Non-missile penetrating head injuries

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University of Stellenbosch
Tygerberg Academic Hospital
South Africa
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Background

Non-missile penetrating head injuries are a specific subset of penetrating head injuries

Focal brain injury along tract of penetrating object.

Missile generally travel at more than 100m/s – injury due to the penetrating tract as well as kinetic energy of missile.

Different to machete/axe – large area of crushing injury not just tract.

Intracranial pathology following stab: tract haematoma, ICH, SDH, EDH, vascular injuries, sepsis.
Background

**Apparent decrease** in incidence **in developed world**, possibly replaced with gunshot wounds and overall decrease in trauma.

**Incidence maintained in developing world** or just South Africa in particular.

**Lack of consensus** in literature as to **optimal management** strategy.

**Little recent data** published.
Penetrating Stab Wounds to the Brain: The Timing of Angiography in Patients Presenting with the Weapon Already Removed

*Du Trevou, Michael D. F.C.S.(S.A.); Van Dellen, James R. F.R.C.S., Ph.D.(Med.)*

*Neurosurgery* November 1992

Patients with retained transcranial knife blades: a high-risk group

*Allan G. Taylor, M.B.,Ch.B., F.C.S.(S.A.), and Jonathan C. Peter, M.B.,Ch.B., F.R.C.S.(Edin)*

*Department of Neurosurgery, Groote Schuur Hospital, University of Cape Town, Cape Town, South Africa*  
*J Neurosurg* 87:512–515, 1997

Vascular lesions due to transcranial stab wounds

*Kieck CF, De Villiers JC.*

*J Neurosurgery* 60:42-46, 1984
Literature review

<table>
<thead>
<tr>
<th></th>
<th>Mortality</th>
<th>Infective complication</th>
<th>Vascular complication</th>
</tr>
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<tbody>
<tr>
<td>De Villiers</td>
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Trans-orbital stabs reported to have higher incidence of vascular complications

Stabs crossing a mucosal surface reported to have higher risk of infective complications
3 Factors to consider:

Primary Injury
Vascular complications
Septic complications

What are the **risk factors** for developing vascular and infective complications?

**Can we alter these risk factors** or our management to reduce the occurrence of these complications and **improve outcome**?
Methods

• Retrospective chart review
  • Tygerberg Hospital (TBH)
  • 1 August 2011 until 31 July 2018.

• Clinical records, laboratory results and radiology imaging examined.

• Outcome data

• Any patient with incomplete data was excluded.

• Statistical analysis through various models
Results

187 Patients
96% Male
70% left sided stabs
Surgery to evacuate a mass lesion = 30%
Overall mortality = 9%
Infective complications = 14%
Vascular complications = 18%
Results

Retained blade

Number of patients = 30 (16%)
Infective complications = 7 (23%)
Only 1 patient presented intubated.
Mortality = 1 (3%)
GOS 5 on discharge = 26 (87%)
## Results

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<td>29%</td>
</tr>
<tr>
<td>Harrington</td>
<td>9%</td>
<td>14%</td>
<td>18%</td>
</tr>
</tbody>
</table>
Results

Deaths = 9%

76% of **patients who died** presented intubated
59% brainstem / basal ganglia
1 patient was GCS 15/15 on admission
   Trans-orbital stab, sudden drop to GCS 3
vascular event
Infective complications

**No deaths** related to intracranial sepsis

Variables associated with increased infection rate
- Antibiotic prophylaxis
- Delayed presentation
- Involvement of mucosal surface
- Retained blade
## Infective complications

### Univariate risk analysis

<table>
<thead>
<tr>
<th>Risk factor</th>
<th>Association with infection</th>
<th>P-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Antibiotic Prophylaxis</td>
<td>Significantly associated</td>
<td>0.001</td>
</tr>
<tr>
<td>Time to referral</td>
<td>Significantly associated</td>
<td>0.0001</td>
</tr>
<tr>
<td>Involvement of mucosal surface</td>
<td>Not associated</td>
<td>0.09</td>
</tr>
<tr>
<td>Retained blade</td>
<td>Not associated</td>
<td>0.13</td>
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</table>
## Infective complications
Multinomial logistic regression

