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Impact of longitudinal versus oblique groin incisions on femoral wound healing in endovascular aortic repair patients

Hakan Saçlı[1], Salih Salihi[1], Halil İbrahim Erkengel[1], Bilal Perçin[2], Bilhan Özalp[1], İbrahim Kara[1]

[1]Department of Cardiovascular Surgery, Sakarya University Faculty of Medicine, Sakarya, Türkiye
[2]Department of Cardiovascular Surgery, Sakarya Training and Research Hospital, Sakarya, Türkiye

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ABSTRACT

Objectives: This study aimed to examine the wound healing problem development status of the longitudinal and oblique incision types applied in our clinic.

Patients and methods: A total of 201 patients (183 males, 18 females; 66.9±9.9 years; range, 34 to 88 years) who underwent emergency or elective abdominal aortic aneurysm endovascular aortic repair (EVAR) or thoracic endovascular aortic repair (TEVAR) between September 2014 and June 2021 were included in this single-center retrospective study. Group 1 (n=115) consisted of patients who underwent longitudinal (vertical) femoral incision, whereas Group 2 (n=86) underwent oblique (transverse) femoral incision. Preoperative risk factors connected with wound healing problems, femoral wound healing problem development, onset time of the femoral wound healing issues, types of the wound healing issue, hospital stay, and mortality were assessed.

Results: Femoral wound healing problems were significantly lower in Group 2 ($p<0.05$). It was observed that wound healing problems started earlier in Group 1. The distribution of diabetes mellitus, chronic kidney disease, and peripheral artery disease rates did not differ significantly ($p>0.05$). Obesity and chronic obstructive pulmonary disease rates were significantly higher in Group 1 ($p<0.05$). Postoperative length of hospitalization were borderline statistically significant in Group 1 ($p=0.076$). The incidence of early mortality was similar.

Conclusion: Femoral wound healing problems were observed more frequently in patients who underwent EVAR with femoral longitudinal incision access. Fewer wound healing problems in the oblique incision group made us routinely prefer the oblique incision in femoral artery access in EVAR cases.

Keywords: EVAR, incision, groin, longitudinal, oblique, TEVAR, transverse, vertical, wound healing, wound infection.

In 1991, before Parodi et al.,[1] open surgery was defined as the only interventional treatment option for thoracic and abdominal aortic aneurysms and dissections. Nowadays, endovascular aortic treatment methods have become increasingly widespread and have emerged as a standard treatment modality for thoracic and abdominal aortic aneurysms, dissections, and ruptures.[2,3] In the endovascular aortic repair (EVAR) procedure, the femoral artery is used as the vascular access route. The groin region, which is the anatomical access point of the main femoral artery, is a moist, folding region and is especially ideal for microbial growth. Because of this nature of the inguinal region, there is a risk of wound infection and closure problems after open surgical access to the femoral artery. The most commonly used incision for the exposure of femoral region is the longitudinal (vertical) incision.[4] With a longitudinal incision, an incision is made from top to bottom perpendicular to the inguinal region to provide a good view of the vessels. Although this incision provides good surgical visualization, wound healing problems are more frequent and the risk of infection is higher.[5] On the other hand, oblique (transverse) incision in the groin is associated with less impairment in lymphatic circulation and less

Corresponding author: Hakan Saçlı, MD. Sakarya Üniversitesi Tıp Fakültesi Kalp ve Damar Cerrahisi Anabilim Dalı, 54100 Adapazarı, Sakarya, Türkiye.
E-mail: mdhakans@yahoo.com

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wound healing complications. However, in addition to these advantages, surgical visualization of the femoral artery is more difficult.[6] In our study, we aimed to evaluate the relationship between these different types of femoral incisions and wound healing problems with our own data.

