Endovascular interventions to treat life and limb threatening vascular injuries in a complex paediatric pelvic fracture patient

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Disclosure

Speaker name: Kei Kwong, Wong

I have the following potential conflicts of interest to report:

☐ Consulting
☐ Employment in industry
☐ Stockholder of a healthcare company
☐ Owner of a healthcare company
☐ Other(s)

☑ I do not have any potential conflict of interest
Vascular injury in orthopaedic trauma

• Uncommon

• 1.6% in adults; 0.6% in pediatric patients (2010)
• Male predominant (70-90%)
• Most common are SFAs & Popliteal Arteries (>50%)
• Open # 10x higher risk than Closed #
屯門輕鐵意外
11歲男童捲車底
被消防救出
17/12/2018 Night

• 11yr old boy hit by Hong Kong Light Rail Train (HK LRT) around 8:30pm
• Arrived Tuen Mun Hospital A&E at 9:10pm
• Attended by trauma team with resuscitation
Physical examination after arrival

- GCS : Full
- BP: 120/70 P – 150, Hgb 6.5
- Neck and back - non tender
- Abdomen soft, FAST scan no fluid collection
- Unstable pelvis
- 10 x 20 cm Right Groin open wound: deglove injury
- Right leg: no pulse, pale looking
- R scrotal skin 7cm long and deep laceration
- 7cm deep laceration from anus to R ischiorectal fossa
- Foley: clear urine
- Continue oozing + **on & off profuse arterial bleeding** from the open pelvis wound, especially when the patient was moved
X-Ray: Compound pelvis and acetabulum fracture
Paediatric Pelvic Fracture - Epidemiology

- Pelvic fractures comprise of 0.33% to 4% of all paediatric fractures in current literature.
- 18.3% of paediatric pelvic fractures are complex (Meyer, *Unfallchirurg* 100:225-253).
Paediatric Pelvic Fracture – mechanism of injury

• High energy trauma – Motor vehicle accident = 83.3%

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<th>Author</th>
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Paediatric Pelvic Fracture - Associated injury

• High rate of concomitant injury from 58% to 87%, average number=5.2
  – Non pelvic fracture (particularly femur fracture), head injury, shock, abdominal and chest injury

• Higher incidence of lower urinary tract(47%) and rectal laceration(66%) in open fracture
Differences between paediatric and adult pelvic fractures

• Physiology
  – The frequency of pelvic fracture-associated haemorrhage is lower in children
  – Lift threatening bleeding is rarely seen (0-2%)
  – Transfusion rate similar to adult but haemorrhage is rarely the primary cause of death because of a more effective vasoconstrictive response with nonarteriosclerotic blood vessels
  – Mortality rate – no consensus
    • 2.4% to 30%, commonly due to associated head injury
Compound Pelvic Fracture

  – Retrospective review from 1983 to 1995, single trauma centre
  – 14 out of 15 patients (>90%) were struck by motor vehicles
  – Three of children died secondary to uncontrollable haemorrhage and chest injury
    mortality rate= 20%
  – 11 out of 12 children had deep wound infection
Progress

• Full rate 1500ml NS + 500ml Gelofusine
• Full rate RBC x 4 FR
• Developed shock and became drowsy
• Cancel CT & decided for E OT x haemostasis

-> “3-in-1 Protocol”
  - on-table angiogram +/- embolization
  - external fixator application
  - extra-peritoneal packing
Vascular Injuries Diagnostic Algorithm

1. Normal physical examination
   - Yes: Observation
   - No:
     - Hard signs of vascular injury:
       - Yes: Surgical intervention
       - No: Soft signs of vascular injury
     - ABI > 0.90
     
2. Change in physical examination
   - No:
   - Yes:
     - Observation
     - Advanced imaging (e.g., CT arteriography)
     - Change in physical examination
     - Normal
     - Yes: Surgical intervention
     - No:
       - Observation
       - Surgical intervention
       - Change in physical examination

Hard and Soft Signs of Vascular Injury in Orthopedic Trauma

**Hard sign**
- Pulselessness
- Pallor
- Paresthesia
- Pain
- Paralysis
- Rapidly expanding hematoma
- Massive bleeding
- Palpable thrill or audible bruit

**Soft sign**
- History of bleeding in transit
- Proximity-related injury
- Neurologic findings from nerve adjacent to a named artery
- Hematoma over a named artery
Vascular Injuries Associated with limbs trauma Treatment Algorithm

Types of Vascular Injuries

- Spasm
- Intimal Injuries (intimal dissection flaps or complete intimal avulsion, subintimal hematoma) with or without occlusion
- Complete wall defects with pseudoaneurysm or bleeding
- Complete transection with bleeding
- Arteriovenous fistulas
Steps in treating this patient’s bleeding and R LL’s ischaemia