<table>
<thead>
<tr>
<th>Risk factor</th>
<th>RR</th>
<th>P-value</th>
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</thead>
<tbody>
<tr>
<td>Time to referral &gt; 24hrs</td>
<td>3.6</td>
<td>0.048</td>
</tr>
<tr>
<td>Time to referral &gt; 144 hrs</td>
<td>10.9</td>
<td>0.003</td>
</tr>
<tr>
<td>AB prophylaxis</td>
<td>0.28</td>
<td>0.024</td>
</tr>
<tr>
<td>Retained blade</td>
<td>5.5</td>
<td>0.015</td>
</tr>
<tr>
<td>Mucosal surface</td>
<td>2.54</td>
<td>0.169</td>
</tr>
</tbody>
</table>
SEPSIS - Time to referral

Lowess smoother

Day 6

24 hours
Vascular complications

**Risk factors** for vascular injury:
- Stab location
- Depth of stab
- Deep subarachnoid haemorrhage
- Tract crossing Circle of Willis, Sylvian fissure, ACA or PCA
- Intracerebral haematoma (bigger than tract)
Vascular Complications

33 vascular complications identified (18%)

<table>
<thead>
<tr>
<th>Vascular injury</th>
<th>No.</th>
<th>%</th>
</tr>
</thead>
<tbody>
<tr>
<td>Aneurysm</td>
<td>16</td>
<td>48</td>
</tr>
<tr>
<td>Cut-off</td>
<td>10</td>
<td>31</td>
</tr>
<tr>
<td>Vasospasm</td>
<td>5</td>
<td>15</td>
</tr>
<tr>
<td>CCF</td>
<td>2</td>
<td>6</td>
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</table>
## Vascular complications

**Univariate risk analysis**

<table>
<thead>
<tr>
<th>Risk factor</th>
<th>Association with infection</th>
<th>P-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Stab location</td>
<td>Not associated</td>
<td>0.124</td>
</tr>
<tr>
<td>Depth of stab</td>
<td>Not associated</td>
<td>0.108</td>
</tr>
<tr>
<td>Deep SAH</td>
<td>Significantly associated</td>
<td>0.0001</td>
</tr>
<tr>
<td>Vascular territories</td>
<td>Significantly associated</td>
<td>0.0001</td>
</tr>
<tr>
<td>ICH &gt; tract</td>
<td>Significantly associated</td>
<td>0.031</td>
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</table>
## Vascular complications
### Multiple logistic regression model

<table>
<thead>
<tr>
<th>Risk factor</th>
<th>OR</th>
<th>P-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Transorbital stab</td>
<td>6.0</td>
<td>0.041</td>
</tr>
<tr>
<td>Depth of stab</td>
<td>1.5</td>
<td>0.57</td>
</tr>
<tr>
<td>Deep SAH</td>
<td>4.5</td>
<td>0.003</td>
</tr>
<tr>
<td>Vascular territories</td>
<td>4.5</td>
<td>0.038</td>
</tr>
<tr>
<td>ICH &gt; tract</td>
<td>1.4</td>
<td>0.520</td>
</tr>
</tbody>
</table>
Retained object

Pre-requisites:
Empty OR
Open CT Scanner

CT Scan
GCS 15/15?

Yes
Is the blade in proximity to a major vessel?

Yes
GA
DSA
Removal in angio suite
DSA

No
OR
Awake removal

“pull out” not feasible

Removal by craniotomy

No
GA
DSA
Removal in angio suite
DSA

Follow up
Clinical for all
When increased risk of infection:
Bloods, CTB

All patients prophylactic antibiotics and primary wound care
Follow up angiography

Follow up
Clinical for all
When increased risk of infection:
Bloods, CTB

All patients prophylactic antibiotics and primary wound care

CTA

CT Scan

High risk of vascular injury

Yes

No

Treatment of vascular injury

Delayed angiography (Timing?)

Follow up angiography

Clinical management
All patients **prophylactic antibiotics** and primary wound care

Follow up
Clinical for all
When increased risk of infection:
Bloods, CTB
Discussion

• Imperative to **prevent complications**
• **All patients** should have an **initial CTB**
• **Prompt referral** from primary centres
• Infective complications:
  • **Antibiotic prophylaxis** should be given
  • Primary wound care
  • **Plateau in rate of infective** complications at **6 days**
    • may provide guide in terms of management and follow up.
Discussion

• Vascular complications:
  • Endovascular treatment invaluable in management of retained blades and vascular lesions.
  • Is angiography necessary for all patients?
  • Follow-up angiography for high risk patients is advised - timing?

• Retained blades:
  • Blade removal can safely be performed without a craniotomy.
Conclusion

• Primary injury can be devastating but are mostly “forgiving”

• There is much we know from our experience and data, but much that we can still learn through good research.

• Not all stabs require the same treatment, management may be adapted depending on the risk factors present.
Cutting edge Neurosurgery

Thank you