Retrospective Analysis of Blunt Abdominal Trauma and Seatbelt Sign: The Hollow Viscus Injury Predictor Score (HPS)

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This study was conducted under a protocol reviewed and approved by the San Antonio Military Medical Center Institutional Review Board and in accordance with the approved protocol.
Background
Key Terms

- Blunt Abdominal Trauma (BAT)
- Hollow Viscus Injury (HVI)
- Exploratory Laparotomy, also known as ex-lap
- Seatbelt Sign (SBS)
Introduction

- Difficult to diagnose hollow viscus injury
- Management based on judgment
- Hollow viscus injury can be missed
  - High mortality (10-28%) & morbidity (44%)
Background: Seatbelt Sign

First Injury Reported 1956

Appears In Literature 1962

Lap Belts 1964

3 Point Restraints 1973

Retrospective Analysis of Blunt Abdominal Trauma and Seatbelt Sign: The Hollow Viscus Injury Predictor Score (HPS)
Seatbelt Sign

- Classic injury pattern
- 10-15% HVI incidence
- Most common HVI is in small bowel
Background: Diagnosis

Retrospective Analysis of Blunt Abdominal Trauma and Seatbelt Sign: The Hollow Viscus Injury Predictor Score (HPS)
Background

• Exploratory laparotomy for unstable patients
• Nontherapeutic ex-lap rates up to 23-53% in BAT
• Role of nonoperative management
Objectives

Retrospective Analysis of Blunt Abdominal Trauma and Seatbelt Sign: The Hollow Viscus Injury Predictor Score (HPS)
The “WHY?”

• Lack of pathway to diagnose HVI
• Need for a tool to identify HVI

Determine if the hollow viscus injury predictor score (HPS) was higher in patients with a known hollow viscus injury (HVI)
Methods

Retrospective Analysis of Blunt Abdominal Trauma and Seatbelt Sign: The Hollow Viscus Injury Predictor Score (HPS)
Literature Review

- **Blunt abdominal trauma**: 13,008 Peer Reviewed Articles
- **Seatbelt sign or injury**: 2,280 Peer Reviewed Articles
- **Hollow viscus injury**: 1,010 Peer Reviewed Articles
- **Laparotomy**: 32 Peer Reviewed Articles
- **Adult**: 12 Peer Reviewed Articles

Retrospective Analysis of Blunt Abdominal Trauma and Seatbelt Sign: The Hollow Viscus Injury Predictor Score (HPS)
Retrospective case-control study that examined 2,632 BAT patients matched by age and injury severity with a HVI compared to those without.

- Admission exam, imaging, labs, and diagnostic modalities were examined alone and in combination.
- Peritonitis 81% specific.
The use of computed tomography imaging for abdominal seatbelt sign: A single-center, prospective evaluation

Patrick T. Delaplain a,*, Cristobal Barrios b, Dean Spencer a, Michael Lekawa b, Sebastian Schubl b, Austin Dosch a, Areg Grigorian a, Megan Smith c, Marija Pejcinovska c, Jeffry Nahmias b

a Department of Surgery, University of California, Irvine Medical Center, United States
b Division of Trauma, Burns and Critical Care, University of California, Irvine Medical Center, United States
c Center for Statistical Consulting, University of California, Irvine, United States

• Prospectively examined 220 adult trauma patients admitted with an abdominal SBS
• Examined CT findings and other admission data (vital signs, exam, & labs) to identify HVI

• Hypotension and leukocytosis with HVI

Retrospective Analysis of Blunt Abdominal Trauma and Seatbelt Sign: The Hollow Viscus Injury Predictor Score (HPS)
Literature Review

Early surgical intervention for blunt bowel injury: The Bowel Injury Prediction Score (BIPS)

Michelle K. McNutt, MD, Naga R. Chinapuvvula, MD, Nicholas M. Beckmann, MD, Elizabeth A. Camp, PhD, Matthew J. Pomerening, MD, Rece W. Laney, MS, O Clark West, MD, Brijesh S. Gill, MD, Rosemary A. Kozar, MD, PhD, Bryan A. Cotton, MD, MPH, Charles E. Wade, PhD, Phillip R. Adams, MD, and John B. Holcomb, MD, Houston, Texas

• Retrospectively examined 110 BAT patients
• Created the Bowel Injury Predictor Score (BIPS) to identify HVI
  • WBC ≥ 17, abdominal tenderness to palpation (TTP), and CT scan
• Leukocytosis & TTP significant in HVI
HVI Predictor Score

- Hypotension
  - Delaplain: BP lower in HVI ($p < .001$)

- Leukocytosis
  - Delaplain: WBC count higher in HVI ($p = .013$)
  - McNutt: WBC $\geq 17$ with HVI ($p = .003$)

