Handling Blunt Cerebro-Vascular Injuries (BCVI) (Carotid & Vertebral) – An evidence based recommendation.

Aronsborg/Stockholm Consensus Conference Oct 2007

Report from the consensus meeting in Aronsborg/Stockholm, October 22-23, 2007 arranged by Nordic Forum for Trauma and Emergency Radiology (NORDTER) with support from Karolinska University Hospital Trauma Steering Committee.

This document is a result from the multidisciplinary meeting held with representatives for general, interventional and neuro-radiology, together with general, emergency/trauma and vascular surgery with participants from Akademiska, Uppsala, Karolinska University Hospital Solna & Huddinge, SÖS and radiologists from Denmark, Norway and Finland. Invited international experts and lecturers were Walter Biffl, trauma surgeon, Denver, Colorado and Clint Sliker, radiologist, Baltimore, Maryland. The consensus conference was followed by an open meeting with input from participants representing additional specialists from neurology, spine surgery and ENT surgery.

Participants:

Surgery– general & vascular& emergency care
–Folke Hammarqvist, Karolinska Huddinge
–Magdalena Elinder Karolinska Solna
–Pär Olofsson, Karolinska Solna
–Calle Wahlgren, Karolinska Solna
–Peep Talving, Karolinska Solna

Radiology- general, interventional & neuroradiology
–Mats Beckman, Karolinska Solna
–Bo Kalin, Karolinska Solna
–Håkan Almqvist, Karolinska Solna
–Michael Söderman, Karolinska Solna (**speaker**)
–Bertil Leidner, Karolinska Huddinge
–Adel Shalabi, Karolinska Huddinge
–Laura Saiepour, Karolinska Huddinge
–Rickard Nyman, Akademiska, Uppsala
–Anders Sundin, Akademiska Uppsala & Karolinska, Solna
–Johan Formgren, SÖS

Nordter representatives - radiology
–Henrik Teisen, Svendborg, Denmark
–Johann Baptist Dormagen, Oslo, Norway
–Seppo Koskinen, Helsinki, Finland

International Guest Speakers
–**Surgery**: Walter Biffl, Denver, Colorado, USA
–**Radiology**: Clint Sliker, Baltimore, Maryland, USA

The goal was to create a recommendation for the care of blunt cerebrovascular injuries with focus on radiological diagnosis & clinical care with an evidence based approach. Available scientific evidence was analyzed and stratified according to the value of the scientific data.

This document is available from NORDTER at www.nordictraumarad.com. It is available as word document in both Swedish and English and as PowerPoint presentation in English. Walter Biffl´s and Clint Slikers´ presentations and the background articles studied are also possible to download. The material is free to use providing that the source is presented.

Document outline

1. **Problem presentation**
2. **Consensus recommendations.**
3. **Evidence based consensus document including reference list + added discussion comments.**

On the basis of the evidence based consensus conference we agreed to recommend the following guidelines:

1. Problem presentation

Blunt injury to the carotid or vertebral vessels is diagnosed in approximately 1/1000 patients hospitalized for trauma in the United States. When asymptomatic patients are screened for BCVI the incidence rises to 1% of blunt trauma patients.
The majority of these injuries are diagnosed following the development of symptoms secondary to central nervous system ischemia with a resultant neurologic morbidity of up to 80% and associated mortality of up to 40%.

2. BCVI Consensus recommendation

We conclude that patients with defined risk factors should be investigated to detect BCVI using multislice CT with minimum of 16 channels, with either a Whole Body CT (WBCT) protocol or with a dedicated Neck Vessel CTA (NV-CTA). When examination is positive for carotid/vertebral artery injury – barring contraindication, the patient should be treated regardless of the grade of injury.

1. Who & How should we investigate for BCVI?

Investigate at arrival if performing WBCT:

Patients with

- risk factors defined at p 3.1 (below) "Who is at increased risk"
- risk factors to judge in the acute situation:
    i. GCS ≤ 8 (= unconscious patients); Horner´s syndrome
    ii. CT preliminary finding of DAI (diffuse axonal injury), skull base fracture, significant facial fracture and any C-spine fracture; neurological deficit incongruous with traumatic CT brain findings; image evidence of acute stroke.

How to perform the WBCT to include neck vessel angiography?
Each institution needs to optimize the WBCT protocol to include the neck vessels in selected cases, according to local conditions. Protocol questions may be directed to ntr@nordictraumarad.com. Protocols used in Baltimore for 16 and 40 channel MDCT are presented in attachments to this document.

Do Dedicated Neck Vessel – CTA (NV-CTA)

- If risk factors (p 3.1) are present and neck vessels are not primarily screened with WBCT
    i. as soon as reasonable possible
    ii. if positive findings - consider to add perfusion imaging.

