EVALUATION AND TREATMENT OF BLUNT CEREBROVASCULAR INJURIES

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BCI - HISTORICAL EXPERIENCE

1980 – 113 Reported Cases

Mortality 28%

Morbidity 56%

Krajewski 1980, Perry 1980

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1980 – 113 Reported Cases

Mortality 28%

Morbidity 56%

Krajewski 1980, Perry 1980

Multicenter Reviews: Mortality 23%

Morbidity 48%

Incidence 0.1%

Davis 1990, Martin 1991, Cogbill 1994, Ramadan 1995

BCVI – CLINICAL PRESENTATION

- Arterial Hemorrhage
- Expanding Hematoma
- Bruit (< 50 yrs)
- Cerebral Infarction
- Transient Ischemic Attack
- Lateralizing Deficit Incongruous with CT

BCI INCIDENCE

Memphis	0.33%	Fabian 1996
Cincinnati	0.24%	Parikh 1997
Louisville	0.14%	Carrillo 1999
Peoria, IL	0.27%	Kraus 1999
Tyler, TX	0.40%	Berne 2001

Increasing Incidence vs Awareness?

"TRUE" INCIDENCE OF BCI

Prospective Study - Denver

Nov 1994 - Aug 1996

Thoracic Aortography

171 Patients

6 BCI - 3 Unsuspected

3.5% Incidence in Severely Injured

Prall, Neurosurgery 1998; 42:495

BCI - MEMPHIS EXPERIENCE

Fabian, Ann Surg 1996; 223:513

67 Patients (0.33%): Mortality 31%
Morbidity 37%

Systemic Anticoagulation → Improved Outcome

93% Symptomatic at Diagnosis

BCVI - PRESENTATION

Latent Period Prior to Symptoms

- 58% >10 hr, 36% >24 hr Krajewski 1980
- 23% >24 hr Perry 1980
- 50% >3 days Mokri 1988
- 33% >12 hr Fabian 1990

BCVI - MECHANISM

Crissey & Bernstein 1974

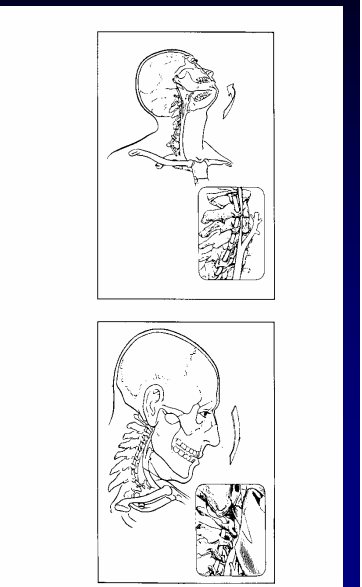
I Direct Cervical Blow

II Hyperextension/Rotation

III Intraoral Trauma

IV Basilar Skull Fracture

Cervical Spine Fracture



BCVI SCREENING – WHO?

- Hyperextension / Hyperflexion
  - Facial Fractures
- Diffuse Axonal Brain Injury
- Near-Hanging
- Soft Tissue Trauma
- Basilar Skull Fx
- Cervical Spine Fx / Distraction

BCVI - IMPACT OF SCREENING

	Pre-Screening 1/90-7/96
Incidence	0.1%
Symptomatic	100%

Biffl, Ann Surg 2002; 235:699

BCVI - IMPACT OF SCREENING

	Pre-Screening 1/90-7/96	Screening 8/96-10/01
Incidence	0.1%	1.6%
Symptomatic	100%	24%

Biffl, Ann Surg 2002; 235:699

BCVI - IMPACT OF SCREENING

Columbia, SC	1.1%	Kerwin, J Trauma 2001; 51:308
Denver, CO	1.6%	Biffl, Ann Surg 2002; 235:699
Memphis, TN	1.0%	Miller, Ann Surg 2002; 236:386
Vancouver, BC	1.4%	Schneidereit, J Trauma 2006; 60:209
Dallas, TX	1.3%	Eastman, J Trauma 2006; 60:925
Tyler, TX	1.2%	Berne, J Trauma 2006; 60:1204

So What?

