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Original Article / Özgün Makale

Does using Jackson-Pratt drain affect the incidence of sternal wound complications after open cardiac surgery?

Açık kalp cerrahisi sonrası sternal yara komplikasyonlarının görülme sıklığı Jackson-Pratt dreni kullanımı ile etkilenir mi?

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ABSTRACT

Background: This study aims to investigate the effect of the Jackson-Pratt drain on sternal wound complications in patients with a Body Mass Index of ≥30 kg/m^2 undergoing open cardiac surgery via median sternotomy.

Methods: A total of 174 patients (124 males, 50 females; mean age 58.2±10.4 years; range, 33 to 78 years) with a Body Mass Index of ≥30 kg/m^2 undergoing cardiac surgery via median sternotomy between January 2011 and December 2015 in our institution were retrospectively analyzed. Of the patients, 94 were inserted a Jackson-Pratt drain (JP group) following median sternotomy, while 80 patients received no drain (non-JP group). Pre-, intra, and postoperative outcomes of both groups including type of operation, length of hospital stay, and complications were compared.

Results: No significant difference in the age, gender, Body Mass Index, and potential risk factors was found between the groups. The median of stay in the intensive care unit was two days and the median time from operation to discharge was seven days in both groups. There was a statistically significant difference in the rate of sternal wound complications between the groups. Sternal wound complications occurred in two patients (2.1%) in the drained group, compared to nine patients (11.25%) in the non-drained group (p=0.01).

Conclusion: Our study results show that Jackson-Pratt drain insertion after median sternotomy in patients with a Body Mass Index of ≥30 kg/m^2 undergoing open cardiac surgery is a simple and reliable method to reduce the risk of postoperative sternal wound complications, compared to the conventional closure technique.

Keywords: Jackson-Pratt drain; median sternotomy; sternal wound complications.

ÖZ

Amaç: Bu çalışmada median sternotomi ile açık kalp cerrahisi yapılan, Vücut Kütle İndeksi ≥30 kg/m^2 olan hastalarda Jackson-Pratt dreninin sternal yara komplikasyonları üzerindeki etkisi incelendi.

Çalışma planı: Ocak 2011 - Aralık 2015 tarihleri arasında Vücut Kütle İndeksi ≥30 kg/m^2 olan, hastanemizde median sternotomi ile açık kalp cerrahisi yapılan toplam 174 hasta (124 erkek, 50 kadın; ort. yaş 58.2±10.4 yıl; dağılım, 33-78 yıl) retrospektif olarak incelendi. Hastaların 94'üne median sternotomi sonrası Jackson-Pratt dreni takılırken (JP grubu), 80 hastaya dren takılmadı (JP olmayan grup). Her iki grubun ameliyat tipi, hastanede kalış süresi ve komplikasyonlar dahil olmak üzere ameliyat öncesi, sırası ve sonrası sonuçları karşılaştırıldı.

Bulgular: Gruplar arasında yaş, cinsiyet, Vücut Kütle İndeksi ve muhtemel risk faktörleri arasında anlamlı bir fark yoktu. Her iki grupta da yoğun bakım ünitesinde median kalış süresi iki gün ve ameliyattan taburculuğa kadar geçen median süre yedi gündü. Gruplar arasında sternal yara komplikasyon oranı açısından istatistiksel olarak anlamlı bir fark bulundu. Dren takılmayan grupta dokuz hastaya (%11.25) kıyasla, dren takılan grupta iki hastada (%2.1) sternal yara komplikasyonu gelişti (p=0.01).

Sonuç: Çalışma bulgularımız, median sternotomi sonrasında Jackson-Pratt dren kullanımının vücut kitle indeksi ≥30 kg/m^2 olan, açık kalp cerrahisi yapılan hastalarda geleneksel kapatma tekniğine kıyasla, ameliyat sonrası sternal yara komplikasyon riskini azaltmada basit ve güvenli bir yöntem olduğunu göstermektedir.

Anahtar sözcükler: Jackson-Pratt dreni; median sternotomi; sternal yara komplikasyonları.

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Despite the increasing use of minimally invasive approaches, the majority of cardiac operations are still performed using median sternotomy.[1] The median sternotomy provides an excellent approach for the performance of cardiopulmonary bypass in cardiac surgery. Sternal wound complications (SWCs) following median sternotomy remain a challenge in cardiac surgery with a severe burden for the patient and high costs for health care providers.[2,3] A change in the spectrum of cardiac surgery has been observed in recent years. Patients are older, suffer more frequently from diabetes mellitus (DM), and have a higher mean Body Mass Index (BMI). Several risk factors have been identified in previous studies. The major risk factors which affect the incidence of SWCs include DM, obesity, technical errors in sternal wiring, and early revision.[4] The Jackson-Pratt drain (JP drain) is a closed-suction medical device which is commonly used as a postoperative drain for collecting bodily fluids from surgical sites. The purpose of a drain is to prevent fluid (blood or other) build-up in a closed space, which may cause either disruption of the wound and the healing process or become an infected abscess.

