Does Triplex Vascular Prosthesis Contribute to Reducing the Inflammatory Reaction after Surgical Repair of Abdominal Aortic Aneurysms?

Naoto Fukunaga, MD, Takehiko Matsuo, MD, and Tadaaki Koyama, MD

Our aim was to evaluate whether a Triplex vascular prosthesis could contribute to reducing postoperative inflammation after surgical abdominal aortic aneurysm (AAA) repair retrospectively. Between July 2011 and December 2013, a Triplex vascular prosthesis was used in 22 patients (group T) and a coated vascular prosthesis in 18 patients (group H) during AAA repair surgery. Body temperature (BT), white blood cell (WBC) count, and C-reactive protein (CRP) level for 5 days were assessed. There was no hospital death in both groups. During the first 2 days after surgery the BT was higher in group T than in group H reaching its maximum on POD 2. On POD 5, it was similar (p = 0.4850). The postoperative WBC count was higher in group H than in group T. It reached its maximum on POD 1 and it was similar in both groups on POD 5 (p = 0.1870). The CRP value increased postoperatively in both groups, peaking during PODs 2 or 3. On POD 5, it was lower in group H than in group T (p = 0.0415). We could not confirm the superiority of Triplex vascular prostheses to other coated vascular prostheses in inflammatory reactions.

Keywords: Triplex vascular prosthesis, inflammatory reaction, abdominal aortic aneurysms

Introduction

Triplex vascular prostheses (Terumo, Tokyo, Japan) are three-layered uncoated, knitted devices used for thoracic and abdominal aortic repair. The inner and outer layers are uncoated knitted polyester. The middle layer is a self-sealing elastomeric membrane. In contrast to these uncoated vascular prostheses, other prostheses are coated with a biologic material that has been thought to induce systemic and local inflammatory reactions after surgery. Tabata and coworkers assessed whether an uncoated vascular prosthesis could reduce postoperative inflammation following thoracic aortic repair. Although Triplex vascular prostheses were created for the purpose of abdominal aortic repair, no information about postoperative inflammation is available with regard to their use for this purpose.

The purpose of this study was to evaluate whether Triplex vascular prostheses contribute to reducing the postoperative inflammatory reaction compared to other, coated vascular prostheses used for surgical repair of abdominal aortic aneurysm (AAA).

Materials and Methods

This study was approved in an institutional review board at our hospital. Between July 2011 and December 2013, a total of 40 patients underwent elective surgical repair of an infrarenal AAA. A Triplex vascular prosthesis was used in 22 of the patients (group T) and a coated vascular prosthesis (Hemashield; Maquet, Rastatt, Germany), in the other 18 patients (group H). We retrospectively evaluated the contribution of the triplex prosthesis to reducing postoperative inflammation following surgical repair of AAA versus that of the coated prosthesis according to medical records. The variables evaluated included fluctuations in body temperature (BT), white blood cell (WBC) count, and C-reactive protein (CRP) level during the first five postoperative days (PODs). Hospitalization length of stay was also assessed. To eliminate preoperative bias based on each patient, we excluded emergency surgery cases or cases of preoperative shock status. Bifurcated graft was implanted in all cases.

Indications for surgical repair were an infrarenal AAA ≥50 mm in diameter or an AAA growth rate of ≥5 mm within the last 6 months. Infected AAAs, suprarenal AAAs, dissecting aneurysms and iliac arterial aneurysms were excluded from the study. The choice of the vascular prosthesis depended on the surgeons’ preference.

The mean follow-up period was 1.7 ± 0.9 years, and follow-up rate was 100%.
Surgical techniques
Open surgical repair was initiated under general anesthesia. Aortic cross-clamping was performed after the active clotting time reached ≥200 s. Bilateral iliac arteries were clamped on the distal side of the aneurysm. We then performed aneurysmectomy and trimmed the anastomotic sites. A felt strip was placed around the abdominal aortic wall on the proximal side of the aneurysm, and anastomosis was performed using a graft insertion technique and 4-0 polypropylene (Corolene, Peters Surgical, France). Similarly, a felt strip was placed around the common iliac artery wall on the distal side, and anastomosis was performed in the same fashion using 5-0 polypropylene (Prolene, Ethicon, Somerville, New Jersey, USA). In patients with a calcified or atherosclerotic common iliac artery, we often performed the distal anastomosis to the external iliac artery and closed the common iliac artery. We applied a bifurcated graft in all cases included in this study. In a case of a patent inferior mesenteric artery, we anastomosed it to the left prosthetic limb.

