Background: Testing of tendon (T) reflex is the basic method used in the diagnostic procedure of clinical neurology. Measurement of T reflexes precisely can be a valuable adjunct to clinical examination. Quantification of T reflexes may provide more accurate results. Aims: To analyze the effect of elbow position on biceps T reflex. Settings and Design: A self-controlled clinical trial of biceps T reflex testing at the Electrophysiology Unit of the Department of Physical Medicine and Rehabilitation. Methods and Materials: Biceps T reflex was obtained utilizing a hand-held electronic reflex hammer in 50 extremities of 25 healthy volunteers and the effect of elbow position (at 90°, 120° and 150°) on reflex response was evaluated. Statistical Analysis: Repeated-measures analysis of variance by the General Linear Model and Pearson correlation test procedures. Results: Onset latency was significantly shorter at 120° of elbow position. The maximum amplitude value of biceps T reflex was obtained at 90° of elbow position. Onset latency of the reflex correlated significantly with the height and arm length but not with age. Conclusions: The electrophysiological measurement of T reflexes is an easy and useful method in the quantification of reflexes, supplying more objective data. However, when performing T reflex studies, the position of the extremity should be taken into consideration to achieve more reliable results.

Key Words: T reflex; electrophysiology; position effect; electrodiagnosis

Introduction

Tendon (T) reflex test is an essential diagnostic procedure in clinical neurology. Quantification of T reflex provides more objective data on the basis of neurophysiology. The clinical use of T reflexes has already been introduced by several authors in a group of neurological conditions, particularly in nerve root lesions. Electrophysiological investigation of T reflex is also a useful method in patients with spasticity to quantify the T reflex more precisely than is currently feasible with standard clinical tests. The measurement of T reflex evoked with a hand-held hammer was found to be reliable in previous studies. However, there are several factors that influence the procedure, causing variations in reflex response. The aim of this study was to quantify the effect of elbow positions on biceps T reflex in normal healthy volunteers.

Materials and Methods

The Ethics Committee of the University Hospital approved the study protocol and informed consent was obtained from the subjects. Biceps T reflex was recorded in 50 limbs of 25 healthy volunteers all with normal neurological examination. The mean age was 58.8±7.07 (range 43 to 71) years. Height and arm length (distance between acromion and olecranon) of the subjects were measured in centimeters. The DISA 2000C electromyography machine and a hand-held electronic reflex hammer of the same apparatus were used to elicit the reflex. TECA surface electrodes were used to record the reflex responses. The subjects were on the examination table in a relaxed supine position with 90° flexion of elbow. The active electrode was placed at the mid-point of biceps muscle and the reference electrode at the acromion. The grounding electrode was placed on the forearm. Skin temperature was kept above 31° C. A universal goniometry was used to position the elbow precisely. Muscle relaxation was controlled electro-acoustically via surface electrodes. The examiner held the subject’s elbow in his left hand with the thumb over the tendon of the biceps muscle. A spongy texture was wrapped around the thumb to reduce the pain induced by the reflex hammer. He tapped the reflex hammer on his thumb to obtain the reflex response. The same procedure was repeated with about a 5-second interval until 8 regular responses were obtained at that position. Afterwards the angle of elbow was first extended to 120° (60° flexion) and then to 150° (30° flexion). The same procedure was also performed for the opposite side. Care was exerted to maintain the strength of the tendon taps similar. The average results of 8 responses were used for calculations. The sweep was 10 msec per division and the sensitivity was adjusted in accordance with the amplitude of the reflex. The amplifier frequency limits were between 20 Hz and 10 kHz in the settings of EMG apparatus. The reflex latency was measured at the onset of the first deflection from the baseline and the amplitude was measured.
from peak to peak.

For statistical calculations the statistical package program, SPSS Release 9.0 for Windows was used. T reflex data obtained at three different elbow positions were analyzed using repeated-measures analysis of variance (ANOVA) by the General Linear Model procedure. The repeating factor was elbow angle with three different positions. When the F ratio for the factor, elbow angle, was significant, multiple comparisons were performed by using paired T test between the repeated measures. The p values were then corrected according to the Bonferroni procedure. Pearson correlations were calculated for all the continuous variables. P values of less than 0.05 were regarded as significant.

**Results**

Characteristics of the study population are presented in Table 1. Onset latency and amplitude of biceps T reflex were recorded in all subjects (Figure 1). Repeated-measures ANOVA showed that the position effect was present across the onset latency and the amplitude of T reflex obtained at three different elbow positions (Table 2).