PATIENTS AND METHODS

This single-center retrospective study included a total of 201 patients (183 males, 18 females; 66.9±9.9 years; range, 34 to 88 years) who underwent emergency and elective EVAR and thoracic endovascular aortic repair (TEVAR) procedures in the Cardiovascular Surgery Department of the Sakarya University Training and Research Hospital from September 2014 to June 2021. Patients were divided into two groups: Group 1 and 2 depending on the femoral incision type. Group 1 is consist of longitudinal femoral incision group and Group 2 is oblique femoral incision group. Group 1 (n=115) consisted of patients who underwent longitudinal (vertical) femoral incision, whereas Group 2 (n=86) underwent oblique (transverse) femoral incision. A longitudinal incision was preferred in the EVAR procedures performed until the mid-2018s from the beginning as the standard incision type to access the femoral artery. Due to femoral wound healing issues, our standard incision type was changed to an oblique groin incision in mid-2018s after an analysis of the data in the literature. Since then, we have exclusively used the oblique groin incision for EVAR procedures. Written informed consent was obtained from all participants. The study protocol was approved by the Sakarya University Ethics Committee (Date: 23.11.2018, No: 71522473/050.01.04/281). The study was conducted in accordance with the principles of the Declaration of Helsinki.

Surgical procedure

Endovascular procedures were performed in the angiography unit with the same surgical team. Anaconda Abdominal Aortic Stent Graft System (Vascutek, Terumo, Inchinnan, Scotland), Medtronic Endurant II Stent Graft System (Medtronic Vascular, Santa Rosa, CA, USA), Medtronic Valiant Thoracic Stent Graft System (Medtronic Vascular, Santa Rosa, CA, USA), and Ankura Abdominal Aortic Stent Graft System (Lifetech Scientific, Shenzen, China) were used as endovascular stent grafts for the procedures. All operations were performed under general anesthesia. Femoral arteries were used for vascular access. Depth and the length of the incisions were similar. Femoral arteries were not excessively explored to avoid further complications. A simple 5-0 Prolene purse-string suture was placed on the anterior side of the femoral artery to control the arterial bleeding during the procedure. The subcutaneous tissue was closed with 1-0 polyglactin (Vicryl) suture. The skin was closed with 3-0 Prolene sutures with a vertical mattress suture technique in all patients. Postoperative routine follow-up was done on the 10th day, at three month and six months, at one year, and annually thereafter following discharge.

Data were collected from the patient files and hospital's online database. Demographic values, preoperative risk factors connected with abdominal aortic aneurysms and wound healing issues, femoral wound healing issues, onset of the femoral wound healing issue, urgent and elective status, types of the wound healing problem, wound culture tests, intensive care unit and hospital stay, and mortality were assessed. Postoperative early mortality was defined as deaths within 30 days after the operation.

Wound healing problems were determined as follows: wound dehiscence, superficial surgical site infection, deep surgical site infection, and lymphatic leak. There were no cases of organ/space surgical site infection; therefore, this category was excluded from the tables.

Statistical analysis

Data were analyzed using IBM SPSS version 27.0 software (IBM Corp., Armonk, NY, USA). Mean, standard deviation, median, minimum, maximum, frequency, and ratio values were used in descriptive statistics of the data. The distribution of variables was measured with the Kolmogorov-Smirnov test. The independent sample t-test was used to analyze quantitative independent data with normal distribution. The Mann-Whitney U test was used to analyze quantitative independent data with nonnormal distribution. The chi-square test was used in the analysis of qualitative independent data, and the Fischer test was used when chi-square test conditions were not met. A p-value <0.05 was considered statistically significant.

RESULTS

Age and sex distribution of the patients did not differ significantly between Groups 1 and 2 (p>0.05). The distribution of hypertension (HT), diabetes mellitus (DM), chronic kidney disease (CKD) and peripheral artery disease (PAD) rates did not differ significantly between the two groups (p>0.05). Obesity was significantly (p=0.020) lower in Group 2 (1.2% n=1) than in Group 1 (8.7% n=10). Chronic obstructive pulmonary disease (COPD) were significantly (p=0.014) lower in the Group 2 (29.1% n=25) than in the longitudinal incision group (46.1% n=53). Smoking rates did not differ significantly between the groups (p=0.821; Table 1).

