Clinical Significance of the V-Shaped Space in the Subluxed Shoulder of Hemiplegics

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Recently, it has been proposed that shoulder subluxation in hemiplegia is accompanied by 1) the appearance of a V-shaped articular configuration occurring between the humeral head and glenoid fossa and 2) the presence of chronic pain. The main purpose of this study was to investigate the validity of these statements. We evaluated 40 hemiplegic subjects over 3 months. Radiographs of the affected and nonaffected shoulders were taken at both a frontal plane (0°) and a 45° incidence. From these patients, subluxed (n=19) and nonsubluxed (n=21) groups were formed. Pain was evaluated using the Present Pain Intensity index of the McGill Pain Questionnaire. On these x-ray films, measurements were taken of the V-shaped space, abduction of the arm, and rotation of the scapula. The statistical analysis (analysis of variance for repeated measures) contrasted the results obtained from the nonaffected side with those from the affected side over the 3 months studied. At the 45° angle, which better exposes the articular configuration of the shoulder, the difference in the V angle between the affected and nonaffected shoulders was significant (p<0.01), indicating that such a V-shaped space can be identified. The measures taken also indicate that a downward subluxation of the humeral head occurs relative to the scapula without any systematic abduction of the humerus or downward rotation of the scapula. None of the results obtained from the frontal plane x-ray films was significant. Finally, no significant relation was found between subluxation and shoulder pain. (Stroke 1991;22:867–871)

The literature on hemiplegia suggests that a subluxed shoulder is accompanied by an abduction of the arm and a downward rotation of the scapula. It has recently been proposed that these clinical observations are accompanied by the appearance of a V-shaped articular configuration occurring between the humeral head and the glenoid fossa. The suggestion was made that such a V-shaped configuration could be considered as a clinical sign indicating the development of a shoulder subluxation. Such a sign would obviously be attractive as a clinical tool if it is strongly associated with the presence or development of shoulder subluxation, an important clinical problem in hemiplegia.

Furthermore, it has been suggested that the presence of this V sign is strongly associated with the presence of chronic pain at the level of the subluxed shoulder. From the χ² value of 8.1 obtained by Shai et al while contrasting these two variables, we calculated a Φ (coefficient of association) of 0.68, a value rather significant. Clinically, however, one can argue against this finding since it is well known that a patient can develop a subluxed shoulder without having pain. This issue of shoulder pain in hemiplegia is in itself a topic lacking clear answers based on scientific evidence.

The purpose of this study was to investigate the validity of this V sign. Furthermore, its association with pain was evaluated using one index taken from the McGill Pain Questionnaire. Subjects and Methods

Forty hemiplegic subjects (22 men and 18 women with a mean±SD age of 46.5±13.8 years) participated in this study. Nineteen subjects were right hemiplegics. They were evaluated before, during, and after treatment over a period of approximately 3 months.

With the subject seated, arms dependent in a neutral position, radiographs of the affected and nonaffected shoulders were taken in an anteroposterior (A–P) projection as well as with the beams at 45° (i.e., parallel to the glenoid fossa). Two anatomic
angle made by a line passing through the superior
scribed previously, such a procedure had to be
defining, and after treatment shoulders. In this way, a
sign was performed on the data of the nonaffected
formance in measuring the presence of the V-shaped
the state of the glenohumeral joint. A perpendicular line was drawn
enior border of the glenoid fossa (D); inferior portion of
from the apex of the humeral head to a horizontal
line passing through the inferior border of the glenoid fossa
with an average difference of about
was called $\theta_1$. These anatomic reference points were
chosen on the basis that they are easily identified on
most x-ray films. As well, since the two lines forming
the angle have no point in common on a given
segment, they are independent, thus offering a best
estimate of the angle sought. The angle of rotation of
the scapula is evaluated as the angle made by a line
passing through the superior and inferior borders of the
glenoid fossa and the horizontal line already
recorded on the film. This angle is identified as $\theta_2$.
The angle of abduction of the humerus is estimated
by the angle made by a line passing longitudinally
through the center of the humerus and the horizontal
line. This angle is identified as $\theta_3$. The center of the
humeral head (E in Figure 1) was estimated as being
the center of a circle that would best fit the humeral
head. It should be noted here that $\theta_2$ and $\theta_3$ are
made to be independent measures. Thus, the
measurement of one is not affected by changes occurring
in the other. Finally, another measure, $\theta_4$, was taken.
This angle is defined as being made by a line passing
through the inferior and superior borders of the
glenoid fossa and a line passing through the inferior
border of the glenoid fossa and a point on the head of the
humerus on which this line falls tangentially.
These two lines have one reference point in common
(the inferior border of the glenoid fossa) and in this
way may be perceived as being dependent. Thus, $\theta_4$
is to be contrasted with $\theta_1$ for their respective sensitivities
in measuring the presence of the V-shaped
space. The procedures for positioning of the subject
and taking of the x-ray film have been reported
elsewhere.

