Transcarotid thoracic endovascular aortic repair for rupture of the aortic isthmus due to high energy blunt trauma: A case report

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Summary

Introduction: Blunt thoracic aortic injury (BTAI) is associated with very high mortality, and managing currently favors thoracic endovascular aneurysm repair (TEVAR) if feasible, especially BTAI due to high energy force, where patients usually suffer from polytrauma, which requires rapid discover and treat spontaneously. However, a remarkable group of patients is contraindicated for the transfemoral route-the established first-line approach in endovascular interventions of the aorta. Here, we report a successful case in which the carotid artery was used to perform TEVAR. *Case presentation:* A young female was transferred to our emergency department after injuries sustained by falling from the fifth floor. Her vital signs were stable on admission. Pan CT scan revealed multiple injuries: A grade III injury of the aortic isthmus, a grade III liver injury without active bleeding, and fracture of the sternum, multiple ribs, T12-L1 vertebral body, and pelvic ring. However, her hemodynamics became unstable, and we decided to perform an urgent endovascular repair. During preparations for TEVAR, we found that the diameter at the proximal landing zone was 17.1mm, so it cannot be accommodated by any of the available thoracic endograft devices. Under the emergency condition, we decide to perform TEVAR by abdominal aortic device and access via the carotid to suit the device's length. After inpatient rehabilitation, she was discharged without neurologic sequelae. *Conclusion:* Transcarotid TEVAR is feasible and could be considered as an alternative approach in some specific patients with BTAI.

Keywords: Thoracic endovascular aortic repair, blunt thoracic aortic injury (BTAI), aortic isthmus.

1. Background

Blunt thoracic aortic injury is a life-threatening event, most commonly associated with rapid deceleration mechanisms. Up to 80% of patients with BTAI die before reaching the hospital [8]. With the advance of a minimally invasive approach via thoracic endovascular aneurysm repair, TEVAR has become a standard of care in treating these injuries, diminishing the need for an open thoracotomy, aortic cross-clamping, or cardiopulmonary bypass [4]. We report a case of successful TEVAR via transcarotid route in a critically ill patient with multiple injuries. During preparations for TEVAR, our measurements showed that the proximal landing zone in this patient is too small to be accommodated by any of the available thoracic endograft devices, so we decided to perform TEVAR

***Received**: 20 October 2023*, ***Accepted**: 5 November 2023*

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with by abdominal aortic device and access via the carotid to suit the device's length. Transcarotid is risky, and only a few experts choose this route when performing TEVAR for BTAI [9].

2. Case presentation

A 31 years old woman was transferred to our emergency department after injuries sustained by falling from the fifth floor. Her Glasgow Coma Scale on arrival was 15/15, and her vital signs were stable. However, due to her high-risk mechanism of injury, we performed a pan CT scan, which revealed the following injuries: A grade III injury of the aortic isthmus, fracture of the sternum, multiple right rib fractures, a grade III liver injury without active bleeding, fracture of T12-L1 vertebral body, sacrococcygeal fracture, and stable pelvic fracture. CT angiography confirmed a rupture of the descending aorta just distal to the left subclavian artery (Figure 1).

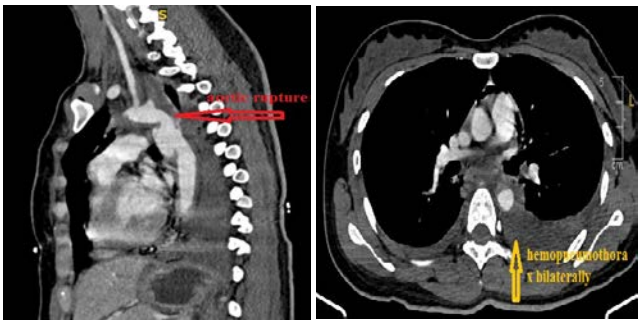

Figure 1.

About 1h after admission in the initial, she quickly became unstable, with a blood pressure of 79/50 mmHg, heart rate of 119 bpm, and pallor mucous membranes. Fluid resuscitation and vasopressors were started immediately. The laboratory test results showed RBC 1.4T/L, Hb 40g/L, HCT 14%, pH 7.21, pCO_2 39mmHg, pO_2 86mmHg, lactate 4.3mmol/L, HCO_3 15.1mmol/L. We diagnosed hemorrhagic shock, urgently started the massive transfuse protocol, and consulted a multidisciplinary trauma team. Reviewing the pan CT scan to identify the source of blood loss, we rule out the grade III liver injury without active bleeding and the stable pelvic fracture; our priority now is the aortic rupture with hemopneumothorax bilaterally as the origin of hemorrhage. Our team decided to perform an urgent aortic repair. Due to her multiple associated injuries, we prefer endovascular over open thoracostomy.

