



Postoperative thoracic and low back pain following endovascular aortic repair associated with stenting location

Hirotsugu Miyoshi^{1,2} · Hiroshi Hamada¹ · Ryuji Nakamura¹ · Takashi Kondo¹ · Toshimichi Yasuda¹ · Noboru Saeki¹ · Masashi Kawamoto¹

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Abstract

Background We have noted that patients frequently complain of thoracic or low back pain after undergoing an endovascular aortic repair, which we speculated was caused by the indwelling stent.

Methods We investigated the patients who underwent an elective thoracic or abdominal endovascular aortic repair (TEVAR or EVAR) and noted the location of stent, and postoperative pain. The incidence of either thoracic or low back pain at individual vertebra levels was determined, after which we fitted the sigmoidal function to the discrete data to obtain a cut-off line. The study patients were then divided into 2 groups using the cut-off line to compare the incidence of pain.

Results We analyzed 96 patients (68 TEVAR, 28 EVAR). The incidence of thoracic pain was significantly higher in TEVAR as compared to EVAR (26.5% vs. 3.6%, $P=0.01$), while that of low back pain was significantly higher in EVAR (35.7% vs. 16.2%, $P=0.04$). With the cut-off line for thoracic pain set at the 12th thoracic vertebra, the incidence of thoracic pain was significantly higher in patients with the upper end of the stent above the cut-off as compared to at a lower point (26.5% vs. 3.6%, $P=0.01$). As for low back pain, the cut-off line was set at the 9th thoracic vertebra, and the incidence of that pain was significantly higher in patients with the lower end of the stent below that line (30.9% vs. 0.0%, $P<0.01$).

Conclusion Thoracic and low back pain after an endovascular aortic repair procedure were associated with stenting site.

Keywords Endovascular aortic repair · Postoperative pain · Thoracic pain · Low back pain

Introduction

Postoperative pain is valuable information for early detection of complications and new-onset disease following surgery. In addition, it is important to understand the common types of pain associated with surgery. Endovascular aortic repair is a revolutionary minimally invasive surgical method used for the treatment of thoracic and abdominal aortic aneurysms, as well as their dissection [1]. At our institution, we have noted that patients frequently complain of chest or low back pain during the early postoperative period after undergoing endovascular surgery, which is often related to the location of the

indwelling stent. Thus, we speculated that thoracic and low back pain following endovascular surgery are caused by the indwelling stent and related to the site of placement. In the present study, we investigated the incidence and characteristics of postoperative thoracic and low back pain in patients who underwent an endovascular aortic repair procedure.

Methods

After obtaining approval from the institutional review board of Hiroshima University Hospital, we retrospectively investigated the electronic medical records of patients who underwent endovascular aortic repair procedures from April 2010 to October 2012 and noted patient background (age, gender, height, body weight and operation time), location of stent placement (consistent vertebral level, i.e., upper-to-lower height of vertebra where the stent exists), and postoperative chest or low back pain. We excluded those who could not complain

✉ Hirotsugu Miyoshi
miyoshi0728@hotmail.co.jp

¹ Department of Anesthesiology and Critical Care, Hiroshima University Hospital, Hiroshima, Japan

² Department of Anesthesiology and Critical Care Institution, Hiroshima University Hospital, 1-2-3 Kasumi, Minami-ku, Hiroshima 734-8551, Japan

of pain because of delirium or impaired consciousness. Emergency cases, patients with preoperative chest or low back pain, and those who had routinely use analgesics for malignant diseases or orthopedic diseases were also excluded. We then examined the relationship between background factors and postoperative chest or low back pain.

All patients were continuously observed in the intensive care unit (ICU) after surgery, during which time the attending nurse occasionally asked regarding pain and administered analgesics according to the instructions of the surgeon if needed. In many cases, 100 mg of celecoxib was given, with 0.1 mg of buprenorphine administered thereafter when pain was not alleviated by celecoxib. We classified postoperative pain as that requiring analgesics within 24 h after surgery. Thoracic pain was defined as that occurring in the chest, upper or middle back, or shoulder, or as hypogastric pain, while low back pain was defined as pain in the lower back area. Pain location were obtained by the patient complaint and by the medical examination. When a patient complained of pain in both the chest and the low back areas, that was counted as pain at both sites. At our hospital, patients who undergo endovascular aortic repair procedures enter the ICU after the procedure and remain for at least 1 day. Therefore, we limited the observational period of postoperative pain to the initial 24 h in the ICU. The thoracic or lumbar vertebra level corresponding to the site of stenting was determined by computed tomography (CT) performed after surgery, while surgical complications related to pain such as hematoma and dissection were also examined using postoperative CT images.

