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REVIEW

Management of the Left Subclavian Artery during Endovascular Stent Grafting for Traumatic Aortic Injury – A Systematic Review CME

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Abstract *Objectives and design:* Traumatic thoracic aortic injuries are serious and may be associated with high morbidity and mortality. Endovascular stent grafting is now an established treatment option which often requires proximal landing zone extension through left subclavian artery (LSA) origin coverage. This in turn can lead to downstream ischaemic complications which may be lessened by LSA revascularisation. This study investigates the consequence of LSA coverage and potential benefit of revascularisation.
Materials and methods: Systematic literature review of studies between 1997 and 2010 identified 94 studies incorporating 1704 patients. Chronological trends in LSA management practice for trauma were sought. Designated outcomes of interest were prevalences of left arm ischaemia, stroke, spinal cord ischaemia, endoleak, stent migration, need for additional procedure and mortality. These outcomes were compared in patients with and without LSA coverage (taking account of the degree of coverage). The impact of revascularisation on these outcomes was also explored. Statistical analysis included examination with Chi-Square or Fisher's tests as appropriate.
Results: Isolated total LSA coverage without revascularisation increases the prevalence of left arm ischaemia [prevalence of 4.06% versus 0.0% ($p < 0.001$)]; stroke [prevalence of 1.19% versus 0.23% ($p = 0.025$)]; and need for additional procedure [prevalence of 2.86% versus 0.86% ($p = 0.004$). In contrast there were no reported cases of stroke, spinal cord ischaemia,

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endoleak, stent migration or mortality when the LSA origin was only partially covered. When the LSA territory was revascularised, again no cases of left arm ischaemia, stroke, spinal cord ischaemia, endoleak, or mortality were reported.
Conclusion: Current evidence suggests that LSA coverage in patients undergoing endovascular stent grafting of the thoracic aorta for trauma should be avoided where possible to avoid ensuing downstream ischaemic complications. When coverage is anatomically necessary, partial coverage is better than complete in terms of avoiding these complications and revascularisation may be considered, however these decisions must be made in the context of the individual patient scenario.

Blunt aortic injury is the second highest cause of post-traumatic death, with the highest mortality occurring early in the first few hours after injury.[1,2] More than 80% with such trauma die on the accident scene.[3] Thirty percent of those surviving the initial insult go on to die at the hospital, with a third of these patients dying before definitive surgical treatment.[4,5]

Injury is often associated with rapid deceleration in road traffic accidents or falls, with patients suffering severe multiple trauma including cranio-cerebral trauma, thoracic contusion and rib fractures, intra-abdominal bleeding and bone fractures. Unlike the survivors of penetrating thoracic injuries, patients who sustain blunt aortic injury present with multiple associated injuries, which not only complicate but can also make early surgical intervention unfeasible.

Blunt aortic injury often occurs in the peri-isthmic region of the thoracic aorta, in close proximity to the ligamentum arteriosum and just distal to the origin of the left subclavian artery (LSA).[6,7] The nature of injury involves shearing or bending stresses, affecting the relatively mobile aortic arch in relation to the fixed descending aorta.[8–10]

Endovascular stent grafting has provided a less-invasive alternative to open surgical repair for thoracic aortic pathology. Endovascular treatment for aortic disorders was first described by Parodi et al. with the use of a stent graft to treat an abdominal aortic aneurysm, whilst Volodos et al. first described thoracic endovascular stent grafting in 1991,[11,12] with this minimally invasive technique being especially suitable in high-risk patients with co-morbidities and poly-trauma. Dake et al. were the first group to report on post-traumatic thoracic aorta stent grafting in 1994 with good success.[13] Stent grafting of the thoracic aorta ideally requires proximal landing zones distal to the LSA and proximal to the mesenteric vessels. There are increasing reports of the use of the aortic arch proximal to the LSA to provide additional length for the proximal landing zone, consequently covering the LSA. This coverage has previously been shown to cause ischaemic complications, such as left arm ischaemia, stroke and spinal cord ischaemia.[14–16] Conversely, successful coverage has been described without the development of such complications.[14] Revascularisation of the LSA with either transposition or bypass from the carotid artery has been shown to prevent or treat these complications.[17]

This article aims to: (1) study the prevalence of outcomes in endovascular stent grafting of the thoracic aorta following trauma, assessing the impact of coverage of the LSA and furthermore revascularisation of the LSA, (2) investigate impact of 'full' coverage versus 'partial' coverage on the outcomes and (3) identify any chronological trend in the practice of LSA management in patients with thoracic aortic trauma.

Materials and Methods

Literature search

The literature search was performed using a predetermined protocol. MEDLINE, Ovid, Embase, Cochrane and the UK National Library for Health databases were searched for all relevant studies up to and including March 2010, using the following MeSH search headings: 'accidents, traffic' AND 'aorta, thoracic/injuries' OR 'aorta, thoracic/surgery' OR subclavian artery/surgery' AND 'complications' OR 'intra-operative complications' OR 'postoperative complications'. All abstracts resulting from the search were screened. The search was then extended by using the 'related articles' function and screening the reference list of those manuscripts identified in the initial search. All full texts were closely reviewed for eligibility to generate the final group of studies.

Data extraction

Two reviewers extracted data from each study according to a predefined protocol. Data extracted included first author; year of publication; study design; number of patients studied; patient population demographics; trauma score used; mechanism of trauma; preoperative investigations; anatomy of aortic trauma ('isthmus'/'non-isthmus'); aortic dimensions; number of LSA covered separated into 'full' and 'partial'; number of LSA revascularised separated into 'transposition' and 'bypass'; stent graft manufacturer, number and dimensions; complications without LSA coverage; complications with LSA coverage with and without revascularisation; and complications of LSA coverage with 'full' and 'partial' coverage (Table 1).

Inclusion and exclusion criteria

All studies reporting endovascular stenting for thoracic aortic injury following trauma were included. This was inclusive of all studies reporting LSA coverage with or without revascularisation from which the defined outcomes were extractable.

We excluded all studies in which the defined outcomes were not extractable, were not specifically described for traumatic cases, there was a patient population of less than