In the present study, we hypothesized the insertion of the JP drain would be helpful in preventing fluid (blood or other) build-up in a closed space during healing and in reducing the risk of SWCs. We aimed to investigate the effect of the JP drain on SWCs in patients with BMI ≥30 kg/m^2 undergoing cardiac surgery via median sternotomy.

PATIENTS AND METHODS

Study design and patients

This retrospective study included a total of 174 patients (124 males, 50 females; mean age 58.2±10.4 years; range, 33 to 78 years) with a BMI of ≥30 kg/m^2 undergoing cardiac surgery via median sternotomy between January 2011 and December 2015 in our institution. All of the operations were performed by a single surgical team. We started using closed-suction drain (JP) on the date of December 2013. Of the patients, 94 had closure with insertion of the JP drain (JP group) and 80 patients had conventional closure (non-JP group). Perioperative intravenous antibiotics were used in all patients. Oral antibiotics were administered, depending on the patient's condition at discharge. Electronic medical records were reviewed for each patient. The type of operation, and the postoperative outcomes including the length of hospital stay and complications were also recorded.

A written informed consent was obtained from each patient. The study protocol was approved by the Okan University Hospital Ethics Committee. The study was conducted in accordance with the principles of the Declaration of Helsinki.

Jackson-Pratt drain

The JP drain is a closed-suction medical device which is commonly used as a postoperative drain to collect body fluids from the surgical sites. The device consists of an internal drain connected to a grenade-shaped bulb via plastic tubing. The JP drain (informally referred to as brain drain) was named after its inventors Drs. Fredrick E. Jackson and Richard A. Pratt. First publications mentioning this device date back to 1971 - 1972.[5,6] The purpose of this drain is to prevent fluid (blood or other) build-up in a closed space which may cause either disruption of the wound and the healing process or become an infected abscess. The drain pulls this fluid (by suction) into a bulb. The resulting vacuum creates suction in the drainage tubing, which gradually draws fluid from the surgical site into the bulb. The bulb may be repeatedly opened to remove the collected fluid and squeezed again to restore suction. The JP drains come in flat and round forms and are available in varying sizes.

Surgical technique

Median sternotomy was performed in the conventional fashion. In all patients, after completion of the cardiac procedures and achievement of hemostasis, the standard closure of the median sternotomy involved the use of peri-sternal, single or figure-of-eight sternal wires with a multi-twist closure. The suturing technique and material for both subcuticular and subcutaneous closures were identical in all patients. The presternal fascia and muscle were reapproximated with size 0 polyglactin 910 suture (Vicryl, Ethicon, Inc., Somerville, NJ, USA) applied in a continuous fashion. The JP drain was inserted at this stage of the operation. Firstly, the skin is opened with a 15 blade. A 14F diameter JP silicone flat drain was inserted easily through this small opening in a suprasternal fashion. The subcutaneous tissue was reapproximated with 2-0 polyglactin 910 suture (Vicryl, Ethicon, Inc., Somerville, NJ, USA) and the skin was closed with a subcuticular 3-0 poliglecaprone 25 suture (Monocryl, Ethicon, Inc., Somerville, NJ, USA), both applied in continuous fashion in all patients. A sterile island-type bandage was, then, applied (Figure 1).

Superficial sternal wound infection was defined as infection limited to skin, subcutaneous tissue, and pectoral fascia. Deep sternal wound infection was defined as the presence of one of the following criteria: *(i)* an organism isolated from culture of mediastinal tissue or fluid; *(ii)* evidence of mediastinitis during