The Present Pain Intensity (PPI) index of the
McGill Pain Questionnaire was used to evaluate the
intensity of pain in this population. Scores on this
PPI index range from 0 (no pain) to 5 (severe pain).
Subjects who scored 0 to 1 were classified as having
no chronic pain. Those scoring 2, 3, 4, or 5 were
considered as having chronic pain. In this way a
2x2 contingency table of subluxed versus nonsubluxed
subjects and chronic versus no pain could be con-
structed, as had been done previously. All scores
were obtained by one or two evaluators trained in the
use of the PPI index.

Results

Table 1 presents the results obtained with
ANOVAs for a given level of significance ($\alpha=0.01$).
None of the results obtained from the A-P films was
significant. Because of the superposition of bony
structures of the shoulder, it was impossible in most
cases to calculate $\theta_4$ on the A-P film. However, on
the 45° angle films the difference in $\theta_1$ between the
affected and nonaffected shoulders was significant
for both groups, with an average difference of about
5°. Furthermore, $\theta_4$ showed significant differences
only for the subluxed group, thus showing sensitivity
to the subluxed state. Finally, the subluxed group had
a significant difference in $\theta_3$, with an average differ-

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**Figure 1. Schematic description of measurements taken to evaluate V-shaped space of glenohumeral joint ($\theta_1$ and $\theta_4$), rotation of scapula ($\theta_2$), and abduction of arm ($\theta_3$). A, superior border of glenoid fossa; B, line through A and H to horizontal; C, apex of humeral head; D, inferior portion of anatomic neck of humeral head; E, center of circle best fitting humeral head; F, line from E through center of humerus to horizontal; G, point on head of humerus containing tangent through H; H, inferior border of glenoid fossa.**
better discloses the articular configuration of the 45° angle. The latter exposes the shoulder more clearly for the measurements taken in this study except for shoulder abduction. This supports earlier findings that a radiograph taken at a certain angle better discloses the articular configuration of the shoulder than an A-P projection. However, clinical studies have often used A-P films to describe and analyze shoulder subluxation, a situation that needs to be corrected.

### Discussion

Even though our results reveal that a radiograph taken at a 45° angle may be more sensitive for evaluating the state of a hemiplegic shoulder, it is clear that the magnitude of the differences found is clinically unimportant. The $R^2$ values of Table 1 and the results of Table 2 disclose this fact for $\theta_1$, $\theta_2$, and $\theta_3$. Moreover, since both the subluxed and nonsubluxed groups presented a significant difference for presence of the V sign as measured by $\theta_1$, the validity of the sign in indicating a subluxation is questionable. Either this measure is not sensitive to this particular state of the shoulder or ANOVA for repeated measures is too sensitive to small differences that clinically are within the range of human error.

However, $\theta_4$ appeared to be more sensitive to presence of the V-shaped space in subluxed shoulders. Let us consider that abduction of the arm can be appropriately measured on an A-P film. As seen in Table 1, no abduction of the arm was observed in the A-P projection. Moreover, let us consider that the possible downward rotation of the scapula that is believed to occur with shoulder subluxation can be best measured on the 45° angle film since we can clearly observe the profile of the glenoid fossa. As seen in Table 1 again, $\theta_2$ did not reach the level of

### Table 1. Summary of Analyses of Variance Performed on $\theta_1$, $\theta_2$, $\theta_3$, and $\theta_4$ for Subluxed and Nonsubluxed Groups

<table>
<thead>
<tr>
<th>Angle</th>
<th>Frontal films</th>
<th>45° angle films</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Intraclass correlation coefficient</td>
<td>$R^2$</td>
</tr>
<tr>
<td>Nonsubluxed ($n=21$)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>$\theta_1$</td>
<td>2.67</td>
<td>0.05</td>
</tr>
<tr>
<td>$\theta_2$</td>
<td>0.34</td>
<td>0.01</td>
</tr>
<tr>
<td>$\theta_3$</td>
<td>0.22</td>
<td>0.00</td>
</tr>
<tr>
<td>$\theta_4$</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Subluxed ($n=19$)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>$\theta_1$</td>
<td>3.79</td>
<td>0.11</td>
</tr>
<tr>
<td>$\theta_2$</td>
<td>3.28</td>
<td>0.13</td>
</tr>
<tr>
<td>$\theta_3$</td>
<td>1.35</td>
<td>0.02</td>
</tr>
<tr>
<td>$\theta_4$</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

$\theta_1$ and $\theta_4$, V-shaped angle; $\theta_2$, rotation of scapula; $\theta_3$, abduction of arm. $^p<0.01$. The descriptive statistics for these results (45° angle films) are presented in Table 2.