During preparations for TEVAR, our measurements showed that the diameter of the proximal landing zone was 17.1mm, which means that it cannot be accommodated by any of the available thoracic endograft devices. So we decided to perform TEVAR with an abdominal aortic device, but the question is which route we can access the aortic isthmus because the device's length is much shorter. The abdominal aorta is a good choice, but in this patient, we were concerned that laparotomy might lead to bleeding from the liver injury. Therefore, we consider the anterograde approach and choose the right common carotid artery (CCA) for graft deployment. Due to the risk of stroke when performing transcarotid intervention, we have to confirm the integrity of the ipsilateral vertebrobasilar system and the presence of a complete circle of Willis by angiography (Figure 2) before performing TEVAR and monitoring the neurologic function during the procedure.

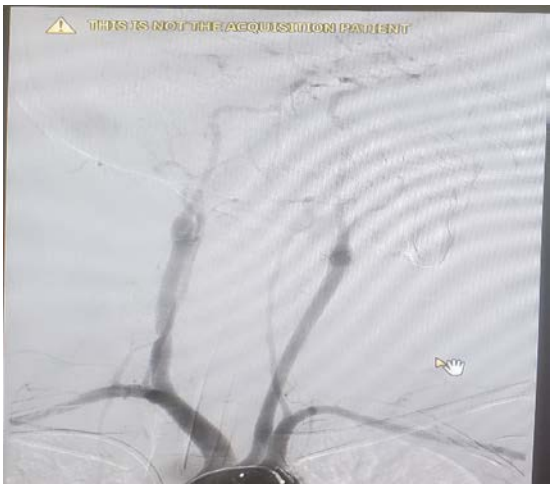

Figure 2.

An Endurant device (Medtronic) was successfully deployed just distal to the left subclavian artery (Figure 3).

Figure 3.

The patient tolerated the procedure without complications. On post-trauma day 7, her vertebral fracture was treated with transpedicular screw fixation. After inpatient rehabilitation, she was discharged home on post-trauma day 30 without signs or symptoms of a stroke. Her 30-day follow-up CT scan showed no evidence of endoleak, and the stent was in a good position (Figure 4).

Figure 4.

3. Discussion

BTAI is associated with a very high mortality rate and has been considered the second leading cause of death behind head injury for young patients. It has been estimated that no more than 25% of patients with such an injury survive long enough to be evaluated in a hospital, and of those who do, up to 50% will die within 24h. Open repair (OR) for BTAI is associated with high morbidity and mortality rates, particularly in polytrauma patients. Kato et al. reported the first case of TEVAR in 1997 [5], and in the following decades, this technique has gradually taken the place of OR as the most commonly used treatment for BTAI. Endovascular repair offers the potential for a durable aortic repair while avoiding the burden associated with thoracotomy, aortic cross-clamping, and cardiopulmonary bypass [6]. The development of endovascular technologies, including stents specific for aortic trauma, and operator experience has decreased the adverse events of endoleak after TEVAR [3]. However, due to the later development, long-term outcomes of TEVAR in trauma patients need more studies to assess. Brenner et al. stated from their long-term outcome data that TEVAR might be at least comparable to OR [1]. Cheng et al., in their nationwide cohort study of 287 patients, demonstrated that compared with OR, TEVAR was associated with better long-term outcomes and a similar rate of survival and reintervention after hospital discharge [2]. In a comprehensive meta-analysis review, Murad et al. reported the mortality rates of patients treated with TEVAR, OR, and nonoperative medical management to be 9%, 19%, and 46%, respectively ($p<0.01$) [7]. The current Society for Vascular Surgery Clinical Practice Guidelines suggest urgent (< 24h) thoracic endovascular aortic repair for Grade II to Grade IV BTAI [6].

Nevertheless, TEVAR is associated with access and device delivery challenges, so the choice of vessel site is one of the critical issues that must be solved when planning for endovascular intervention. Although the retrograde approach using the femoral artery has been established as the first-line approach in TEVAR, there remains a select group of patients in which the retrograde approach is not an option due to the small diameter, occlusion, or tortuosity of the anatomy. In addition, endovascular repair through the abdomen can also be challenging in patients with multiple previous abdominal surgeries, obese patients, or patients with other abdominal pathology. In such cases,

anterograde approaches through transcarotid or transaxillary are potential alternatives. To compare with CCAs, axillary arteries are usually more tortuous and narrower, which makes the procedure potentially very challenging to deploy the graft into the descending aorta.