The relationship between the site of stenting and postoperative thoracic or low back pain in all patients was analyzed according to the following procedure. As a first step, we calculated the incidence of either thoracic or low back pain at individual vertebra levels by dividing the number of patients who had pain at each vertebra level by the number who had stenting located at the corresponding vertebra level. We then fit the sigmoidal function to the discrete data for incidence and vertebra level using the least squares method, and obtained a formula for estimating incidence at each vertebra level. From those results, we determined cut-off lines, which were defined based on the flexion point of the estimated incidence at each vertebra level curve. Next, for thoracic pain, we divided the study patients into 2 groups depending on whether the upper end of the stent was higher than the previously obtained cut-off line, while for low back pain, we divided the study patients into 2 groups depending on whether the lower end of the stent was below the previously obtained cut-off line. We compared both groups for thoracic and low back pain.

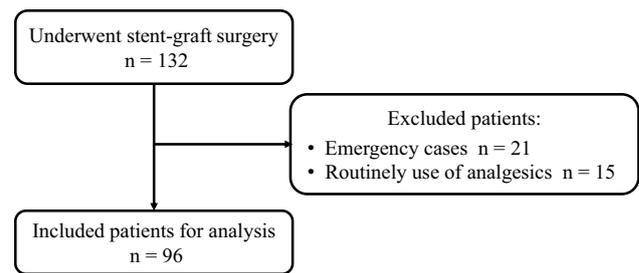


Fig. 1 Number of patients screened. Of 132 patients who underwent stent-graft surgery, 36 were excluded from analysis

Table 1 Patient background information

	Total	TEVAR	EVAR	<i>P</i> value
Number of patients	96	68	28	
Age (years)	74.5 ± 8.9	73.9 ± 9.2	75.7 ± 8.0	0.38
Gender (male:female)	68:28	43:25	25:3	<0.01
Height (cm)	160.3 ± 8.9	159.3 ± 10.3	163.7 ± 6.1	<0.01
Body weight (kg)	59.6 ± 13.3	59.4 ± 14.6	61.1 ± 9.4	0.33
Operation time (min)	109.1 ± 51.4	98.4 ± 50.6	136.2 ± 43.7	<0.01

Values are shown as the mean ± SD. A Chi-square test was used for categorical variables (gender, presence of pain), and Student's *t* test for continuous variables (age, height, body weight). *P* values were derived from comparisons of TEVAR with EVAR cases

TEVAR thoracic or thoracic and abdominal endovascular aortic repair, EVAR endovascular abdominal aortic aneurysm repair.

Statistical analysis

Data are shown as the mean ± SD. Correlation analysis, Student's *t* test, and a Chi-square test were used as statistical methods, with significance set at *P* < 0.05.

Results

During the study period, 132 patients underwent stent-graft surgery, of whom 36 were excluded from analysis because they fulfilled the exclusion criteria (Fig. 1). We analyzed the records of those 96 patients (mean age 74.5 ± 8.9 years, 68 males), of whom 68 underwent a thoracic or thoracic and abdominal endovascular aortic repair procedure (TEVAR group), while 28 received endovascular abdominal aortic aneurysm repair procedure (EVAR group) (Table 1).

Thirty-six of the 96 patients (37.5% of all study patients) required analgesics. There were 11 patients in

the TEVAR group who required an administration of buprenorphine in addition to celecoxib for thoracic pain, while none in the EVAR group required buprenorphine. The average time period for requiring analgesics was 8.2 h (range 2–22 h) after surgery. All 96 patients received general anaesthesia with propofol and remifentanyl, with ropivacaine injected into the surgical wound site. No other analgesics, e.g., fentanyl and NSAIDs, were administered during surgery. There was no evidence of hematoma or dissection in postoperative CT images in any of these patients.

Table 2 shows relationships between investigated factors and the presence of thoracic or low back pain. The incidence of thoracic pain was significantly higher in TEVAR as compared to EVAR (26.5% vs. 3.6%, $P=0.01$), while that of low back pain was significantly higher in those with EVAR (35.7% vs. 16.2%, $P=0.04$). On the other hand, there

was no difference in regard to background factors between patients with and without chest pain, or between those with and without low back pain (Table 2).