The results of analyses testing the relation between presence versus absence of a subluxation and presence versus absence of chronic pain are reported in Table 3. From the value of $\chi^2$ we calculated a $\Phi$ of 0.10. This coefficient is nonsignificant and indicates that no relation exists between pain and subluxation.

Figure 2, top shows a radiograph of the affected shoulder of a patient taken in the A-P projection. Figure 2, bottom shows the same shoulder taken at a 45° angle. The latter exposes the shoulder more clearly for the measurements taken in this study except for shoulder abduction. This supports earlier findings that a radiograph taken at a certain angle better discloses the articular configuration of the shoulder than an A-P projection. However, clinical studies have often used A-P films to describe and

### Table 2. Descriptive Statistics Summarizing Data for $\theta_1$, $\theta_2$, $\theta_3$, and $\theta_4$ for Subluxed and Nonsubluxed Groups

<table>
<thead>
<tr>
<th>Angle</th>
<th>Nonaffected shoulder</th>
<th>Affected shoulder</th>
<th>Nonaffected shoulder</th>
<th>Affected shoulder</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Before treatment</td>
<td>During treatment</td>
<td>After treatment</td>
<td>Before treatment</td>
</tr>
<tr>
<td>$\theta_1$</td>
<td>Mean</td>
<td>22.7</td>
<td>28.2</td>
<td>27.5</td>
</tr>
<tr>
<td></td>
<td>SD</td>
<td>7.8</td>
<td>7.1</td>
<td>4.8</td>
</tr>
<tr>
<td>$\theta_2$</td>
<td>Mean</td>
<td>84.5</td>
<td>88.5</td>
<td>87.8</td>
</tr>
<tr>
<td></td>
<td>SD</td>
<td>6.9</td>
<td>5.0</td>
<td>4.6</td>
</tr>
<tr>
<td>$\theta_3$</td>
<td>Mean</td>
<td>98.3</td>
<td>98.4</td>
<td>98.2</td>
</tr>
<tr>
<td></td>
<td>SD</td>
<td>4.7</td>
<td>3.5</td>
<td>4.6</td>
</tr>
<tr>
<td>$\theta_4$</td>
<td>Mean</td>
<td>0.3</td>
<td>2.1</td>
<td>2.3</td>
</tr>
<tr>
<td></td>
<td>SD</td>
<td>5.7</td>
<td>5.6</td>
<td>4.7</td>
</tr>
</tbody>
</table>

$\theta_1$ and $\theta_4$, V-shaped angle; $\theta_2$, rotation of scapula; $\theta_3$, abduction of arm. Values are degrees, taken from 45° films.
significance. Consequently, the downward subluxation was not accompanied by a rotation of the scapula and an abduction of the humerus. This may explain why 01 did not detect the presence of the V-shaped space since the C-D line (Figure 1) was simply shifted downward along the A-B line, keeping its angle more or less constant. However, 04 disclosed this V-shaped space, which is created by a downward movement of the head of the humerus relative to the glenoid fossa, a movement followed by the tangential line G-H (Figure 1). This phenomenon can, according to our experience, be observed only on a 45° angle film and not on an A-P film or radiograph as proposed earlier. Our previous work on this topic disclosed the fact that rotation of the scapula and abduction of the arm are not phenomena systematically related to subluxation of the shoulder in hemiplegia. Even though these are interpreted as being clinically important signs by practitioners, scientific evidence has not yet been presented to support this belief.

The fact that pain is not statistically associated with subluxation is not really surprising (Table 3). Many factors other than subluxation can cause pain...
in hemiplegic shoulders.11-13 Furthermore, even patients with an impressive degree of subluxation may have no pain. Previous papers have at times been vague on how pain was quantified.3 It is our belief that the PPI index of the McGill Pain Questionnaire5 is applicable to a good proportion of the hemiplegic population, at least to that proportion that participates on a day-to-day basis in an intensive rehabilitation program. We are thus confident that our way of scoring the intensity of pain felt at the time of evaluation is more than acceptable for the present situation. The literature on shoulder pain in hemiplegia is, however, still awaiting answers and clarifications.

In conclusion, the search for a clinically valid sign3 and model1 to describe and understand the appearance and progression of shoulder subluxation is very commendable and necessary. However, any proposed sign and model need to be validated before being used in clinical practice. Our present attempt has been partially successful with regard to validating the previously proposed V sign3 and is complementary to our previous work on the topic.7,8

The complexity of the hemiplegic condition and the high variability between subjects for variables such as shoulder pain and shoulder subluxation have to be recognized by the clinician and the researcher alike.14,15 Thus, standardized evaluation protocols have to be developed, validated, and used by everyone in this field. Only then will our efforts produce progress toward a better understanding of this important clinical problem.

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References


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