soon as possible after surgery, as it can take several days to reach therapeutic levels. In contrast, newer oral anticoagulants have a rapid onset of action and are typically restarted within 48–72 h post-surgery [24].

To summarize, although patients who started anticoagulation on postoperative Day 0 or Day 1 showed a statistically significant hemoglobin drop, this drop did not reach a clinically significant threshold requiring intervention (e.g., transfusion). Therefore, our findings do not suggest a justification for routine delay of anticoagulation initiation. Additionally, no cases of documented DVT or PE were observed in patients who received delayed anticoagulation (Day 2), however, further studies with larger sample sizes are needed to assess thromboembolic risk.

In conclusion, the association between drain volume and both heart rate and blood pressure was not statistically significant, but there was a significant weak inverse correlation between volume for bloody drain character and hemoglobin value on postoperative day 1 which is a normal physiological response, as previously mentioned. In addition, a significant association was observed between drain color character and the timing of postoperative anticoagulant initiation. Specifically, there was a significant association on day 0 and day 1, while no association was found on days 2 and 3. Regardless of drain usage, the patient's clinical condition remains paramount in detecting complications. While drains can be valuable in identifying issues, they are never as crucial as the patient's clinical presentation. Drains become particularly significant in the presence of leaks. Their role is vital in draining collections, secretions, or intraperitoneal fluids, potentially allowing patients to avoid additional surgeries. With our study findings, we can recommend a more thoughtful use of the drains to Palestinian surgeons in bariatric surgeries.

Our results are limited in generalizability to our age population; as this study involved adults older than 14, it cannot be expanded to those younger. Our results also have limited generalizability to the eastern populations, given the high variability of comorbidities and medication use among the two populations.

Finally, it's important to acknowledge the limitations, as it is a retrospective study, we had limited control over confounding factors, and information collected may not fully represent the sample due to incorrect recording for example over or under-reporting of events might have occurred by providers caring for patients. Another limitation of this study is the small number of patients who experienced postoperative bleeding (only seven cases), which may limit our ability to accurately assess the impact of drain placement and hemoglobin levels on postoperative bleeding. Also, this study was conducted exclusively at a single Palestinian hospital. However, it's noteworthy that this hospital serves as the primary center for bariatric surgery. Future studies could explore multiple Palestinian hospitals to enhance the generalizability of the findings.

Conclusion

Drains are commonly used in bariatric surgery; however, their effectiveness in detecting complications like bleeding and leaks remains uncertain. There was no association between drain volume and signs of bleeding and leak complications, and the clinical assessment, especially the vital signs, is the most effective method in identifying postoperative issues. These findings support a more cautious approach to the use of drains in bariatric surgeries by Palestinian surgeons.

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Author contributions
Khaled Alashawwa: Conceptualization, Writing – review & editing. Bayan Fathi Al-Qtisha: Conceptualization, Formal analysis, Writing – original draft, Writing – review & editing. Fatima az-Zahra Mohammed Thawabtah: Formal analysis,

Writing – original draft.Taqwa Riad Abu Ghanieh: Data Collection, Writing – review & editing. Osama J. Makhamreh: Data Collection, Writing – review & editing. Ruba Maher Salameh: Data Collection, Writing – review & editing. Omar Abu Zaydeh: Writing – original draft, review & editing.All authors have participated in writing the manuscript and reviewed the literature. All authors contributed to revision of the manuscript. All authors read and approved the final manuscript.

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Data availability
The datasets used and/or analyzed during the current study are available from the corresponding author on reasonable request.

Declarations

Ethics approval and consent to participate
All procedures performed in this study involving human participants complied with the institutional and/or national research committee ethical standards and the 1964 Helsinki declaration and subsequent amendments or equivalent ethical standards. The study was designed and conducted in accordance with the ethical principles established by Al-Quds University. Therefore, ethical approval was obtained from the Institutional Review Board Committee, Al-Quds University. Written informed consent was obtained from all the participants for the participation of this study and accompanying images. A copy of the written consent is available for review by the Editor-in-Chief of this journal on request.

Consent for publication
The manuscript contains no images or videos—not applicable.

Competing interests
The authors declare no competing interests.

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