Mayberry, Velmahos et al

STROKE PREVENTION

Patients Treated While Asymptomatic

Heparin:	**1 of 84 (1%) Stroke**
Antiplatelet:	**3 of 33 (9%) Stroke**
	p = .07
None:	**22 of 43 (51%) Stroke**

Biffl, Ann Surg 2002; 235:699

STROKE PREVENTION – MEMPHIS

Patients Treated While Asymptomatic
Carotid Artery injuries

Heparin:	**1 of 9 (11%) Stroke**
Antiplatelet:	**1 of 6 (17%) Stroke**

Overall: 33% Stroke

Miller, Ann Surg 2002; 236:386

STROKE PREVENTION - BCI

Asymptomatic Patients

Heparin / Antiplatelet: 1 of 187 (0.5%) Stroke

No Treatment: 10 of 48 (21%) Stroke

Cothren et al, Am J Surg 2005; 190:845

BCI STROKE PREVENTION – MEMPHIS

Heparin / Antiplatelet: 6 of 65 (9%) Stroke

77% of Strokes Occurred Prior to Diagnosis and Treatment

Edwards et al, J Am Coll Surg 2007; 204:1007

BCVI HIGH-RISK FACTORS

Factor	p	Odds Ratio
GCS ≤6	.029	1.98 (1.07-3.65)
Petrous Fx	.025	2.64 (1.13-6.19)
DAI	.030	3.09 (1.12-8.57)
LeFort II / III Fx	.033	3.70 (1.12-12.29)
C-Spine Fx	<.001	14.50 (5.30-39.63)

Biffl, Am J Surg 1999; 178:517

20% Had None of These

BVI - CERVICAL SPINE INJURIES

1/96 - 6/02: 92 BVI Patients

71 (77%) C-Spine Fxs

- 38 (49%) Subluxation
- 18 (25%) Foramen Transversarium
- C1 (8 Pts), C2/3 (5 Pts)

Cothren, J Trauma 2003

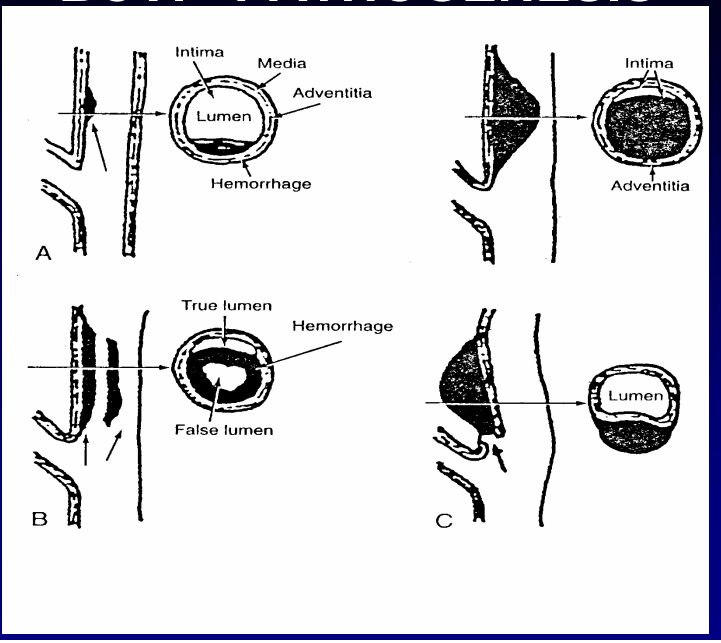
WHO TO SCREEN - SUMMARY

1. **Selective Criteria** Will Miss Injuries
2. **Liberal Criteria** Have High Yield- 27% of Asymptomatic Pts Had BCVI
   Biffl, Am J Surg 1999; 178:517
3. **Institutional Guidelines Should be Established Based on Rational Assessment of Literature and Resources**

BCVI SCREENING – HOW?

- **Cerebral Arteriography**
- Duplex Scanning
- Computed Tomographic Angiography (CTA)
- Magnetic Resonance Angiography (MRA)

BCVI - PATHOGENESIS



DUPLEX SCANNING

- Imaging Modality of Choice for Extracranial Carotid Artery

Role in BCVI Screening (?)