Our young female patient with a small-diameter thoracic aorta (17.1mm) cannot be accommodated by any of the available thoracic endograft devices with the appropriate degree of oversizing to ensure proximal fixation so that we must choose an alternative approach uses the abdominal aortic device. Although using these nondedicated stent-grafts, which some authors have reported with favorable outcomes, is considered "off-label," abdominal endograft was perfectly suitable in this case. Nevertheless, these devices are shorter than the thoracic stent-graft delivery system, making it challenging to choose an appropriate access site for shortening distance to the landing zone. In our case, the selection of the transcarotid approach to deploy endograft devices is based on several essential considerations, all of them adequately assessed before the procedure. Stroke due to hypoperfusion, carotid injury, and embolism are of major concern regarding using the carotid approach. We performed CT angiography in preoperative planning to evaluate the integrity of the ipsilateral vertebrobasilar system and the presence of a complete circle of Willis and aortic arch/ branch origin disease to stratify the risk of stroke. Ideally, both common should be disease free to accommodate all catheters and wires while ensuring adequate cerebral perfusion. Adequate and aggressive intraoperative anticoagulation, maintenance of MAP (80-90), and intraoperative EEG are also methods described to help monitor and ensure adequate cerebral perfusion. Finally, the right CCA access allows the best coaxial alignment for a proper stent-graft delivery. Our case has some particular characteristics. It was performed via the right CCA in a patient rupture of the aortic isthmus with multiple trauma and hemodynamic instability. The severity of the case required prompt resolution and stabilization of the aorta. The carotid access gives some potential advantages in this situation. Regarding the thoracic aortic rupture, this approach reduced the procedure time with better coaxially and stability of the device at the aortic isthmus. Less invasive intervention, less operative time, and less blood loss are vital for polytrauma patients with hemodynamic deterioration.

To the best of our knowledge, this is the first report of a successful case in which a transcarotid approach was used to implant an abdominal aortic endograft for repairing BTAI. In the trauma centers where TEVAR cannot be performed with dedicated devices, we think that transcarotid access could be an important, feasible approach to widen the indication of TEVAR for BTAI patients who cannot tolerate the retro route approach.

4. Conclusion

Transcarotid thoracic endovascular aneurysm repair is feasible and could be considered as an alternative approach in some specific patients with blunt thoracic aortic injury.

References

1. Brenner M, Teeter W, Hadud M, Hoehn M, O'Connor J, Stein D et al (2017) *Long-term outcomes of thoracic endovascular aortic repair: A single institution's 11-year experience*. J Trauma Acute Care Surg 82(4): 687-693.
2. Cheng YT, Cheng CT, Wang SY, Wu VC, Chu PH, Chou AH et al (2019*) Long-term Outcomes of Endovascular and Open Repair for Traumatic Thoracic Aortic Injury*. JAMA Netw Open 2(2): 187-197.
3. DuBose JJ, Leake SS, Brenner M, Pasley J, O'Callaghan T, Luo-Owen X et al (2015) *Contemporary management and outcomes of blunt thoracic aortic injury: a multicenter retrospective study*. J Trauma Acute Care Surg 78(2): 360-369.
4. Fox N, Schwartz D, Salazar JH, Haut ER, Dahm P, Black JH et al (2015) *Evaluation and management of blunt traumatic aortic injury: A practice management guideline from the Eastern Association*

for the Surgery of Trauma. J Trauma Acute Care Surg 78(1): 136-146.

5. Kato N, Dake MD, Miller DC, Semba CP, Mitchell RS, Razavi MK et al (2017) *Traumatic thoracic aortic aneurysm: Treatment with endovascular stent-grafts.* Radiology 205(3): 657-662.
6. Lee WA, Matsumura JS, Mitchell RS, Farber MA, Greenberg RK, Azizzadeh A et al (2011) *Endovascular repair of traumatic thoracic aortic injury: Clinical practice guidelines of the Society for Vascular Surgery*. J Vasc Surg 53(1): 187-192.
7. Murad MH, Rizvi AZ, Malgor R, Carey J, Alkatib AA, Erwin PJ et al (2011) *Comparative effectiveness of the treatments for thoracic aortic transection*. J Vasc Surg 53(1): 193-199.
8. Sevitt S (1997) *The mechanisms of traumatic rupture of the thoracic aorta.* Br J Surg 64(3): 166-173.
9. Wada D, Hayakawa K, Kanayama S, Maruyama S, Iwamura H, Miyama N et al (2017) *A case of blunt thoracic aortic injury requiring ECMO for acute malperfusion before TEVAR.* Scand J Trauma Resusc Emerg Med 25(1): 110.