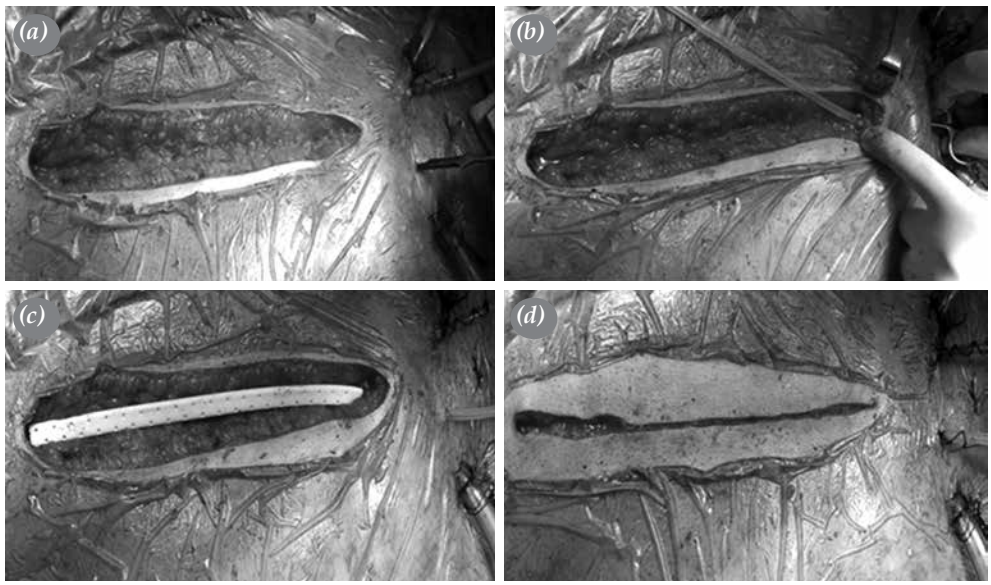

Figure 1. (a) An incision was made for the insertion of the drain, then, **(b)** the perforated part of the drain was inserted in a suprasternal fashion. **(c)** Finally, the drain was fixed and **(d)** the incisions were closed.

operation; or *(iii)* presence of either chest pain, sternal instability or fever (>38°C), and either purulent drainage from the mediastinum, isolation of an organism present in blood culture or culture of the mediastinal area.[7]

Statistical analysis

Statistical analysis was performed using PASW statistics version 18.0 software (SPSS Inc., Chicago, IL, USA). Descriptive data were expressed in

Table 1. Preoperative characteristics of patients

	Jackson-Pratt group (n=94)			Non-Jackson-Pratt group (n=80)			
Preoperative factors	n	%	Mean±SD	n	%	Mean±SD	*p*
Age (year)			57.9±11.2			58.5±9.5	0.71
Gender							
Female	30	32		20	25		0.32
Diabetes mellitus	32	34		39	48.75		0.07
Hypertension	69	73.4		57	71.2		0.75
Chronic obstructive pulmonary disease	10	10.6		14	17.5		0.19
BMI (kg/m^2)			37.0±4.6			36.0±5.5	0.19
30-40	71	75.5		64	80		
>40	23	24.5		16	20		
Renal dysfunction	2	2.1		1	1.25		0.56
Coronary artery disease	65	69		64	80		0.10
Preoperative atrial fibrillation	18	19		8	10		0.09
Operative priority (urgent)	1	1		0	0		0.54
Left ventricle function (ejection fraction)			59.1±8.7			60.6±6.7	0.20
Good	73	77.6		68	85		
Moderate	18	19		10	12.5		
Poor	3	3.2		2	2.5		
Extracardiac arteriopathy							
Peripheral arterial disease	1	1		0	0		0.54
Carotid artery disease	10	10.6		4	5		0.25

SD: Standard deviation; BMI: Body Mass Index.

Table 2. Operative procedures

	Jackson-Pratt group (n=94)		Non-Jackson-Pratt group (n=80)	
Surgical procedure	n	%	n	%
Coronary artery bypass grafting	53	56.4	56	70
Coronary artery bypass grafting + other	2	2.1	1	1.25
Coronary artery bypass grafting + valve	10	10.6	7	8.75
Valve	14	14.9	6	7.5
Valve + other	7	7.4	3	3.75
Others	8	8.5	7	8.75

Others include atrial septal defect closure, ventricular septal defect closure, maze procedures, thoracic aortic procedures and carotid artery endarterectomy.

mean ± standard deviation, number and frequency (%), or median (min-max) values, unless otherwise stated. Significance testing was performed by an independent biostatistician using a two-sample t test for comparisons between groups (continuous data), either a chi-square test or a Fisher's exact test for homogeneity between groups (categorical data), or Mann-Whitney U test, when median (range) was presented. A p value of <0.05 was considered statistically significant.

RESULTS

A total of 174 patients were included in the study. Demographic characteristics of the patients and preoperative risk factors are summarized in Table 1. No significant difference was found between JP and non-JP groups in terms of potential risk factors such as chronic renal failure, hypertension, chronic obstructive pulmonary disease (COPD), peripheral artery disease, and coronary artery disease (Table 1).

Primary indications for surgery included on-pump coronary artery bypass grafting (CABG) in 101 patients, off-pump CABG (n=8), repair or replacement of one or more valves (n=47) and other procedures (n=18). The distribution of surgical procedures is summarized in Table 2.