MRI/MRA is an alternative to

- Investigate patients with Horners syndrome when CTA is negative

Do DSA - cath angio

- When finding of stroke on primary or secondary scan
- Investigate symptomatic patients when CTA is negative
    - Symptom definition:
        - arterial haemorrhage
        - cervical bruit in patient < 50 years
        - the "red eye sign" indicative of carotid-cavernous-fistula
        - expanding cervical haematoma

- focal neurological deficit
- neurological examination results incongruent with findings on head CT scan

2. **Who should we treat?**
    - When examination is positive for carotid/vertebral artery injury – barring contraindication, treat regardless of grade.

3. **How should we treat?**
    - Barring contraindications (at the discretion of the physician in charge), Grade I - IV injuries should be treated with antithrombotic agents such as aspirin or heparin. Dicumarol can also be used. In the literature there is not enough evidence to define that any of these drugs is more effective than the other.
    - Special notice should be taken to injuries grade II and III if there is progressive narrowing, expanding or partially thrombosed pseudoaneurysm or hypoperfusion,
    - Grade V lesions - treat with surgical and/or endovascular procedure.

4. **Follow- up examination**
    - NV-CTA as follow-up. Timing to consider - 7-10 days
    - If change in management is considered, rescan is indicated.
    - If treatment is with-held due to contraindications – do NV-CT before starting treatment.
    - Decision of later follow-up is made on an individual basis.
    - Consider MRA as an alternative in the long term follow-up

5. **Role of the different departments/hospitals**
    - Who should be doing what?
        i. It is desirable to do CTA with $\geq$ 16 Ch MDCT in patients with risk factors as soon as possible, ie in the hospital where the patient is cared for primarily.
        ii. Catheter angiography should be performed by sufficient expertise, i.e. most often referred to neuroradiology.

3. BCVI evidence based consensus document

We analyzed the following questions with an evidence based approach:

- ***Evidence Based Analysis***
  - ***1. Who is at risk?***
  - ***2. Why should we screen?***
  - ***3. What is the optimal screening test?***
  - ***4. How should BCVI be treated?***

Each question is presented with the evidence based data followed by additional comments from our group discussion, and the article references.

In our work three evidence based reviews have been studied for all subtopics (see attachments):

- EAST Practice Management Guidelines Committee
- Blunt Cerebrovascular Injury: Guidelines by the Department of Surgical Education, Orlando Regional Medical Center
- Anticoagulation for blunt carotid artery injury. Guidelines by the Department of Surgical Education, Orlando Regional Medical Center

1. Who is at risk?

Level 2 evidence

Patients with the following injury patterns/presentation are at increased risk:

- Coma unexplained by CT findings
- Lateralizing neurological deficits
- Cervical spine injuries
  - Subluxations at any level
  - Fractures from C1 to C3
  - Fractures through the transverse foramen at any level
  - Rotation & hyperextension mechanism
- Glasgow Coma Scale ≤ 6
- Le Fort II or III facial fractures
- Horner's syndrome
- Skull base fractures involving the carotid canal/vessel
- Significant neck soft tissue injury / neck seat belt sign*
- A history of strangulation or near hanging*

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*neck seat belt sign and near hanging may be of less significance

COMMENTS

In addition we recognize additional risk factors:

- periarterial hematoma
- major facial fracture such as NOE (Naso-Orbital-Ethmoidal) + smash fracture
- neck vessel bruit < age of 50
- Any c-spine fracture
- Hanging with a finding of c-spine fracture and anoxic brain finding; if CT is ordered for any reason DO scan with CTA
- Major chest injury

NB high risk criteria are NOT present in 20% of BCVI cases
NB dissections DO also occur with TRIVIAL TRAUMA

Signs and symptoms that mandates pursued imaging with DSA – catheter angiography if CT Angiography is negative

- arterial haemorrhage
- cervical bruit < age of 50
- the “red eye sign” indicative of carotid-cavernous-fistula
- expanding cervical hematoma
- focal neurological defecit
- neurological examination results incongruent with findings on head CT scan
- Stroke on secondary scan

1. Who is at risk? reviewed documents

Biffl WL, Moore EE, Offner PJ, et al. Optimizing screening for blunt cerebrovascular injuries. Am J Surg 1999; 178:517-522.

Cothren CC, Moore EE, Biffl WL, et al. Cervical spine fracture patterns predictive of blunt vertebral artery injury. J Trauma 2003; 55:811-813.

DiPerna CA, Rowe VL, Terramani TT, Salim A, Hood DB, Velmahos GC, Weaver FA. Clinical importance of the "seat belt sign" in blunt trauma to the neck. Am Surg. 2002 May;68(5):441-5.

