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Endovascular management of traumatic peripheral arterial injuries

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ABSTRACT

Background: Traumatic injuries to peripheral arterial vessels are increasingly managed with endovascular techniques. Early small series have suggested that endovascular therapy is feasible and decreases operative blood loss, but these data are limited. The purpose of this study was to evaluate the feasibility and outcomes of endovascular management of nonaortic arterial trauma.

Materials and methods: We reviewed records of traumatic nonaortic arterial injuries presenting at an urban level 1 trauma center from December 2009–July 2013. Patients undergoing treatment in interventional radiology and patients whose injuries occurred >72 h before presentation were excluded. Demographics, indicators of injury severity, operative blood loss, transfusion requirements, and clinical outcome were compared between patients undergoing endovascular and open management using appropriate inferential statistics.

Results: During the study period, 17 patients underwent endovascular interventions and 20 had open surgery. There were 19 upper extremity and/or thoracic outlet arterial injuries, 15 lower extremity injuries and 11 pelvic injuries. Endovascular cases were completed using a vascular imaging C-arm in a standard operating room. Estimated blood loss during the primary procedure was significantly lower with endovascular management (150 *versus* 825 cc, $P < 0.001$). No differences were observed between cohorts in age, injury severity score, intensive care unit length of stay, arterial pH, transfusion requirements, inpatient complication rate, or mortality.

Conclusions: Our experience with endovascular management demonstrates its feasibility with commonly available tools. Operative blood loss may be significantly decreased using endovascular techniques. Further study is needed to refine patient selection criteria and to define long-term outcomes.

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1. Introduction

Blunt traumatic injuries to the thoracic and abdominal aorta are commonly treated using endovascular techniques [1,2]. Peripheral arterial injuries have also been increasingly treated using endovascular techniques, but open repair remains the standard of care [2,3]. A variety of factors, including limited data on repair outcomes and perceived need for hybrid operating suites, have likely slowed adoption of endovascular therapy for these injuries. Early studies suggest that

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endovascular repair has advantages such as decreased operative time, decreased operative blood loss, and lower frequency of iatrogenic injuries [4–6]. Furthermore, many vascular surgeons now perform more endovascular procedures than open procedures, and as this trend continues, there is a possibility that the skillset required for open repairs may be lacking. Open repair of transition zone injuries (subclavian to axillary, iliac to femoral, and femoral to popliteal arteries) remains challenging operations, especially in the presence of hemorrhagic shock and anatomic distortion from trauma to the tissue. Tissue loss, hematoma, and contamination may all complicate the open repair. Challenges in endovascular repair include availability of suitable landing zones for coated stent deployment, ability to traverse injuries with wire access, concomitant visceral and solid organ injuries, and timely access to imaging asset support. Finally, it remains unclear whether endovascular repair is feasible at institutions without access to hybrid operating suites.

Resuscitative aortic balloon occlusion is now frequently performed by acute care and/or trauma surgeons to treat hemorrhagic shock. Thus, the skill of initially obtaining endoluminal access is already present in many nonvascular surgeons. This provides an opportunity to explore whether these surgeons can serve as a gateway to endovascular repair of nonaortic traumatic injuries.

The purpose of this study was to evaluate the feasibility of endovascular repair of nonaortic arterial injury in the setting of an urban safety-net hospital without access to a hybrid operating suite. We hypothesized that short-term outcomes such as operative blood loss and inpatient 30-d complication rates would be equivalent between patients undergoing endovascular intervention and patients undergoing open surgery.

2. Methods

We performed a retrospective chart review on patients presenting with traumatic peripheral arterial injuries between December 15, 2009 and July 15, 2013. This study was performed with approval from our Institutional Review Board.

2.1. Participants and setting

The trauma database at a 586-bed urban level I trauma center, which serves as a county safety-net hospital, was queried to obtain a list of patients with vascular injuries. Patients with arterial injuries to the subclavian artery or distal in the upper extremities and to the common iliac artery or distal in the lower extremities were included. Patients were excluded from the study if they did not undergo a vascular intervention by either the acute care surgery team or a vascular surgeon, if their injury occurred greater than 72 h before presentation, or if they underwent treatment in interventional radiology. Patients with treatment in interventional radiology were excluded to focus the study on the feasibility of intervention within a resource-limited operating room (OR) by the acute care team with assistance from vascular surgery when needed.

2.2. Data collection

The charts of patients admitted with injuries to these arteries were reviewed by two reviewers (N.M.T. and A.R.S.) using a standardized data collection tool. When there were discrepancies among reviewers, a third reviewer (R.G.) evaluated data as a tie breaker. We collected demographics, clinical history and mechanism of injury, surgical approach, transfusion requirements, inpatient complications, mortality, and limb salvage at discharge. Hypotension was defined as a blood pressure of <100 mm Hg systolic on the presenting blood pressure. The first recorded arterial pH and base deficit were collected as clinical indicators of hypoperfusion. At our institution, lactic acid levels and coagulation parameters are not routinely drawn in patients who are taken immediately to the OR and were not analyzed in this study. Estimated blood loss and transfusion volumes were taken from anesthesia records and nursing flow sheets as volumes with surgeon operative notes used in the few cases when anesthesia records did not record blood loss and transfusion volumes. In limited cases when only the number of units of blood products transfused was available, the following volume estimates were used: Packed red blood cells, 250 cc's; fresh frozen plasma, 200 cc's; platelets, 200 cc's; and cryoprecipitate, 40 cc's. Blood volumes lost and transfused were for the entire case including both the vascular portion and other concomitant repairs. Limb salvage was assessed in patients who survived to discharge and underwent repair rather than embolization of their injury.

2.3. Data analysis

Patients were grouped for analysis according to type of operative intervention (endovascular or open). Patients who were converted from endovascular to open surgery were analyzed with the open group to analyze the effect of the treatment provided. The groups were compared on demographic data, mechanism of injury, injury severity score (ISS), base deficit and arterial pH at presentation, preoperative hypotension (Systolic blood pressure <100 while in the emergency center), door to OR time, length of surgery, transfusion requirements, complications and mortality during the initial hospitalization, and limb viability at discharge. Limb viability at discharge was used as a surrogate for vascular patency given inconsistent documentation of vascular status at both discharge and follow-up. Categorical variables were analyzed using chi-square and Fisher exact tests as appropriate, whereas numerical variables were compared using the Wilcoxon rank-sum test.

3. Results

3.1. Study population

A total of 67 patients were identified in the registry. Ten patients were excluded because of management in interventional radiology, ten patients were excluded because of lack of arterial injuries, four were excluded because of central arterial injuries, four had iatrogenic nontrauma injuries, and two presented >72 h after injury leaving a study population of 37 patients.

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