An intra-aortic balloon pump was required in four patients (JP group: 2.1%, non-JP group: 2.5%; p=0.63). The median stay in the intensive care unit was two days and the median time from operation to discharge was seven days in both groups.

Surgical outcomes are presented in Table 4. Accordingly, there was no significant difference in reoperation for bleeding or cardiac tamponade between the groups. The complications of sternal site were divided into superficial wound infections and deep sternal complications. Analysis of the primary outcome of SWCs showed statistically significant

Table 3. Intraoperative data

	Jackson-Pratt group (n=94)				Non-Jackson-Pratt group (n=80)				
Variables	n	%	Median	Min-Max	n	%	Median	Min-Max	p
Off-pump	4	4.3			4	5	86.5	45-209	0.55
Reoperation	3	3.2			2	2.5	59	26-163	0.54
Bilateral internal mammary artery	7	7.4			1	1.25			0.07
Cardiopulmonary bypass time			117.5	52-312			86.5	45-209	0.00
Aortic clamping duration			81	29-254			59	26-163	0.00
Intra-aortic balloon pump	2	2.1			2	2.5			0.63
Intensive care unit stay (days)			2	1-17			2	1-28	0.51
Hospital stay (days)			7	2-20			7	5-33	0.70

Min: Minimum; Max: Maximum.

Table 4. Comparison of postoperative adverse events between JP and non-JP groups

	Jackson-Pratt group (n=94)		Non-Jackson-Pratt group (n=80)		
	n	%	n	%	*p*
Mortality	2	2.1	1	1.25	0.56
Reoperation for bleeding/tamponade	2	2.1	1	1.25	0.57
Low cardiac output syndrome	3	3.2	2	2.5	0.57
Inotropic support >24 hours	10	11	10	12.5	0.70
Acute renal failure	2	2.1	1	1.25	0.56
Cerebrovascular accident	2	2.1	1	1.25	0.56
Sternal wound complications	2	2.1	9	11.25	0.01
Superficial sternal complications	1	1	7	8.75	0.02
Superficial (no treatment)	0	0	1	1.25	
Superficial (treated with antibiotics)	0	0	5	6.25	
Superficial (treated with VAC pump)	1	1	1	1.25	
Deep sternal complications	1	1	2	2.5	0.44
Deep (treated with antibiotics)	0	0	0	0	
Deep (treated with surgical rewiring/ debridement)	0	0	1	1.25	
Deep (treated with VAC pump)	1	1	1	1.25	

VAC: Vacuum-assisted closure.

differences between the groups (Table 4). Sternal wound complications occurred in two patients (2.1%) in the JP group, compared to nine patients (11.25%) in the non-JP group (p=0.01). Superficial wound infection occurred in one patient (1.1%) in the JP group and seven patients (8.75%) in the non-JP group (p=0.02), whereas deep wound infection was seen in one patient (1.1%) in the JP group versus two patients (2.5%) in the non-JP group (p=0.44). The patient with a deep sternal complication in the JP group was a 65-year-old male hypertensive and diabetic patient with a height of 173 cm and body weight 126 kg (BMI 42 kg/m^2), underwent CABG. After 30 days from discharging the patient, pressing anterior chest pain due to violent coughing was initiated. On clinical evaluation, the patient showed sternal instability on palpation from the wound. After a control computed tomography scan, it was decided to perform surgical revision of the wound using thermoreactive clips.

DISCUSSION

We used JP drain in 94 patients with a BMI of ≥30 kg/m^2 undergoing cardiac surgery via median sternotomy (JP group). Superficial wound complications occurred in 1% of patients and deep sternal complications were observed in one patient. Regarding SWCs, the rate was 2.1% in the patients with JP group and 11.25% in the cases in which no drains were inserted.

Mediastinal wound complications are a significant source of postoperative mortality and increased costs.[8] Wound infections can be classified as superficial (skin and/or subcutaneous tissue) or deep (bone and retrosternal space). Despite modern cardiac surgery procedures, the reported incidence of sternal wound infections has not considerably decreased.[9,10] The incidence of superficial sternal infections ranges from 0.9 to 20%.[11,12] The risk factors of sternal wound infections can be classified as preoperative (i.e., diabetes, male gender, obesity), operative (i.e., use of bilateral mammary arteries), and postoperative (i.e., mechanical ventilation) variables.[13-17] Salehi Omran et al.[18] reported that female sex, hypertension, and re-exploration for bleeding were significant risk factors in the development of sternal wound infections.[18] Furnary et al.[19] showed that reducing glucose levels in diabetic patients could decrease the incidence of SWCs after cardiac surgery. In another study, it was reported that hyperglycemia during immediate postoperative period was a risk factor for developing sternal wound infections.[20] Obesity

