Aortic graft perforation by a rib stump after thoracic aorta replacement: A case report and literature review

Tomoko Ishii, MD, a Yusuke Iguchi, MD, a Toru Tsukada, MD, a and Motoo Osaka, MD, PhD, b Tsukuba, Japan

Aortic graft perforation by a rib stump after thoracotomy is extremely rare. We present a case of fatal aortic graft perforation by sustained rib contact after descending aorta replacement for chronic type B aortic dissection with a review of the relevant literature.

CASE DESCRIPTION

A 54-year-old man was referred to our hospital with a chronic type B dissecting and descending aortic aneurysm, measuring 55 mm in diameter, that ranged from the left subclavian artery to the tenth thoracic vertebra. During surgery, the posterior portion of the left fourth rib was cut, and the fifth and sixth ribs were cut at the middle axillary line. The sixth intercostal space was then opened, each rib was stump smoothed with a file, and partial cardiopulmonary bypass was established before graft replacement (Triplex Straight, 26-mm Terumo Aortic; Vascutec, Inchinnan, Scotland) was performed. The chest was closed using rib pins for the fifth and sixth (but not the fourth) ribs and the graft alongside the aneurysmal wall was left unwrapped. Routine, evaluative computed tomography (CT) performed on postoperative day (POD) 12 revealed overlapping fourth rib stumps, one of which was protruding toward the chest cavity in contact with the aortic graft (Figure 1).

On POD 18, the patient suddenly collapsed. Cardiopulmonary resuscitation was started, and emergency CT revealed massive intrathoracic bleeding. A quick redo thoracotomy revealed a longitudinal 8-mm tear on the aortic prosthesis close to the fourth rib stump (Figure 2). Partial graft clamping and direct sutureting of the tear successfully restored hemostasis, and all rib stumps were smoothed again before wrapping with felt strips. Despite our efforts, however, death occurred from hypoxic encephalopathy on POD 20. As Institutional Review Board approval was waived owing to the single case report nature, individual informed consent was not required.

DISCUSSION

Only 3 cases of aortic graft perforation from rib stump friction after thoracotomy have been described since 2009, in addition to 4 cases of graft perforation from other causes, such as sharp calcification inside the wrapped aortic wall, exposed normal ribs, or spinal bone spurs. Table 1 presents the demographics and clinical outcomes of 8 graft perforation cases caused by rib stumps or other factors, including the present case. All 4 rib stump graft perforations occurred after descending or thoracoabdominal aortic replacement for chronic aortic dissection, with an onset time ranging from 18 days to 6 months after surgery. Three patients with early onset developed left hemotorax, and 2 of these patients collapsed suddenly and died.

The larger size of the tears in rib stump cases are often thought to cause massive bleeding and collapse, but late
onset may localize bleeding by tissue adhesion, especially with smaller tears. In the present case, even after spotting rib stump contact on POD 12, we could not anticipate possible graft disruption by sustained friction because the rib edges had been carefully smoothed. Given that this unfortunate and lethal complication is rarely reported, we believe that extra caution is warranted whenever the possibility of rib stump tearing is encountered.

Tanaka and colleagues⁴ experimentally investigated the durability of grafts against friction in a simulated calcified aorta model. Their ex vivo experiment, consisting of an acryl tube containing fragments of shell, disrupted 2 of 3 adjacent pulsatile Dacron grafts on the 10th and 18th days, similar in timing to our present case. Careful consideration thus should be given to avoid any rib stump–to–graft contact, together with removing hard and sharp objects around the graft to the furthest extent possible. If contact is unavoidable, a cushioning wrap around the graft by the aortic wall is mandatory, and if contact between rib stumps and vascular grafts is observed on postoperative CT, reoperation should be immediate.

CONCLUSIONS
We experienced a rare and fatal case of aortic graft perforation due to sustained friction with a rib stump. Contact of vascular prostheses with hard, sharp tissues should be avoided.

References
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| Author             | Year | Age and sex | Diagnosis         | Surgical procedure | Onset of perforation | Symptoms                                        | Imaging findings | Surgical intervention | Length of tear | Cause of perforation | Outcomes |
|--------------------|------|-------------|-------------------|--------------------|----------------------|------------------------------------------------|-----------------|------------------------|----------------|------------------------|----------|
| Due to rib stump   |      |             |                   |                    |                      |                                                 |                 |                        |                |                        |          |
| Yamamoto et al     | 2009 | 42 M        | DTAA (St A)       | DAR, TAR           | 25 d                 | Sudden circulatory collapse                     | SR              |                        | 6 mm           | 8th rib stump          | Died     |
| Tshomba et al      | 2010 | 40 F        | DTAAA (Cf II)     | TAAR               | 6 mo                 | No symptoms                                     | TEVAR and SR    |                        | Not described | 6th rib stump          | Discharged |
| Yalcin and Aytekin | 2016 | 49 M        | DTAA (St B)       | DAR                | 45 d                 | Dyspnea, bulging of thoracotomy                 | SR              |                        | 5-6 mm         | 4th rib stump          | Discharged |
| Present case       | 2019 | 54 M        | DTAA (St B)       | DAR                | 18 d                 | Sudden circulatory collapse                     | SR              |                        | 8 mm           | 4th rib stump          | Died     |
| Other causes       |      |             |                   |                    |                      |                                                 |                 |                        |                |                        |          |
| Tanaka et al       | 2006 | 52 M        | TAAA (St B)       | TAAR               | 18 d                 | Sudden circulatory collapse                     | SR              |                        | 1 mm           | Aortic calcification   | Discharged |
| Ozaki et al        | 2012 | 74 M        | DTAA (St B)       | DAR                | 30 d                 | Massive bloody effusion                         | SR              |                        | Small hole      | Aortic calcification   | Discharged |
| Matsuyama et al    | 2014 | 54 M        | AEF, TAAA (Cf III)| DAR, TAAR         | 4 mo                 | Sudden back pain and preshock                    | TEVAR and SR    |                        | Small hole      | Normal uncut 10th rib | Discharged |
| Yoon and Park      | 2019 | 78 M        | TAAA (Cf III)     | TAAR               | 49 d                 | Fever, abdominal pain and distention             | SR              |                        | 2 mm           | L2 spinal bony spur    | Discharged |

DTAA, Dissecting thoracic aortic aneurysm; St, Stanford type; TAR, total arch replacement; DAR, descending aortic replacement; SR, surgical repair; DTAAA, dissecting thoracoabdominal aortic aneurysm; Cf, Crawford type; TAAR, thoracoabdominal aortic replacement; TEVAR, thoracic endovascular aortic repair; TAAA, thoracoabdominal aortic aneurysm; AEF, aorto-esophageal fistula.