As shown in Fig. 1, the incidence of thoracic pain declined abruptly below the level of the 11th thoracic vertebra. The determination coefficient between the measured and estimated incidence at each vertebra level was determined to be 0.93. The flexion point of the estimation curve was the 11.9th thoracic vertebra, which was adopted as the cut-off line (Fig. 2). In contrast, the incidence of low back pain increased below the level of the 8th thoracic vertebra, and the determination coefficient between the measured and estimated incidences of each vertebra level was determined to be 0.79. Thus, the cut-off line for low back pain was set at the 8.8th thoracic vertebra (Fig. 3).

The criterion for group division based on the upper end of the stent above or below the 12th thoracic vertebra is

Table 2 The relationship between investigated factors and the presence of thoracic or low back pain

	Present	Absent	<i>P</i> value
<i>Thoracic pain</i>			
Number of patients	19	77	
Age (years)	73.9±6.3	74.5±9.3	0.74
Gender (male:female)	12:7	56:21	0.41
Height (cm)	160.4±10.9	160.7±8.9	0.92
Body weight (kg)	62.8±12	59.±13.3	0.23
Operation time (min)	101.6±52.6	111.±51.3	0.49
Surgical procedure			
TEVAR	18	50	0.01
EVAR	1	27	
The upper end of located stent			
Higher than the 12th thoracic vertebra	18	50	0.01
Below the 12th thoracic vertebra	1	27	
<i>Low back pain</i>			
Number of patients	21	75	
Age (years)	73.8±6.2	74.5±9.4	0.66
Gender (male: female)	16:5	52:23	0.54
Height (cm)	162.5±7.7	160.±9.7	0.22
Body weight (kg)	62.4±7.7	59.±14.3	0.16
Operation time (min)	107.4±36.4	109.6±55.2	0.83
Surgical procedure			
TEVAR	11	57	0.04
EVAR	10	18	
The lower end of located stent			
Above the 9th thoracic vertebra	0	28	<0.01
Lower the 9th thoracic vertebra	21	47	

Values for number of patients are shown as the mean±SD. A Chi-square test was used for categorical variables (gender, presence of pain) and Student's *t* test for continuous variables (age, height, body weight, operation time). The incidence of thoracic pain was significantly greater in patients in whom the upper end of the stent was higher than the 12th thoracic vertebra as compared to that completely below the 12th thoracic vertebra, while the incidence of low back pain was significantly higher in patients in whom the lower end of the stent was lower than the 9th thoracic vertebra as compared to stenting completely above the 9th thoracic vertebra

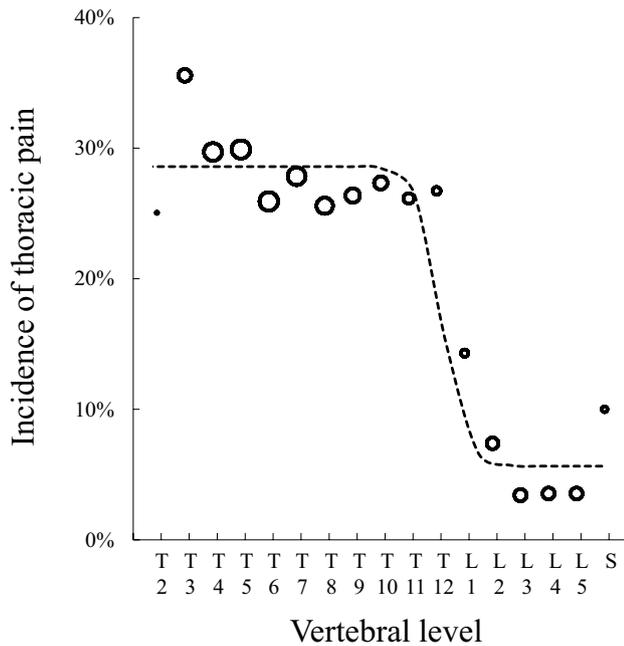


Fig. 2 Incidence of and number of patients with thoracic pain at each vertebra corresponding to indwelling stent location. *T* thoracic vertebra, *L* lumbar vertebra, *S* sacral vertebra. Short dashed line shows the most matched sigmoidal curve by the least squares method. Circle indicates the incidence of thoracic pain and circle size indicates the number of patients. The coefficient of correlation value for the most matched sigmoidal curve was 0.93 and the cut-off line was the 11.9th thoracic vertebra