Davis 1990, Martin 1991, Fry 1994

- Inaccurate at Base of Skull
- Relies on Flow Disturbances

WTA Multicenter Review

86% Sensitivity

Cogbill 1994

MRA

- No Need for Contrast
- No Bony Interference
- Detect Infarction Sooner

Role in BCVI Screening (?)

BCVI Identified by MRA

Friedman 1995, Bok 1996, Punjabi 1996, Giacobetti 1997, Weller 1999, Hughes 2000

DENVER MRA RESULTS (n=16)

	ART (+)	ART (-)
MRA (+)	3	4
MRA (-)	1	8

SENS 75% **SPEC 67%**

Biffl, J Trauma 2002; 53:850

MEMPHIS MRA RESULTS (n=21)

Carotid	2 / 4 Dx'ed (50%)
Vertebral	8 / 17 Dx'ed (47%)

Miller, Ann Surg 2002; 236:386

CTA

- Accurate for Dissections & Stenoses
  Leclerc 1996, Simeone 1997
- Accurate for Penetrating Injuries
  LeBlang 1997, Munera 2000

Role in BCVI Screening (?)

- Patients Need CT Scans
- Brain, Face and Neck Imaged
- BCVI Identified by CTA
  Rogers 1999, Ofer 2001

DENVER CTA RESULTS (n=46)

	ART (+)	ART (-)
CTA (+)	15	8
CTA (-)	7	16

SENS 68% SPEC 67%

Biffl, J Trauma 2002; 53:850

MEMPHIS CTA RESULTS (n=143)

Carotid	8 / 17 Dx'ed (47%)
Vertebral	16 / 30 Dx'ed (53%)

Miller, Ann Surg 2002; 236:386

3 / 9 (33%) Missed BCI Had Stroke

16-SLICE CTA

East Texas Medical Center

486 Pts Screened
- Basilar Skull Fx
- C-Spine Injury
- Multiple / Severe Facial Fx
- Cervical Abrasion / Hematoma
- GCS ≤8

2 Yrs - 4 Slice / Rotation

1 Yr - 16 Slice / Rotation

Berne, J Trauma 2004; 57:11

16-SLICE CTA

19 Pts - 25 BCVI (0.6% Blunt Trauma Admissions)

3.7% Yield of Screening

18 True Positive

30 False Positive

438 True Negative*

Berne, J Trauma 2004; 57:11

THE REALITY

- CT Technology is Advancing; Multi-Detector Row CT Rivals DSA in Imaging Intracerebral Vessels

  Jayaraman et al, Radiology 2004; 230:510

- No Support for Prospective Comparative Trials
- Seeing is Believing

Difficult to Justify Liberal Screening DSA in Asymptomatic Patients

RIH SCREENING PROTOCOL

DSA for Signs / Symptoms

CTA for Patients with High Risk Mechanisms / Injury Patterns

Liberal Screening of Patients with Cranial or Cervical Trauma Requiring CT Scanning

CTA SCREENING

June 2004 – May 2005

331 Pts Screened

20 BCVI in 18 (5.4%) Patients

Incidence 0.66%

11 Carotid, 9 Vertebral

1 Bilateral VA; 1 ICA + VA

Biffl et al, J Trauma 2006

CTA ACCURACY

No Pt with Normal CTA Developed Sx of BCVI

CTA ACCURACY

No Pt with Normal CTA Developed Sx of BCVI

2 Pts Who Did Not Meet Screening Criteria Presented w/ Sx

Biffl et al, J Trauma 2006

16-SLICE CTA ACCURACY

435 CTA – Same Results

Berne, J Trauma 2006; 60:1204

16-SLICE CTA vs DSA

Parkland Memorial Hospital

146 Pts CTA + DSA

46 BCVI in 43 Pts

100% Sensitivity for BCI

96% Sensitivity for BVI

Eastman, J Trauma 2006; 60:925

16-SLICE CTA vs DSA

Medical College of Virginia

92 Pts CTA + DSA (27 No DSA)

23 (+) - 10 (43%) False (+)

62 Normal - 6 (9%) False (-)

3 not treated; all in 1st half of study

Malhotra et al, Ann Surg 2007; 246:632

CONCLUSIONS

Symptomatic Pts Should Undergo Arteriography

16-Slice CTA is a Reliable Noninvasive Screening Test for Clinically Significant BCVI