- Vascular access from L CFA
- On-table angiogram: bleeding R EIA & R IIA, traumatic avulsion & dissection from proximal R EIA to proximal R SFA
- Balloon occlusion of proximal R EIA
- Coils embolization for R IIA
- Temporary vascular shunt from L CFA to distal R SFA
- External fixators by O&T colleagues
- R LL’s revascularization by bridging cover stent from proximal R EIA to middle R SFA
- R leg fasciotomy
OT started at 11:30pm on 17/12/2018 (3 hrs after the incident)
R IIA Embolisation
External Fixators
by O&T
Colleagues
R LL re-vascularisation by bridging cover stenting from proximal R EIA to proximal R SFA
Progress

- Patient was stabilized after the operation
- R lower limb re-perfusion well
- To ICU care
- Not on any anti-platelet or anti-coagulant due to DIC
- Found deteriorated L LL’s circulation 12 hrs after 1st operation
  -> L foot becomes cold, pallor and pulseless
2nd Operation for the missed L EIA Traumatic dissection resulted into near complete occlusion
Progress

• Bilateral lower limbs circulation well
• No significant re-perfusion injury or compartment syndrome

• Multiple debridement done by O&T
• Cover stents covered by soft tissue and new granulation tissues

• Sudden profuse R groin bleeding one day after debridement on Post-op D24
3rd OT for sudden profuse wound bleeding on 10/1/2019 (Post-op D24)
Completion Angiogram after additional Cover Stent
Progress (1/2019, 1 month after injury)

- Connect to posterior pelvis
- Sciatic nerve is intact

Turbid discharge
C/ST: *Enterococcus faecalis*
A/B: Vancomycin, Levofloxacin and Unasyn

R Leg Fasciotomy wound
Progress (2/2019, 2 months after injury)

Lateral

Medial

Turbid discharge
C/ST: *E. coli*, Fusarium
A/B: Timentin, Levofloxacin
Antifungal: Variconazole
Progress ( 2/2019, 2 months after injury )

R leg fasciotomy wound after skin grafting
Progress (2/2019, 2 months after injury)

Inlet view

Outlet view
Progress (3/2019, 3 months after injury): Off Frame
VAC Wound dressing
CT – Pelvis with SI screw

Right

Left
Progress (12/2019, 1 year after injury)

Physical examination

1/ Passive Range
   1a/ Right Hip:
   - F/E: 0 - 30 degrees
   - Abduction / Adduction: 20 / 20 degrees

   1b/ Right Knee:
   - F/E: 0 - 30 degrees

   1c/ Right Ankle:
   - F/E: 0 - 20 degrees

2/ Power:
   - No active motion at lower limb

3/ Sensation:
   - Light touch posterior thigh
     (Posterior cutaneous n) and
     medial knee (Obturator n)

4/ Circulation:
   - well, all distal pulses palpable on both sides
Lesions to learn from this case

- Endovascular intervention for vascular injuries is feasible in some selected cases, even pediatric patients, with the potential benefits:
  - allow remote access from convenience and “clean zone”
  - avoid “hostile injured zone” manipulation which may resulted into more iatrogenic injuries like bleeding, nerve injury, etc.
  - sometimes allow faster bleeding control and reperfusion
  - extra-anatomical temporary arterial shunting maybe helpful to save limbs and lessen systemic trauma

- Always look for any other possible concomitant vascular injuries like traumatic intimal dissection, etc. especially when complete CTA is not available
Increasing use of endovascular therapy in acute arterial injuries: Analysis of the National Trauma Data Bank

Brian C. Reuben, MD, a, c Matthew G. Whitten, MD, a, c Mark Sarfaty, MD, b, c and Larry W. Krams, MD, a, c Salt Lake City, Utah

Objective: The application of endovascular technology for the emergency treatment of traumatic vascular injuries is a new frontier. This study examines recent nationwide use of endovascular therapy in acute arterial traumatic injuries.

Methods: This retrospective study used the National Trauma Data Bank (NTDB). Cases with a diagnosis of arterial vascular injury were identified according to the International Classification of Diseases, Ninth Revision, Clinical Modification, and procedure codes for endovascular therapy were selected. A descriptive analysis and multiple regressions were performed to identify variables predictive of outcomes.

Results: From 1994 to 2003, 12,732 arterial injuries were identified. Between 1997 (when the first endovascular repair was recorded in the NTDB) and 2003, 7386 open arterial repairs and 281 endovascular repairs were recorded for an overall utilization rate for endovascular procedures of 3.7%. The yearly number of endovascular procedures registered in the NTDB increased 27-fold, from four in 1997 to 107 in 2003. Use of stents substantially increased from 12 in 2000 to 30 in 2003; endograft use increased from one in 2000 to 37 in 2003. Nearly equal numbers of blunt (n = 134) and penetrating (n = 111) injuries were treated. The injury severity score (median, interquartile range [IRQ]) was significantly lower in patients who underwent an endovascular procedure at 15 (IRQ, 9 to 26) for trauma vs patients requiring an open procedure at 20 (IRQ, 10 to 34; P < .001), a finding corroborated by the lower number of associated injuries in patients undergoing endovascular repair (8.7 ± 7.2 vs 13.0 ± 6.1; P < .001). Using multivariable regression to control for differences in injury severity score and associated injuries, mortality was significantly lower for patients undergoing endovascular procedures (odds ratio, 0.18; P = .029) including those with an arterial injury of the torso or head and neck (odds ratio, 0.61, P = .007). Total length of hospital stay also tended to be lower for patients undergoing endovascular procedures by 18% (P = .064).

