Sensory Organization Testing (SOT) and the Sport Concussion Assessment Tool (SCAT) are routinely used to assess impaired balance in patients following concussion.

The SCAT is useful to evaluate patient symptoms post-concussion but is not recommended to be used on its own to make or exclude a diagnosis of concussion.

In a previous study, SOT composite scores more clearly separated concussion patients from healthy patients compared to other concussion assessment tools.

This study examined differences in SOT and SCAT scoring based on the timing of concussions relative to a single visit and, separately, the scores of each respective assessment between multiple visits.

We hypothesize that:
- Among single-visit patients, SOT scores will be lower and SCAT symptom scores will be higher with fewer days elapsed since concussion
- Both SOT and SCAT scores will improve with time among patients seen for multiple visits
- With increasing SCAT symptom scores, SOT composite scores will decrease

Tracking patterns of balance-related symptoms and measurable deficits in patients with concussion will be important to maximize the utility of Osteopathic Manipulative Medicine (OMM) for treatment.
This study is a retrospective chart review. Data were derived from a database of patients who received (SOT) at the Academic Healthcare Center (AHCC) in Old Westbury, NY between 9/1/15 and 6/18/19. Subjects were included if they had received an ICD9/10 diagnosis of concussion as verified in electronic medical records (EMR). Subjects were excluded if they received SOT for non sports-related concussions or other clinical indications (i.e. Parkinson’s disease). Corresponding SCAT symptom severity scores, as well as those scores from SOT and SCAT at follow-up visits, if applicable, were recorded. The study was approved by the New York Institute of Technology Institutional Review Board (BHS-1167).

METHODS

- This study is a retrospective chart review.
- Data were derived from a database of patients who received (SOT) at the Academic Healthcare Center (AHCC) in Old Westbury, NY between 9/1/15 and 6/18/19.
- Subjects were included if they had received an ICD9/10 diagnosis of concussion as verified in electronic medical records (EMR).
- Subjects were excluded if they received SOT for non sports-related concussions or other clinical indications (i.e. Parkinson’s disease).
- Corresponding SCAT symptom severity scores, as well as those scores from SOT and SCAT at follow-up visits, if applicable, were recorded.
- The study was approved by the New York Institute of Technology Institutional Review Board (BHS-1167).

DATA ANALYSIS

- Data analysis was completed using Microsoft Excel and RStudio
- Patients were separated into those who were seen for one visit or more than one visit at the AHCC for concussive events.
- Among patients who were seen for more than one visit, SOT and SCAT scores were compared via one-way analysis of variance (ANOVA).
RESULTS

SINGLE VISIT

- Average SOT composite and SCAT scores for single visit patients were 74.74 (SD = 9.52) and 18.21 (SD = 18.52), respectively.
- SOT vs SCAT showed an inverse relationship between these variables for single-visit patients (\(y = -0.295x + 80.108, R^2 = 0.3295\)).

MULTIPLE VISIT

- Among multiple-visit patients, SOT scores increased between their first, second, and third visits (mean \([SD] = 77.6 [10.5], 84.42 [7.01], and 88.4 [1.14], respectively; p < 0.01\)).
- SCAT scores decreased between their first, second, and third visits (mean \([SD] = 36.8 [26.05], 20.42 [27.46], and 14.8 [27.65], respectively; p <0.05\)).
- SOT vs SCAT showed an inverse relationship between these variables for multiple-visit patients’ first visit (\(y = -0.0987x + 81.233, R^2 = 0.06\)).
- However, a direct relationship was shown between SOT and SCAT for second and third visits (\(y = 0.0368x + 83.669, R^2 = 0.0208\) and \(y = 0.0158x + 88.166, R^2 = 0.1473\), respectively).

Table 1. Study participant demographics.