Onset latency at 120° elbow position was significantly shorter than latencies obtained at the positions of 90° (p<0.001) and 150° (p<0.01) (Figure 2). As can be seen in Figure 3 and Table 2, maximum biceps T reflex amplitude was obtained at 90° elbow position and somewhat smaller at 120°, but it diminished significantly when the joint angle was increased from 120° to 150° (p<0.001). The difference between 90° and 120° positions was not significant (p>0.05), in contrast to the difference between 90° and 150° (p<0.001). A positive correlation was found between onset latency and the height or arm length at all three angles. Age did not show correlation with onset latency at any elbow position (Table 3).

**Discussion**

Electrophysiological recordings of muscle stretch reflex are helpful in quantifying the responses. Measurement of reflex latency provides information about the entire reflex arc and evaluates peripheral nerve conduction, especially in proximal segments. Latency of T reflex is expected to be constant, in contrast to the amplitude, which shows inevitable variability in such studies. However, even the latency may show alterations in different studies depending on the methods and techniques used to elicit the reflex.\(^{11}\)

**Table 1: Characteristics of the study population**

<table>
<thead>
<tr>
<th>Number of subjects (male/female)</th>
<th>14/11</th>
</tr>
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<tbody>
<tr>
<td>Age (mean±SD, years)</td>
<td>58.8 ± 7.1</td>
</tr>
<tr>
<td>Height (mean±SD, cm)</td>
<td>162.27 ± 9.87</td>
</tr>
<tr>
<td>Arm length (mean±SD, cm)</td>
<td>34.66 ± 2.07</td>
</tr>
<tr>
<td>SD: Standard deviation</td>
<td></td>
</tr>
</tbody>
</table>

**Table 2: Mean values of biceps T reflex response at different elbow positions**

<table>
<thead>
<tr>
<th>Biceps T Reflex Parameters</th>
<th>90°</th>
<th>120°</th>
<th>150°</th>
<th>Repeated-measures ANOVA</th>
</tr>
</thead>
<tbody>
<tr>
<td>Onset latency</td>
<td>13.95 ± 1.26</td>
<td>13.75 ± 1.37</td>
<td>13.86 ± 1.24</td>
<td>F: 8.657, P: 0.001</td>
</tr>
<tr>
<td>Amplitude</td>
<td>2.27 ± 1.17</td>
<td>2.23 ± 0.97</td>
<td>1.75 ± 0.69</td>
<td>F: 18.436, P: 0.001</td>
</tr>
</tbody>
</table>

: msec, †: mV, SD: Standard deviation
In the present study onset latency values of the biceps T reflex were higher than those reported previously. Biceps T reflex latency was investigated in Karam’s study and in Schott and Koenig’s studies previously and the latencies were reported to be 11±1.3 msec and 11.4±1.4 msec respectively. Our method to elicit the T reflex was quite similar to those studies, except that we used a spongy texture wrapped around the thumb to reduce the pain due to repetitive taps. Indeed, it has been reported that placement of the thumb over the tendon causes a delay of about 2 msec due to the mechanical delay and it is probable that the spongious texture might also cause a further delay of latency.

In the present study we observed that the reflex response alters with elbow position. The mean onset latency at 120° elbow position was significantly shorter than the latencies obtained at other positions. Tarkka and Hayes also reported that the triceps brachii T reflex, taken at two different elbow joint angles in a group of healthy subjects, showed significant differences relating to latency and amplitude. They emphasized the influence of reciprocal inhibition and Group II (muscle spindle secondary afferents), Golgi tendon organ and joint afferent inputs associated with varied lengths of the triceps brachii muscle, and they also concluded that motoneuron pool activation by Ia inputs may influence the reflex response. Similar mechanisms may be responsible for the variations of reflex response at different elbow positions in our study.

The magnitude of the reflex response alters in several ways, depending on the rate of stretch, angle of joints and some other probable factors like intensity of the tapping. Weiss and colleagues examined the position effect of stretch reflex dynamics at the human ankle and concluded that position-independence of reflex response at different elbow positions in our study.

Similar mechanisms may be responsible for the variations of reflex response at different elbow positions in our study.

In conclusion, electrophysiological evaluation of T reflex, which is the quantification of motor neuron excitability, may be useful in many neurological conditions. However, the position effect of extremity should be taken into account while eliciting T reflexes electrophysiologically in order to obtain more accurate results.

References