There was no significant difference between Groups 1 and 2 in terms of the rate of aneurysm, dissection, and rupture diagnoses at the time of intervention (p>0.05; Table 1). Urgent and elective intervention status of the patients resulted similarly and no statistical difference was found (Table 1).

The number of patients with femoral wound healing problems was compared for statistical analysis. Three patients had both wound dehiscence and lymphatic leak in one groin in Group 1. As the statistical analysis was based on the number of patients rather than the number of complications, these cases were each counted as a single femoral wound healing problem to avoid duplication (Table 2). Femoral wound healing problems were significantly (p=0.042) lower in Group 2 (7.0% n=6) than in Group 1 (16.5% n=19). Although the onset of postoperative femoral wound healing problems did not differ significantly (p=0.13) between Group 1 (12.8±8.9 days) and Group 2 (19.0±6.3 days), it was observed that wound closure problems started earlier in Group 1. There was no significant difference between the both groups in terms of wound culture results and rates of different wound closure problems (p>0.05; Table 2).

There was no significant difference in the reoperation rate and in terms of intensive care unit length of stay between the both groups (p>0.05). Postoperative length of hospitalization between the both groups were borderline statistically significant (p=0.076). Postoperative early mortality was similar between the groups (Table 2).

Treatment methods used in the wound healing process are summarized in Table 3.

Table 1
Demographic and preoperative data comparison of both groups

	Longitudinal incision				Oblique incision				
	n	%	Mean±SD	Median	n	%	Mean±SD	Median	*p*
Age (year)			67.0±9.9	68.0			66.8±10.0	70.0	0.711*
Sex									0.100†
Female	7	6.1			11	12.8			
Male	108	93.9			75	87.2			
Hypertension	104	90.4			76	88.4			0.636†
Diabetes mellitus	17	14.8			12	14.0			0.869†
Obesity	10	8.7			1	1.2			**0.020**†
Chronic kidney disease	22	19.1			11	12.8			0.230†
Peripheral artery disease	44	38.3			22	25.6			0.058†
COPD	53	46.1			25	29.1			**0.014**†
Cigarette smoking	61	53.0			47	54.7			0.821†
Aneurysm (+)	114	99.1			85	98.8			1.000†
Dissection (+)	24	20.9			14	16.3			0.411†
Rupture (+)	24	20.9			11	12.8			0.135†
Emergent (+)	30	26.1			15	17.4			0.146†
Elective (+)	85	73.9			71	82.6			0.146†

SD: Standard deviation; COPD: Chronic obstructive pulmonary disease; * Mann-Whitney U test; † Chi-square test (Fischer test).

Table 2
Postoperative data between groups

	Longitudinal incision				Oblique incision				
	n	%	Mean±SD	Median	n	%	Mean±SD	Median	*p*
Femoral wound healing problem¶	19	16.5			6	7.0			**0.042**†
Onset of femoral wound healing problem (d)			12.8±8.9	12.0			19.0±6.3	20.5	0.130t
Wound culture									1.000†
(–)	16	84.2			5	83.3			
(+)	3	15.8			1	16.7			
Wound dehiscence	16	13.9			4	4.7			0.562†
SSI-superficial	3	2.6			1	1.2			1.000†
SSI-deep	0	0.0			1	1.2			0.240†
Lymphatic leak*	3	2.6			0	0.0			0.133‡
Reoperation	13	11.3			8	9.3			0.646†
ICU stay (day)			2.9±6.1	1.0			2.3±2.6	1.0	0.508*
Hospital stay (day)			8.3±8.1	6.0			6.8±5.3	5.0	**0.076***
Operative mortality	0	0			0	0			
Postoperative early mortality									0.189†
(–)	110	95.7			85	98.8			
(+)	5	4.3			1	1.2			

SD: Standard deviation; SSI: Surgical site infection; ICU: Intensive care unit; ¶ Described in the article above; * Mann-whitney u test; † Chi-square test (Fischer test); ‡ Independent sample t-test.