Clinicians Should Draft Institutional Guidelines Based on Resource Availability and Literature

Multicenter Prospective Trials Need to be Done to Clarify Risk Factors, Assess Accuracy of Noninvasive Screening Tests, and Evaluate Efficacy of Treatment Strategies

BCVI MANAGEMENT

To Determine Whether:

a) Systemic Anticoagulation is Superior to Antiplatelet Therapy in Injury Healing, Neurologic Improvement, or Stroke Prevention

b) Routine Follow-Up Arteriography Impacts Therapy

BCVI ANALYSIS

Jan 1990 - Oct 2001: 171 Patients

157 BCI / 114 Pts - 43 (38%) Bilat

97 BVI / 79 Pts - 18 (23%) Bilat

22 (13%) BCI + BVI

BCVI Incidence = 1.55%

BCI = 1.11% BVI = 0.77%

Biffl, Ann Surg 2002; 53:850

DHMC GRADING SCALE

Grade	Description
I	Irregularity, <25% Luminal Narrowing
II	≥25% Narrowing / Thrombus / Flap
III	Pseudoaneurysm
IV	Occlusion
V	Transection

Biffl, J Trauma 1999; 47:845

BCVI STROKE RATES

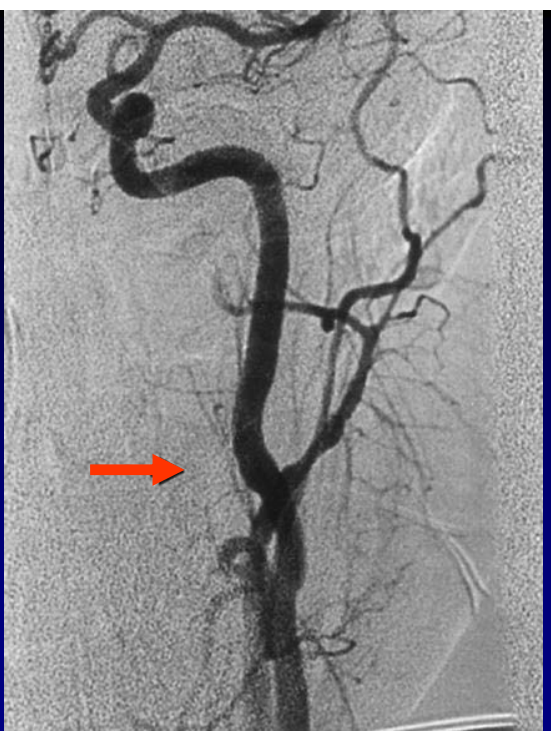
Worst Grade	BCI Stroke	BVI Stroke
I		
II		
III		
IV		
V		