Statistical analysis
All statistical analyses were conducted with StatView version 5.0 software (SAS Institute, Cary, NC, USA). Categorical variables were expressed as the number and percent of patients. Comparison between the two groups was conducted using the χ2 test. Continuous variables were expressed as the mean ± standard deviation (SD) and were compared between the two groups using Student’s unpaired t test.

Correlations between fluctuations in BT, WBC count, CRP, and duration of hospitalization were assessed by repeated measures analysis of variance.

All values of p values ≤0.05 were considered statistically significant.

Results
The patients’ preoperative profiles are summarized in Table 1. The mean age was similar in both groups (p = 0.5668). There were no significant differences between the two groups regarding their past medical histories excepting chronic obstructive pulmonary disease.

Early outcomes
Postoperatively, intravenous antibiotic was infused within 72 h in both groups.

Intraoperative and postoperative outcomes are summarized in Table 2. Durations of aorta cross-clamp, lower limb ischemic and operative time were similar. There was no hospital death in both groups. One patient in group T suffered from postoperative gastrointestinal bleeding, which was treated by endoscopically. One in group H underwent re-intubation, but successful re-extubation could be achieved.

There were no statistically significant differences between the groups regarding days to oral intake or duration of intensive care unit and hospital stay.

Inflammatory markers following AAA surgery
BT fluctuation (Fig. 1):
During the first 2 days after surgery the BT was higher in group T than in group H reaching its maximum on POD 2. After POD 2, the BT in group T decreased gradually until it was lower than that in group H. On POD 5, BT in Group T was 36.9°C, while BT in Group H 37.1°C (p = 0.4850).

WBC count (Fig. 2):
The postoperative WBC count was higher in group H than in group T. It reached its maximum on POD 1 (10720 vs. 13066/mm³, groups T vs. H), after which it decreased until it was similar in both groups on POD 5 (6960 vs. 6966/mm³, groups T vs. H) (p = 0.1870).

CRP value (Fig. 3):
The CRP value increased postoperatively in both groups (6.89 vs. 7.64 mg/dl on POD 1, 20.82 vs. 15.11 mg/dl on 2, 21.95 vs. 14.78 mg/dl on 3, 16.93 vs. 12.83 mg/dl on 4, groups T vs. H). After peaking during PODs 2 or 3, it decreased in both groups. As a whole, the difference...
Triplex Vascular Prosthesis’s Contribution to Anti-Inflammatory Reaction after Surgery of Abdominal Aortic Aneurysms

Ohta et al. also reported that a Triplex vascular prosthesis attenuated the postoperative inflammatory reaction (measured by the CRP level and BT) following total arch replacement for a thoracic aortic aneurysm.

Up to now, however, there has been no available information whether an uncoated vascular prosthesis can reduce postoperative inflammation after surgical repair of an AAA. Prolonged low-grade fever after implantation of coated prostheses impregnated with collagen or gelatin is a well-known complication after AAA repair surgery. It has been speculated that fever after implantation of coated prostheses reflected the host’s reaction to the implanted heterogenic proteins. Shindo and colleagues concluded that more inflammatory reactions have been recognized in patients between two groups was statistically significant (p = 0.0415).

**Discussion**

This study showed that postoperative parameters like BT and WBC were normalized within postoperative day 5 in both groups. We could not confirm the superiority of Triplex vascular prostheses to other coated vascular prostheses in inflammatory reactions.

This new type of vascular prosthesis was introduced and has been available in Japan since 2009. The prosthesis has an uncoated, knitted, three-layer construction, raising the expectation of reducing postoperative inflammation.

Tabata and colleagues noted that during thoracic aortic surgery a Triplex vascular prosthesis for the thoracic aorta reduced the amount and duration of mediastinal drainage. They concluded that these results might contribute to promoting early recovery. Ohta et al. also reported that a Triplex vascular prosthesis attenuated the postoperative inflammatory reaction (measured by the CRP level and BT) following total arch replacement for a thoracic aortic aneurysm.

Up to now, however, there has been no available information whether an uncoated vascular prosthesis can reduce postoperative inflammation after surgical repair of an AAA.