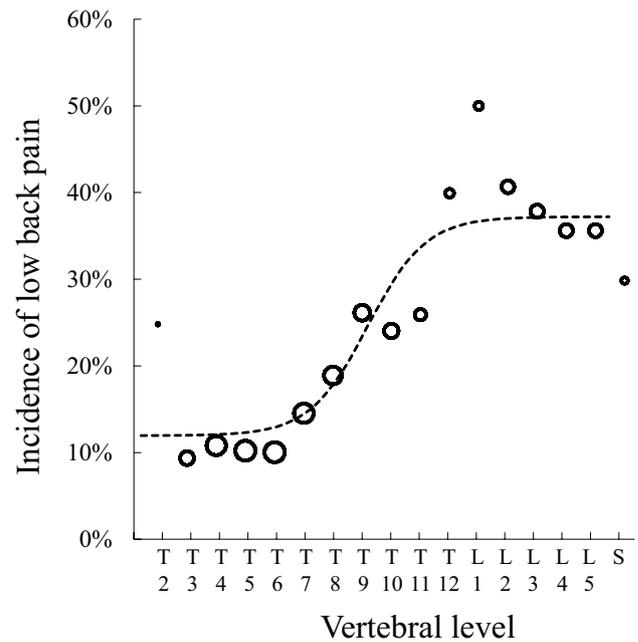


Fig. 3 Incidence of and number of patients with low back pain at each vertebra corresponding to indwelling stent location. *T* thoracic vertebra, *L* lumbar vertebra, *S* sacral vertebra. Short dashed line shows the most matched sigmoidal curve by the least squares method. Circle indicates the incidence of low back pain and circle size indicates the number of patients. The coefficient of correlation value for the most matched sigmoidal curve was 0.79 and the cut-off line was the 8.8th thoracic vertebra

same as used for the definitions of TEVER and EVAR, and the relationship between the incidence of thoracic pain and stent site is the same as the division used for surgical procedures (26.5% vs. 3.6%, $P=0.01$). In contrast, the criterion for group division based on the lower end of the stent at above or below the 9th thoracic vertebra was superior that the division used for surgical procedures (30.9% vs. 0.0%, $P<0.01$) (Table. Table 2).

Discussion

To the best of our knowledge, no reports have been presented regarding the incidence and characteristics of thoracic and low back pain following endovascular aortic repair. In this study, we found that the incidence of thoracic pain was significantly higher in patients who underwent stenting in the thoracic region, while that of low back pain was significantly higher in patients with stenting in the lower thoracic and lumbar regions. Furthermore, thoracic pain occurred at a relatively high incidence in patients with stent placement higher than the 12th thoracic vertebra level, while low back pain was found to occur at a relatively high incidence in patients with stent placement

lower than the 9th thoracic vertebra level. These findings indicated a consistent association of both thoracic and low back pain that occurs following an endovascular aortic repair procedure with the site of stenting. Notably, thoracic pain rarely was noted in patients with a stent placed in the lower thoracic or lumbar region. Thus, it is necessary to question whether new-onset disease exists or if there is another cause when such patients complain of pain in the thoracic region [2].

Thoracic and low back pain are frequently noted as initial symptoms of a dissecting aortic aneurysm, and thought to be a kind of vascular pain caused by direct dissociation or referred pain related to the dissected aorta. It is also known that the site of referred pain is associated with the site of a dissected aorta [3, 4]. In other words, pain caused by invasive irritation of the aorta is known to radiate into the chest or back as a type of referred pain. Since we excluded patients who had preoperative pain and none had surgical complications that could be determined as the origin of pain, stent placement itself was considered to be the cause of pain in the present cohort. Although the mechanisms of such pain remain a matter of speculation, direct contact stimulation, stretching, dilated stimulation, inflammation, and the ischemic state of the vascular wall itself are all thought to

be potential causes of such stenting pain. Further studies are needed to reveal the mechanisms related to stenting pain.

Our study has some limitations. First, since thoracic or low back pain after undergoing an endovascular aortic repair mainly occurs within a few hours after surgery, we limited the present analysis to the first 24 postoperative hours and did not determine the duration of stent-related pain. In addition, since we only analyzed patients who required analgesics, some may have had thoracic or low back pain that did not require such treatment, indicating the possibility of underestimation of the incidence of pain in this cohort. Furthermore, low back pain is frequently observed in patients who undergo various types of surgery, and can be caused by surgical positioning or postoperative resting position [5]. We did not attempt to distinguish between low back pain caused by surgery and that caused by posture, thus the frequency related to surgery might have been overestimated. Finally, while stent indwelling site was the only factor shown to be strongly related to chest or low back pain in the present univariate analysis, we did not perform multivariate analysis because of the single-center design of the study and small patient cohort. It will be necessary to conduct a larger-scale multicenter research project to validate the present results.

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Compliance with ethical standards

Conflict of interest The authors declare that they have no competing interests.

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