is also known to increase the risk of postoperative SWCs, although the exact mechanisms are not well-understood yet and may include hypovascularity of adipose tissue, decreased oxygen tension, compromised collagenization, compromised immunity, oxidative stress, and adiponectin deficiency.[21-25] Consistent with other reports,[15,16] Lu et al.[26] found that obesity was one of the significant risk factors for sternal wound infections. In another study from Ridderstolpe et al.,[13] obese patients were found to be 2.1 times more likely to develop sternal wound infections. Milano et al.[27] suggested that skin preparation could be difficult and inadequate in obese patients.

Considering all these factors, additional preventive measures are needed to decrease the incidence of sternal wound infections, particularly in patients with a BMI of ≥30 kg/m^2. Karabay et al.[28] demonstrated an increased rate of superficial sternal wound infections, when the intracutaneous suture technique was used compared to the transcutaneous method. Balkanay et al.[29] reported that using gentamicin-soaked sponges during CABG could decrease sternal wound infections.

A particular attention should be given to patients who have a high BMI, as they have a significantly higher rate of SWCs. Although many techniques for closing median sternotomy in obese patients have been attempted until now, there is no report in the literature regarding the use of JP drains in cardiac surgery.[30,31] The JP suction drains have been used in various areas of surgery including urologic surgery, gynecologic oncology surgery, and after breast reconstruction.[32-34]

In our study, the JP drain was used to prevent fluid build-up in a closed space during healing of sternal wound. We hypothesized that the insertion of the JP drain would help to prevent fluid (blood or other) build-up in a closed space during healing, by reducing the risk of SWCs after median sternotomy. Noveksky et al.[33] inserted a JP drain below the Camper's fascia in women with a BMI of ≥30 kg/m^2 who underwent gynecologic surgery. This surgical protocol led to a decreased rate of wound complications among women with a BMI of 30 to 39.9 kg/m^2. In our study, we used the JP drain in 94 patients with a BMI of ≥30 kg/m^2 undergoing cardiac surgery via median sternotomy. The JP group patients had a significantly lower risk of superficial wound complications compared to the non-JP group (1.1% vs. 8.75%, p=0.02). We believe that superficial sternal infections are important, as they may progress to deeper layers, leading to deep sternum complications.

The incidence of deep sternal wound infection varies from 0.4 to 5%.[35] In addition to physical problems, the patient usually faces with the mental burden of additional surgical procedures, a longer hospital stay, and prolonged intake of antibiotics. These complications are also associated with a considerable financial burden for patients, families, and the entire health care system.[36]

In their study including 2,809 patients, Magedanz et al.[37] identified five risk factors for mediastinitis in patients undergoing CABG including include COPD, obesity, multiple blood transfusions in the postoperative period, surgical intervention, and angina Class IV. In another recently published study, 107 patients developed mediastinitis in a cohort of 18,532 patients who underwent CABG with a mean follow-up of 10.3 years.[38] The authors identified as independent risk factors for developing mediastinitis: COPD, age, male gender, stenosis of the left main coronary artery, DM, and obesity (BMI >30 kg/m^2). These last two were also identified as risk factors for mediastinitis after CABG by Sá et al.[39]

In our study, there was no significant difference in hospital stay between the groups. Sternal wound complications occurred in two patients (2.1%) in the JP group, compared to nine patients (11.25%) in the non-JP group (p=0.01). Deep sternal complications rate was 1% for the JP group and 2.5% for the non-JP group (p=0.44). Although there were no statistically significant differences in the development of a postoperative deep wound infection between the groups, the number of patients was higher in the non-JP group.

Furthermore, the use of bilateral mammary arteries is a known contributor to SWC rates.[13] As shown in our study, the use of bilateral mammary arteries was higher in the JP group, and the operation time was longer; however, the number of SWCs was higher in the non-JP group. The use of the JP drain might have probably decreased the rate of SWCs in the JP group.

The major limitations of this study are the retrospective design and small sample size.

In conclusion, Jackson-Pratt drain insertion after median sternotomy in patients with a Body Mass Index of ≥30 kg/m^2 undergoing cardiac surgery is a simple and reliable method to decrease fluid (blood or other) collection in a closed space during healing after median sternotomy. Our study results also suggest that the use of suprasternal JP drain for this purpose may reduce the risk of sternal wound complications, compared to the conventional closure technique.

Declaration of conflicting interests

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