Table 3
Treatment methods used in the wound healing process in patients who had wound closure problems depending on the incision type

	Number of patients with incision type and wound closure problems	
	Longitudinal (n=19)	Oblique (n=6)
	n	n
Debridement + surgical closure	4	4
Vacuum assisted closure + surgical closure	10	
Secondary healing with local dressing	5	2

DISCUSSION

Surgical site infections are one of the most common complications after vascular surgery and an important cause of morbidity that may progress to prolonged hospitalization, graft-related complications, and even limb loss.[7] Apart from increased morbidity, another important situation is that the wound healing issues cause prolonged hospitalization with repeated interventions applied during the wound closure process, which leads to increased health care costs.[8] The incidence rate of surgical wound complications, such as infection, hematoma, and lymphatic drainage ranges from 1 to 10%[9] to 4.8%,[10] and a meta-analysis by Ng et al.[6] showed that close to 30% of patients were affected by surgical wound infection after surgery in the femoral region despite all preoperative, intraoperative, and postoperative precautions. In our study, 25 (12.4%) of a total of 201 patients developed

femoral surgical wound healing problems, and only five (2.48%) of these patients developed surgical site infection, with similar results to the literature.

According to the classification of the Centers for Disease Control and Prevention (CDC), surgical wound infections are divided into three classes.[11] These were classified as superficial incisional, deep incisional, and organ/space surgical site infections, and this classification was standardized accordingly. In these specific incision types we compared in the femoral region, organ/space surgical site infection was not compared in our study because there was no such deep organ/space level in this region. However, since superficial incisional surgical site infections are classified with a wide range of regions including epidermal, dermal, and subcutaneous tissue, we evaluated patients with wounds that did not reach the subcutaneous tissue and had only a mechanical closure problem in the skin in a separate class as "wound dehiscence."

The rate of wound healing problems in the longitudinal incision group was statistically significantly higher than in the oblique incision group (p=0.042). In the literature, prospective, randomized controlled, and meta-analysis studies also show that infection and wound healing problems are more common in longitudinal incisions compared to oblique incisions.[4-6] In all patients in whom wound dehiscence was observed, this was encountered as a partial closure problem. When compared according to the CDC's surgical site infection classification, there was no statistically significant difference between the groups. In addition to the patients with wound dehiscence, three patients with accompanying lymphatic leakage were in the longitudinal incision group and were evaluated under this group. No lymphatic complications were observed in the oblique incision group.

Although there was no statistically significant difference in the timing of the onset of wound healing problems, it was observed that these problems started earlier in the longitudinal incision group. Although the onset time is not discussed in many articles in the literature, in the randomized controlled study of Swinnen et al.,[5] it was mentioned that the infection developed by the 10th day in a significant portion of the patients with wound infection and the infection developed by the 28th day in a large portion of the remaining patients. In our study, wound healing problems were observed on average on the 12th day in the longitudinal incision group and on the 20th day in the oblique incision group. This suggests that oblique incisions have a lower incidence of healing issues with a later onset of healing complications.

When the duration of hospitalization was analyzed, it was observed that hospitalization in the longitudinal incision group was borderline statistically significant (p=0.076). This result may be attributed to the earlier onset of wound healing problems in the longitudinal incision group and longer hospitalization for this reason. Siracuse et al.[12] also showed that the longitudinal incision access group was hospitalized statistically longer than the oblique incision access group in their study in which they compared the results according to access route differences. Prolonged hospitalization increases both economic costs and the burden of healthcare services. Therefore, fewer wound healing problems will positively contribute to this additional cost-effectiveness analysis and patient bed occupancy rate.

No statistically significant difference was found between the two groups in terms of operative and postoperative mortality. Similarly, no statistically significant difference was observed in the literature according to incision type.[12,13] Similarly, there was no significant difference between the reoperation rates except for surgical wound healing problems.