McKevitt EC, Kirkpatrick AW, Vertesi L, Granger R, Simon RK. Blunt vascular neck injuries: diagnosis and outcomes of extracranial vessel injury. J Trauma 2002;53(3):472–6.

Utter GH, Hollingworth W, Hallam KD, Jarvik JG, Jurkovich GJ. Sixteen-slice CT angiography in patients with suspected blunt carotid and vertebral artery injuries. J Am Coll Surg 2006(6);203:838-848.

2. Why should we screen?

Level 3 evidence:

- Untreated BCVI have a significant stroke rate.
- Treatment decreases morbidity (lowers the stroke rate) and mortality
- Treatment is cost-effective.

2. Why should we screen? *Reviewed documents*

Berne JD, Norwood SH, McAuley CE, et al. The high morbidity of blunt cerebrovascular injury in an unscreened population: more evidence of the need for mandatory screening protocols. J Am Coll Surg 2001; 192:314-321.

Kerwin AJ, Bynoe RP, Murray J, et al. Liberalized screening for blunt carotid and vertebral artery injuries is justified. J Trauma 2001; 51:308-314.

Biffl WL, Ray CE Jr, Moore EE, et al. Treatment-related outcomes from blunt cerebrovascular injuries: importance of routine follow-up arteriography. Ann Surg 2002; 235:699-707.

Miller PR, Fabian TC, Croce MA, et al. Prospective screening for blunt cerebrovascular injuries: analysis of diagnostic modalities and outcomes. Ann Surg 2002; 236:386-395.

Schneidereit NP, Simons R, Nicolaou S, et al. Utility of screening for blunt vascular neck injuries with computed tomographic angiography. J Trauma 2006;60(1):209–15.

3. What is the optimal screening test?

Level 2 evidence:

1. Diagnostic four vessel cerebral angiography (FVCA) remains the gold standard for the diagnosis of BCVI.
2. Duplex ultrasound and MRA are **not** adequate for screening for BCVI.
3. CT angiography with a 4 (or less)-slice multidetector array is neither sensitive nor specific enough for screening for BCVI.

Level 3 evidence:

1. Multi-slice (≥16) CTA has the same rate of detection for BCVI when compared to historic control rates of diagnosis with FVCA and should be considered as a screening modality in place of FVCA.

Whole Body CT (WBCT)

- In the Baltimore experience the WB-CT results are equivalent with dedicated Neck CTA and useful for practical purposes (16/40 Ch MSCT).
- Radiation dose with whole body CT reduces dose compared to region by region scanning.

Comments:

- There are no published data on 64 slice CTA.
- Few studies are made with full angiographic correlation.
- 16 Ch is good enough but maybe not as good as some reports indicate.
- "False positives" are mainly Grade I injuries.
- False negatives are mainly Grade I injuries.
- There is a learning curve when interpreting CTA examinations.
- It is necessary to optimize scanning and reconstruction parameters.
- Normal WBCT + clinical signs and symptoms of BCVI mandates further studies (ie angiography and/or dedicated MDCT).
- *Follow up examinations are of great value – Grade 1 and grade2 injuries frequently **changed therapy** because of result of re-examination at 7-10 days – this fact is supported by study by Biffl et al.*
- When you consider change in treatment – consider reimaging (i.e. if the treatment has been withheld due to other injuries).
- Dissections – cause lumen narrowing & hypoperfusion & embolic risk- vs pseudoaneurysms- risk for enlargement and rupture. Follow-up exams are done more frequently for pseudoaneurysms**.**
- **Do consider the high radiation dose for multiple follow-up exams – consider MRA.**
- Use the test that images the lesion best for follow-up!
- There are no solid data on the time dynamics change of BCVI.

3.What is the optimal screening test? Reviewed documents.

Biffl WL, Ray CE Jr, Moore EE, et al. Noninvasive diagnosis of blunt cerebrovascular injuries: a preliminary report. J Trauma 2002; 53:850-856.

Miller PR, Fabian TC, Croce MA, et al. Prospective screening for blunt cerebrovascular injuries: analysis of diagnostic modalities and outcomes. Ann Surg 2002; 236:386-395.

Hollingworth W, Nathens AB, Kanne JP, et al. The diagnostic accuracy of computed tomography angiography for traumatic or atherosclerotic lesions of the carotid and vertebral arteries: a systematic review. Eur J Radiol 2003; 48:88-102.

Biffl WL, Egglin T, Benedetto B, et al. Sixteen-slice computed tomographic angiography is a reliable noninvasive screening test for clinically significant blunt cerebrovascular injuries. J Trauma 2006; 60:745-752.