- Abnormal abdominal exam finding
  - McNutt: tenderness (TTP) clinically significant ($p < .001$)
  - McNutt: TTP combined with elevated WBC $\Rightarrow$ HVI was 19x higher
  - Williams: peritonitis highly specific (81%)

Retrospective Analysis of Blunt Abdominal Trauma and Seatbelt Sign: The Hollow Viscus Injury Predictor Score (HPS)
HVI Predictor Score

<table>
<thead>
<tr>
<th></th>
<th>Yes</th>
<th>No</th>
</tr>
</thead>
<tbody>
<tr>
<td>SBP (≤ 110)</td>
<td>1</td>
<td>0</td>
</tr>
<tr>
<td>WBC (≥ 17)</td>
<td>1</td>
<td>0</td>
</tr>
<tr>
<td>Abnormal Abdominal Exam</td>
<td>1</td>
<td>0</td>
</tr>
</tbody>
</table>

Hypothesis:
Those **with a HVI** will have an **increased HPS** compared to those **without (nHVI)**
Methods: Study Design

• Single-center retrospective cohort analysis
• All adult trauma patients (age 18 or older)
• Inclusion:
  • ≥ 18 years old
  • Blunt abdominal trauma with a seatbelt sign
• Exclusion:
  • Penetrating abdominal trauma
  • Pregnant
  • Emergency resuscitative thoracotomy
  • Death within 60 minutes of arrival
  • Surgery at an outside facility prior to arrival
  • Unstable needing emergency surgery
All Trauma admissions
Jan 1, 2016 – July 31, 2020

- Penetrating abdominal trauma
- Blunt, > 18 years old
- No SBS
- With SBS
  - Exclusion Criteria
  - HVI
  - nHVI

Retrospective Analysis of Blunt Abdominal Trauma and Seatbelt Sign: The Hollow Viscus Injury Predictor Score (HPS)
Methods

• The dependent variable and primary outcome was **presence of HVI**

• Independent variable was our **HPS**

• Secondary Variables
  • Laparotomy
  • Abdominal pain
  • Specific abdominal exam findings
Statistical Analysis

• Continuous data
  • Summarized using means and standard deviations or **medians** and **inter-quartile ranges**
  • Analyzed using a **Student’s T-Test** and ANOVA or **Wilcoxon’s Test**

• Categorical data
  • Summarized using **count and percentages**
  • Analyzed for association between the variables using **Chi-Squared** or Fisher’s exact test
Logistical regression was performed to determine independent prognostic factors for diagnosis of a HVI
  • Odds ratio with 95% Confident Interval (CI)

Receiver Operating Characteristic (ROC) performed to analyze discrimination accuracy of independent variable
  • Area under the curve (AUC) with 95% CI
Retrospective Analysis of Blunt Abdominal Trauma and Seatbelt Sign: The Hollow Viscus Injury Predictor Score (HPS)
Results
# Demographics

<table>
<thead>
<tr>
<th>Demographics</th>
<th>HVI $(n = 18)$</th>
<th>nHVI $(n = 126)$</th>
<th>p-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age (y)</td>
<td>47.5</td>
<td>45.5</td>
<td>.686</td>
</tr>
<tr>
<td>Male (%)</td>
<td>9 (50)</td>
<td>63 (50)</td>
<td>1</td>
</tr>
<tr>
<td>BMI (kg/m²)</td>
<td>32.02</td>
<td>32.77</td>
<td>.477</td>
</tr>
<tr>
<td>ISS</td>
<td>14.5</td>
<td>9</td>
<td><strong>.002</strong></td>
</tr>
</tbody>
</table>
Primary Outcome

<table>
<thead>
<tr>
<th></th>
<th>HVI (n = 18)</th>
<th>nHVI (n = 126)</th>
<th>P-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>HPS Score</td>
<td>1.28 ± .85</td>
<td>.82 ± .72</td>
<td>.008*</td>
</tr>
</tbody>
</table>

Data expressed as mean ± standard deviation
*Statistically significant (p < .05)
Secondary Outcomes

Retrospective Analysis of Blunt Abdominal Trauma and Seatbelt Sign: The Hollow Viscus Injury Predictor Score (HPS)
### Secondary Outcomes

**Retrospective Analysis of Blunt Abdominal Trauma and Seatbelt Sign: The Hollow Viscus Injury Predictor Score (HPS)**

<table>
<thead>
<tr>
<th></th>
<th>HPS 0 (n = 48)</th>
<th>HPS 1 (n = 66)</th>
<th>HPS ≥ 2 (n = 30)</th>
<th>P-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>HVI</td>
<td>3 (17)</td>
<td>8 (44)</td>
<td>7 (39)</td>
<td>.035*</td>
</tr>
<tr>
<td>nHVI</td>
<td>45 (35)</td>
<td>58 (46)</td>
<td>23 (18)</td>
<td></td>
</tr>
</tbody>
</table>

*Note. Each cohort had 1 patient with HPS score of 3.*

Data expressed as number (%)