Conclusions: The use of endovascular therapy in the setting of acute trauma is increasing in a dramatic fashion and is being used to treat a wide variety of vessels injured by blunt and penetrating mechanisms. Endovascular therapy appears to be particularly suitable for patients who present with less severe injuries and greater hemodynamic stability. These preliminary data suggest that the use of endovascular therapy for acute traumatic arterial injuries yields shorter lengths of stay and improved survival. (J Vasc Surg 2007;46:1222–6.)

Increasing use of endovascular therapy in pediatric arterial trauma

Bernardino C. Branco, MD, a Bindi Naik-Mathuria, MD, a Miguel Montero-Baker, MD, a Ramyar Gillani, MD, a Charles A. West, MD, a Joseph L. Mills Sr, MD, a and Jayer Chung, MD, MSC, a Houston Tex

ABSTRACT

Background: Endovascular therapy has been increasingly used for critically injured adults. However, little is known about the epidemiology and outcomes of endovascularly managed arterial injuries in children. We therefore aimed to evaluate recent trends in the endovascular management of pediatric arterial injuries and its association with early survival.

Methods: An 8-year analysis of the National Trauma Databank (2007-2014) was performed to extract all pediatric trauma patients aged ≤16 years with arterial injuries. Demographics, clinical data, interventions (endovascular vs open) and outcomes (in-hospital mortality and length of stay) were extracted. Patients undergoing endovascular or open procedures were compared for differences in clinical characteristics using univariate analysis. Multivariable logistic regression analysis quantified the association between endovascular therapy and survival in the context of other variables predictive of survival on univariate analysis, with α ≤ .05.

Results: There were 55,771 pediatric patients available for analysis. Overall, there was a significant increase in the use of endovascular procedures from 7.6% in 2007 to 12.9% in 2014 (P < .001), particularly among blunt trauma patients (5.8% in 2007 to 15.7% in 2014, P < .001). Conversely, a significant decrease was noted for open procedures (P < .001). There was a stepwise increase in the proportion of patients managed endovascularly as the Injury Severity Score (ISS) increased (highest in the ISS spectrum of 31–50). Angiembolization of internal iliac injury and thoracic aortic endograft placement were the two most common endovascular procedures (n = 88 [33.4%] and n = 60 [22.9%], respectively). There were 331 decedents (9.8% vascular injured children), 242 (73.3%) of whom were dead on arrival. After controlling for differences in demographics and clinical data, when outcomes were compared between patients who underwent endovascular and open procedures, there were no significant differences regarding in hospital mortality (6.0% vs 3.6%; odds ratio, 0.79; 95% confidence interval, 0.61–1.0; P = .778). A logistic regression model identified Glasgow Coma Scale score <8, ISS >16, positive result of ethanol or drug screen, and systolic blood pressure <90 mm Hg on admission as independent risk factors for death.

Conclusions: The use of endovascular therapy in pediatric vascular arterial trauma has significantly increased, especially among severely injured blunt trauma patients. Despite this successful integration into care, there was no in-hospital survival advantage conferred by endovascular therapy compared with traditional open therapy. Approximately 10% of children with arterial injuries died during initial trauma assessment before therapy could be offered. Glasgow Coma Scale score <8, ISS >16, positive result of ethanol or drug screen, and systolic blood pressure <90 mm Hg on admission were identified as independent risk factors for death. As children are a population of vulnerable patients, long-term, multicenter studies are required to determine the most appropriate use of end indications for endovascular therapy in pediatric arterial trauma. (J Vasc Surg 2017;65:19.)
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<td>Blunt trauma to R knee by falling heavy metal bar</td>
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<td>Open # dislocation R Knee: R Femur supracondylar #</td>
<td>R LL viable</td>
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Accidental Vascular Injuries

- 10/11 are males
- 6/11 are RTA
- 10/11 are arterial injury
- 8/11 involved bone fracture (6/8 are open fracture)
- 6/10 arterial injury involve SFAs or Popliteal Arteries
- 5/11 treated by endovascular stenting, 2/11 with endovascular embolization
- 3/11 treated by open repair with vein graft, 1/11 treated by direct vessel repair
- Don’t forget conservative management (2/11)
- The trend is more patients are treating by endovascular approach in recent years
Unanswered Questions:

• Durability of endovascular stenting?
  - migration, stenosis & thrombosis, stent fracture, etc.

• Safe to have stents in contaminated zones?
  - stent graft infection, “anastomosis” (landing zone) breakdown

• What will be the long term result when stent is put into pediatric patients?
Thank You
Endovascular interventions to treat life and limb threatening vascular injuries in a complex paediatric pelvic fracture patient

By Dr KK Wong
Chief of Vascular Service
Tuen Mun Hospital & Pok Oi Hospital
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LINC 2020