<table>
<thead>
<tr>
<th>Group</th>
<th>Single Visit</th>
<th>Multiple Visits</th>
</tr>
</thead>
<tbody>
<tr>
<td>n</td>
<td>38</td>
<td>15</td>
</tr>
<tr>
<td>Age (mean)</td>
<td>19.9</td>
<td>19.5</td>
</tr>
<tr>
<td>Gender (%)</td>
<td>Male 73</td>
<td>Female 27</td>
</tr>
<tr>
<td>Sport</td>
<td>See Figure 4</td>
<td>See Figure 5</td>
</tr>
</tbody>
</table>

Table 2. Average time, SCAT, and SOT for study groups.

<table>
<thead>
<tr>
<th>Group</th>
<th>Single Visit</th>
<th>Multiple Visits</th>
</tr>
</thead>
<tbody>
<tr>
<td>Days post concussion (mean)</td>
<td>6.28</td>
<td>10.91</td>
</tr>
<tr>
<td>Days between visits (mean)</td>
<td>N/A</td>
<td>4.09</td>
</tr>
<tr>
<td>SCAT Severity (mean)</td>
<td>18.21</td>
<td>36.8</td>
</tr>
<tr>
<td>SOT Composite (mean)</td>
<td>74.74</td>
<td>77.6</td>
</tr>
</tbody>
</table>

Figure 4. Single visit patients’ sport participation.

Figure 5. Multiple visit patients’ sport participation.

Figure 6. Single visit patients’ SOT by SCAT scores.

Figure 7. Multiple visit patients’ SOT by SCAT scores.
These findings help illustrate the patterns of SOT and SCAT scores measured in single and multiple visits to the AHCC following concussion.

These data could be enhanced through more consistent use of both SOT and SCAT at every visit following concussion.

As expected, scores reflected more impairment (higher SCAT and lower SOT) at first visits and improvement in each parameter in following visits.

The trends of SOT and SCAT scores become more discrepant with time in serial visits post-concussion, raising the possibility that they differ in their reliability as diagnostic tools to help clinicians treat concussion.

These results suggest that SOT scores do not entirely reflect the trends seen in subjective symptom scoring following concussion.

Physicians using OMM to treat patients with concussions should be aware of the differences in SOT and SCAT trends for patients with multiple visits if using such tests to evaluate treatment effectiveness.

CONCLUSION

LIMITATIONS

Small sample size, particularly among patients with multiple visits.

Self-reporting bias with SCAT symptom severity scoring.

Possible "learning effect" with SOT resulting in improved scores for patients who have received multiple SOT previously.\(^3\)

While SOT measures balance impairment, SCAT scores include both balance- and non-balance-related symptoms. As a result, comparison of SOT and SCAT is not optimal.

REFERENCES

Figure 1. Sample SOT score report. SOT is a machine which measures the postural stability of an individual. The test includes six conditions with varying visual, proprioceptive, and vestibular cues to assess changes in posture and body sway.

Figure 2. Sample SCAT evaluation form. This form is given to patients and they are asked to rate each symptom on a scale from 0-6. Symptom ratings are totaled to provide the symptom severity score utilized in this study.
Figure 4. "Other" category includes 5% from each sport Baseball, Rugby, and Wrestling, and 3% from each sport Boxing, Cheerleading, Equestrian, Running, and Volleyball.

Figure 5. "Other" category includes equal representation from sports Basketball, Field Hockey, Rugby, Soccer, Volleyball, Wrestling, and Hockey.
Figure 6. Trendline shows an inverse relationship between SOT and SCAT scores. This means as symptoms improved (lower SCAT), the SOT machine showed less balance impairment (higher SOT).
Figure 7. Visit 1 trendline (black line) shows an inverse relationship between SOT and SCAT scores. This means as symptoms improved (lower SCAT), the SOT machine showed less balance impairment (higher SOT). However, Visit 2 (blue line) and Visit 3 (red line) trendlines show a direct relationship between SOT and SCAT scores. Therefore, when patients rated their symptoms as improving (lower SCAT), SOT showed more balance impairment (lower SOT).