Eastman AL, Chason DP, Perez CL, et al. Computed tomographic angiography for the diagnosis of blunt cervical vascular injury: is it ready for primetime? J Trauma 2006; 60:925-929.

Berne JD, Reuland KS, Villarreal DH, et al. Sixteen-slice multi-detector computed tomographic angiography improves the accuracy of screening for blunt cerebrovascular injury. J Trauma 2006; 60:1204-1210.

Sliker CW, Mirvis SE. Imaging of blunt cerebrovascular injuries. Eur J Radiol 2007; Mar 15 (Epub ahead of print)

Sliker CW, Mirvis SE, Shanmuganathan K. Diagnosis of Blunt Cerebrovascular Injuries with 16-channel Multidetector Computed Tomography: Accuracy of Whole-body MDCT Compared to Neck MD-CTA. AJR-American Journal of Roentgenolology (In Press, accepted for publication (2007) – accepted manuscript attached courtesy of C.W. Sliker).

3A. Whole-body MDCT (background material for CT techniques)

Ptak T, Rhea JT, Novelline RA. Radiation dose is reduced with a single-pass whole-body multi-detector row CT trauma protocol compared with a conventional segmented method: initial experience. *Radiology* 2003; 229:902–905

Fanucci E, Fiaschetti V, Rotili A, Floris R, Simonetti G. Whole-body 16-row multislice CT in emergency room: effects of different protocols on scanning time, image quality and radiation exposure. *Emerg Radiol* 2007; 13:251–257

Borisch I, Boehme T, Butz B, Hamer OW, Feuerbach S, Zorger N. Screening for carotid injury in trauma patients: image quality of 16-detector-row computed tomography angiography. Acta Radiol. 2007 Aug;48(7):798-805.

4. How should BCVI be treated?

Grading scale (Biffl et al) is the base for treatment and research
Grade I – intimal irregularity with <25% narrowing
Grade II – dissection or intramural hematoma with >25% narrowing
Grade III – pseudoaneurysm
Grade IV – occlusion
Grade V – transection with extravasation

Level 2 evidence:
1. Barring contraindications, Grade I - IV injuries should be treated with antithrombotic agents such as aspirin or heparin.

Our comments

- Definition of contraindications - = multidisciplinary decision in each individual patient).
- Dicumarol can also be used. In the literature there is not enough evidence to define that any of the recommended drugs is more effective than the other.
- Special notice should be taken to injuries grade II and III if there is progressive narrowing, expanding or partially thrombosed pseudoaneurysm or hypoperfusion,
- Some grade II lesions may also benefit from more aggressive treatment
- Grade V lesions - treat with surgical and/or endovascular procedure.
- Low-Weight-Molecular-Heparin (LWMH) is used in our patient population in Karolinska Solna – no evidence exists whether this prevents strokes or not.
- Treatment length should be at least 3 month and then individualized.
- Grade III - V injuries + AV-fistulas needs invidualized management based on symptoms and radiological investigation & findings including more invasive measures like surgery and stent placement.
- The role of stents is under rapid change and development. No evidence based recommendation could be agreed on.
- Antiplatelet = anticoagulation = prevents embolic events/strokes (but does not address the hypoperfusion problem = research area)

4. What is the optimal treatment & role of stents? ***Reviewed documents***

Cothren CC, Moore EE, Biffl WL, et al. Anticoagulation is the gold standard therapy for blunt carotid injuries to reduce stroke rate. Arch Surg 2004; 139:540-546.

Edwards NM, Fabian TC, Claridge JA, et al. Antithrombotic therapy and endovascular stents are effective treatment for blunt carotid injuries: results from longterm followup. J Am Coll Surg 2007; 204:1007-1015.

Wahl WL, Brandt MM, Thompson G, et al. Antiplatelet therapy: an alternative to heparin fro blunt carotid injury. J Trauma. 2002;52:896-901.

Stein DM, Boswell S, Sliker CW, Lui FY, Scalea TM. Blunt cerebrovascular injuries: does treatment always matter? J Trauma (In Press, accepted for publication (2007) – Manuscript provided by Deborah Stein, M.D.)

Cothren CC, Moore EE, Ray CE Jr, et al. Carotid artery stents for blunt cerebrovascular injury: risks exceed benefits. Arch Surg 2005; 140:480-486.

Cohen JE, Ben-Hur T, Rajz G, Umansky F, Gomori JM. Endovascular stent-assisted angioplasty in the management of traumatic internal carotid artery dissection. Stroke 2005;36(4):e45–7.

Veras LM, Pedraza-Gutierrez S, Castellanos J, Capellades J, Casamitjana J, Rovira-Canellas A. Vertebral artery occlusion after acute cervical spine trauma. Spine 2000;25(9):1171–7.