Prolonged low-grade fever after implantation of coated prostheses impregnated with collagen or gelatin is a well-known complication after AAA repair surgery. It has been speculated that fever after implantation of coated prostheses reflected the host’s reaction to the implanted heterogenic proteins. The inflammatory reaction subsides after the coated materials have been completely absorbed. Shindo and coworkers concluded that more inflammatory reactions have been recognized in patients

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**Table 2** Intraoperative and postoperative outcomes

<table>
<thead>
<tr>
<th>Variable</th>
<th>Mean ± SD or N (%)</th>
<th>p value</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Group T (n = 22)</td>
<td>Group H (n = 18)</td>
</tr>
<tr>
<td>AoX time (min)</td>
<td>43.9 ± 16.8</td>
<td>49.2 ± 17.7</td>
</tr>
<tr>
<td>Operative time (min)</td>
<td>275.5 ± 63.6</td>
<td>289.2 ± 87.7</td>
</tr>
<tr>
<td>LI time (m)</td>
<td>108.8 ± 24.9</td>
<td>110.9 ± 34.5</td>
</tr>
<tr>
<td>Hospital death</td>
<td>0 (0)</td>
<td>0 (0)</td>
</tr>
<tr>
<td>Pneumonia</td>
<td>0 (0)</td>
<td>0 (0)</td>
</tr>
<tr>
<td>Gl bleeding</td>
<td>1 (5)</td>
<td>0 (0)</td>
</tr>
<tr>
<td>Paraplegia</td>
<td>0 (0)</td>
<td>0 (0)</td>
</tr>
<tr>
<td>Colon resection</td>
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<td>0 (0)</td>
</tr>
<tr>
<td>SSI</td>
<td>0 (0)</td>
<td>0 (0)</td>
</tr>
<tr>
<td>Tracheostomy</td>
<td>0 (0)</td>
<td>0 (0)</td>
</tr>
<tr>
<td>Re-intubation</td>
<td>0 (0)</td>
<td>1 (6)</td>
</tr>
<tr>
<td>Food intake (days)</td>
<td>3.5 ± 2.2</td>
<td>3.1 ± 1.2</td>
</tr>
<tr>
<td>ICU stay (days)</td>
<td>2.5 ± 1.7</td>
<td>2.2 ± 1.2</td>
</tr>
<tr>
<td>Hospital stay (days)</td>
<td>13.5 ± 4.4</td>
<td>12.4 ± 3.3</td>
</tr>
</tbody>
</table>

Results are given as the mean ± SD or the number and percent. SD: standard deviation; AoX: aortic cross clamp; LI: lower ischemic; Gl: gastrointestinal; SSI: surgical site infection; ICU: intensive care unit

**Fig. 1** Body temperature fluctuation after surgery.

**Fig. 2** White blood cell count after surgery.
with coated prostheses than in those with noncoated prostheses. The coated prosthesis used in this study was composed of woven polyester coated with collagen. Although there was no statistically significant difference in BT fluctuation in both groups, BT on POD 5 was lower in Group T than Group H (Fig. 1). Thus, according to the literature, the BT fluctuation described for our group H could be explained by effect of the collagen used for coating.

Among the surgical cases, we sometimes encounter persistent fever after surgery although the patient appears well and no infection is detected. This clinical phenomenon could be explained by higher secretion of inflammatory cytokines and a prolonged inflammatory reaction, which is recognized more frequently in patients in whom coated vascular prostheses are applied than in those who have noncoated prostheses. These inflammatory reactions continue for at least 2 weeks the time required for effective degradation and absorption of the heterogenic proteins. Since the triplex vascular prosthesis has been introduced, we have used it predominantly for surgical repair of AAAs with the aim of reducing the inflammatory reaction. We also experienced persistent fever after implantation of Triplex vascular prostheses on occasion. We assumed that this might depend on patients. I meant that more and more young were patients; the higher were postoperative inflammatory reactions despite kinds of vascular prostheses. However, the precise reason was unclear.

There are some limitations of this study. It was retrospective in nature and not a randomized trial. Sample size might be too small to allow any substantive conclusions. Also, we considered effect of antipyretics usage on BT fluctuation because it seemingly decreased BT. We believe, however, that the present study is useful to readers who are selecting vascular prostheses for their patients in the era of endovascular aortic repair.

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**Disclosure Statement**

Naoto Fukunaga and co-workers have no conflict of interest.

**Author Contributions**

Study conception: NF
Data collection: NF
Analysis: NF
Investigation: NF
Writing: NF
Funding acquisition: none
Critical review and revision: all authors
Final approval of the article: all authors
Accountability for all aspects of the work: all authors

**References**