BCVI STROKE RATES

Worst Grade	BCI Stroke	BVI Stroke
I	8%	
II	14%	
III	26%	
IV	50%	
V	100%	

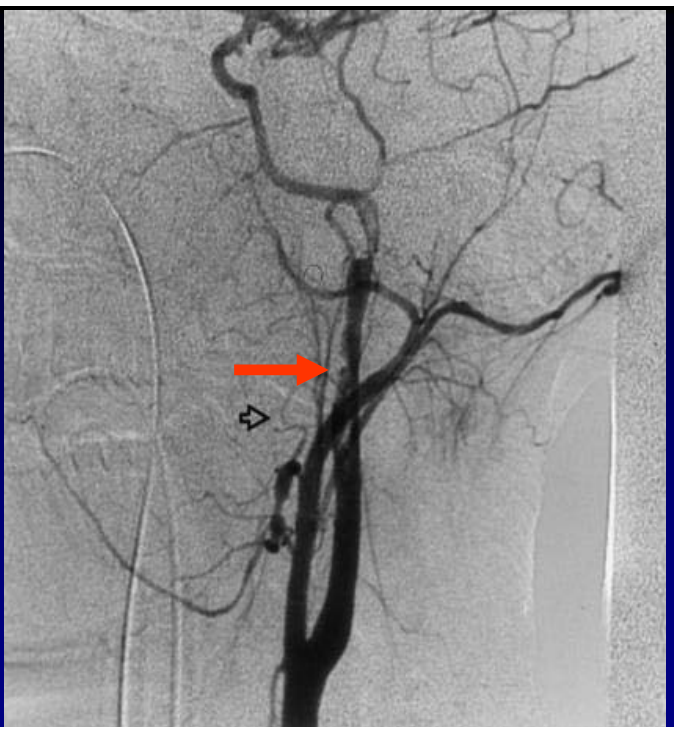
BCVI STROKE RATES

Worst Grade	BCI Stroke	BVI Stroke
I	8%	6%
II	14%	38%
III	26%	27%
IV	50%	28%
V	100%	-

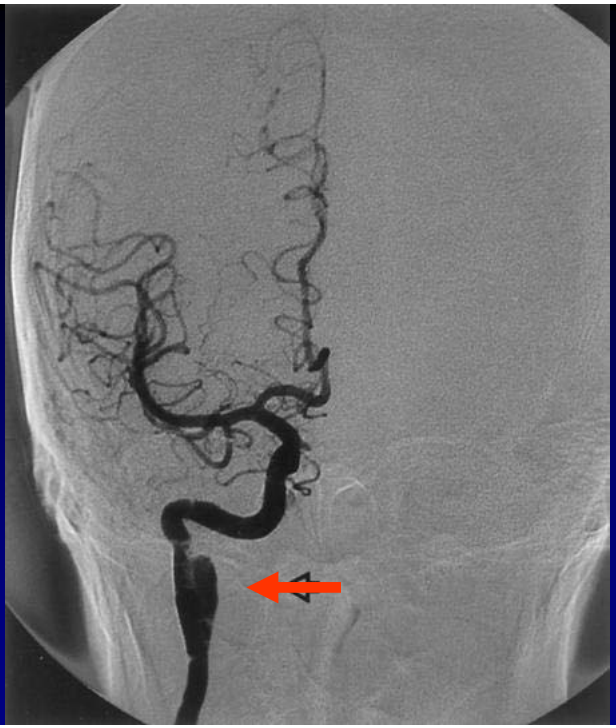


Grade I

Grade II



Grade II



Grade III

Grade IV

Grade V

SUMMARY

1. Heparin and Antiplatelet Therapy Appear Equivalent in Healing of Injuries
2. Heparin May be More Effective Than Antiplatelet Therapy in Neurologic Improvement and Stroke Prevention
3. Follow-up Arteriography Changes Treatment in 65% of Grade I and 51% of Grade II Injuries, and Helps Plan Therapy in Grade III Injuries

BCVI MANAGEMENT GUIDELINES

- Signs / Symptoms Mandate Emergent Cervical Arteriography
- High Risk Mechanism or Injuries Warrant Screening for BCVI
- 4-Vessel Cerebral Arteriography is Diagnostic Gold Standard
- 16-Slice CTA Has Become the Preferred Screening Test

BCVI MANAGEMENT GUIDELINES

- Surgical Repair of Accessible Grade II - V Lesions
- Nonoperative Management if Severe Fixed Neurologic Deficit, Coma, or Infarction
- Anticoagulation for Inaccessible Gr I - IV Lesions Unless Contraindicated

ANTICOAGULATION GUIDELINES

- Heparin 15 U/kg/hr; No Bolus
- PTT 40-50 Seconds
- Antiplatelet Rx if Contraindications
- F/U Angio 7-10 Days
- Long-Term Coumadin vs Antiplatelet Rx

Prospective Comparison

ENDOVASCULAR TREATMENT GUIDELINES

- Embolization or Balloon Occlusion for Inaccessible Gr V
- Endovascular Stents for Severe Gr II or Persistent Gr III, but Must be Studied under Controlled Protocols
- Stent 7-10 Days Postinjury, Anticoagulate

CAROTID ARTERY STENTS - RISKS EXCEED BENEFITS

46 Grade III BCI

23 Stents

4 (17%) Complications (3 CVA, 1 SCA Dissection)

8 (45%) Occlusion

1 CVA, 95% Patency with Antithrombotic Rx

Cothren, Arch Surg 2005