Advanced age, female sex, DM, obesity, cigarette smoking, dialysis-dependent CKD, PAD, COPD are considered factors that increase the risk of developing surgical site infection in previous studies.[7,14,15] When we analyzed our preoperative demographic data, there was no significant difference in terms of patient age and sex. Diabetes mellitus in itself is a risk factor in the development of atherosclerosis and leads to adverse effects on wound healing with inadequate angiogenesis, impaired cellular response, and increased oxidative stress.[16] In terms of DM, the data were similar between the two groups, and there was no statistically significant difference. Obesity is another factor that increases the risk of surgical wound infection not only in EVAR procedures but also in all other surgeries.[17] Although the mechanism has not been fully explained, impaired microcirculation and immune system response, increased lymphedema, and negative effects on respiratory functions appear to be obesity-related

factors in impaired wound healing.[18] It should again be emphasized that DM and atherosclerosis are more common in obese patients, and these have negative effects on the wound healing process. In our study, the rate of obesity in the longitudinal incision group, in which wound healing problems were observed more frequently, was statistically more significant than the other group (p=0.020). Peripheral artery disease, which adversely affects micro- and macrocirculation of the extremity and thus causes diminished tissue oxygenation, was borderline statistically significant in the longitudinal incision group (p=0.058), where wound healing problems were more common. Finally, the incidence of COPD, which is also associated with an increased risk of wound infection, was statistically significantly higher in the same group (p=0.014). In this context, tissue hypoxia caused by impaired respiratory functions in patient groups with COPD is interpreted as the main relationship.[17]

Treatment modalities used in the wound healing process were classical wound debridement and healing with simple suturization, healing with vacuum-assisted closure devices, and, finally, suturization of the wound. In some patients, secondary healing with local dressing applications was applied. Skin grafting or skin flap application methods were not required in any patient who developed wound healing problems.

Wound healing is an important postoperative complication and requires attention as it requires additional surgical intervention, prolongs hospitalization, and may sometimes lead to limb loss and mortality. In previous studies, EVAR was compared to open surgery were shown to be effective and safe in the early period,[19] which increased the preference for endovascular procedures in appropriate patients. However, in the current era of advanced surgical techniques, new approaches are being explored to minimize possible wound healing complications. Nowadays, percutaneous methods have also started to be used in femoral access, and studies in the literature comparing open surgical and percutaneous access in the femoral access route[20] will contribute to the practice in terms of surgical interventions with less femoral wound closure issues, at least for endovascular procedures in the future.

This study had some limitations. Although most of the risk factors were similar in the preoperative group comparison, the fact that risk factors such as obesity, COPD, and to a lesser extent PAD (borderline statistically significant in this study), which may have a negative effect on femoral wound healing, were higher in the longitudinal incision group, raises additional questions as to whether adverse wound healing occurred only due to the type of incision or also with the effect of these risk factors. The retrospective design is another limiting factor, and comparing different incisions with prospective randomized controlled studies would provide more robust results. The number of patients is relatively sufficient; nonetheless, a larger number would provide more statistically significant results.

In conclusion, femoral wound healing problems were observed more frequently in patients who underwent EVAR with longitudinal incision access from the femoral region in our study. Furthermore, wound healing problems started earlier, and hospitalization was longer in the longitudinal incision group. This prolongs treatment, leads to additional interventions, and ultimately increases treatment costs and patient bed occupation time. Therefore, surgical procedures that cause less femoral wound healing problems should be selected. The fact that the oblique incision group had fewer wound healing problems resulted in us routinely preferring the oblique incision for femoral access in EVAR.

Data Sharing Statement: The data that support the findings of this study are available from the corresponding author upon reasonable request.

Author Contributions: Idea/concept, design, control/supervision, analysis, processing, literature review, writing the article, critical review, materials: H.S.; Idea/concept, data collection, analysis, idea/concept, data collection, analysis: H.İ.E; Materials, interpretation: B.P.; Materials, data collection, literature review: B.Ö.; Idea/concept, interpretation, critical review: İ.K.

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