*Statistically significant (p < .05)
## Secondary Outcomes

### Hollow Viscus Injury Predictor Score (HPS)

<table>
<thead>
<tr>
<th>HPS Score</th>
<th>OR</th>
<th>95% CI</th>
<th>P-value</th>
<th>AUC</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 vs 0</td>
<td>3.47</td>
<td>(0.71 – 16.90)</td>
<td>.123</td>
<td></td>
</tr>
<tr>
<td>≥ 2 vs 0</td>
<td>6.70</td>
<td>(1.29 – 34.88)</td>
<td>.024*</td>
<td>.665 (p = .042*)</td>
</tr>
</tbody>
</table>

*Statistically significant (p < .05)*

### Injury Severity Score (ISS)

<table>
<thead>
<tr>
<th>Factor</th>
<th>OR</th>
<th>95% CI</th>
<th>P-value</th>
<th>AUC</th>
</tr>
</thead>
<tbody>
<tr>
<td>ISS</td>
<td>1.01</td>
<td>(1.03 – 1.16)</td>
<td>.001*</td>
<td>.767 (p &lt; .001*)</td>
</tr>
<tr>
<td>HPS</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1 vs 0</td>
<td>2.79</td>
<td>(.55 – 14.24)</td>
<td>.217</td>
<td></td>
</tr>
<tr>
<td>≥ 2 vs 0</td>
<td>5.86</td>
<td>(1.08 – 31.76)</td>
<td>.040*</td>
<td></td>
</tr>
</tbody>
</table>

*Statistically significant (p < .05)*
## Secondary Outcomes

### Retrospective Analysis of Blunt Abdominal Trauma and Seatbelt Sign: The Hollow Viscus Injury Predictor Score (HPS)

<table>
<thead>
<tr>
<th>Cutoff Point</th>
<th>True Positives</th>
<th>True Negatives</th>
<th>Coordinates of the ROC curve</th>
<th>False Positives</th>
<th>P-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>16</td>
<td>44</td>
<td>Sensitivity</td>
<td>89%</td>
<td>.136</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Specificity</td>
<td>37%</td>
<td></td>
</tr>
<tr>
<td>≥ 2</td>
<td>7</td>
<td>103</td>
<td>False Positives</td>
<td>63%</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>P-value</td>
<td>.233</td>
<td></td>
</tr>
</tbody>
</table>

*Note.* A HPS of ≥ 2 had a negative predictive value (NPV) of 90% and a positive predictive value (PPV) of 23% for a HVI.
Discussion/Conclusion

Retrospective Analysis of Blunt Abdominal Trauma and Seatbelt Sign: The Hollow Viscus Injury Predictor Score (HPS)
Discussion

<table>
<thead>
<tr>
<th></th>
<th>Literature</th>
<th>Ours</th>
</tr>
</thead>
<tbody>
<tr>
<td>BAT</td>
<td>12%</td>
<td>11.2%</td>
</tr>
<tr>
<td>HVI in trauma</td>
<td>1%</td>
<td>1.1%</td>
</tr>
<tr>
<td>HVI in BAT with SBS</td>
<td>10-15%</td>
<td>12.5%</td>
</tr>
</tbody>
</table>

HVI Injuries

- Small Bowel: 44%
- Large Bowel: 31%
- Mesentery: 25%

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Discussion

- HPS higher and predictive of HVI

- HPS ≥ 2 had an AUC .76 (p < .001)
  - Sensitivity 39%, specificity 82%, & NPV 90%

- BIPS ≥ 2 had AUC .81
  - Sensitivity 86%, specificity 76%, & NPV 89%
Secondary Outcomes

Retrospective Analysis of Blunt Abdominal Trauma and Seatbelt Sign: The Hollow Viscus Injury Predictor Score (HPS)
Conclusion

• Fills the gap in literature

• Not only statistically significant, but clinically relevant

• HPS is a useful tool
References


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Retrospective Analysis of Blunt Abdominal Trauma and Seatbelt Sign: The Hollow Viscus Injury Predictor Score (HPS)
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Recommendations

<table>
<thead>
<tr>
<th></th>
<th>Yes</th>
<th>No</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>SBP</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>100-110 mmHg</td>
<td>1</td>
<td>0</td>
</tr>
<tr>
<td>91-99 mmHg</td>
<td>2</td>
<td></td>
</tr>
<tr>
<td>≤ 90 mmHg</td>
<td>3</td>
<td></td>
</tr>
<tr>
<td><strong>WBC</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>17-18.99</td>
<td>1</td>
<td>0</td>
</tr>
<tr>
<td>19.01-20.99</td>
<td>2</td>
<td></td>
</tr>
<tr>
<td>≥ 21</td>
<td>3</td>
<td></td>
</tr>
<tr>
<td><strong>Abnormal Abdominal Exam</strong></td>
<td>1</td>
<td>0</td>
</tr>
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