Hand position in microsurgery

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Success in microvascular surgery depends on adequate vascular repair. The primary factor in adequate vascular repair is the technical skill of the surgeon. One of the essential aspects of this skill is the ability of the operator to eliminate uncontrolled events and movements.

In the process of demonstrating microsurgical techniques to the increasing number of surgeons desiring to learn and to apply microsurgery to their practices, the most frequent inquiries are "How do you hold the instruments?" and "How do you eliminate tremor?"

In any clinical situation the surgeon's hand position and angle of approach, to some extent, are dictated by the anatomy of the part. However, in every situation the conscientious application of the basic principles of stability, mobility, and relaxation can change the activity from an exhausting chore to a more enjoyable technical exercise with improved clinical results, shorter operative time, and greater willingness of the surgeon to widen his application of microsurgical technique.

The purpose of this study was to evaluate photographically and by electromyography the effect of certain changes in the surgeon's hand and forearm position on tremor and on the activity of specific large muscle groups. This information is extrapolated into clinically useful suggestions for the elimination of hand tremor.

Materials and methods

The positions evaluated include the "full rest position" (Fig. 1), in which support extends out along the full length of the little finger; the "hypothenar rest position" (Fig. 2), in which the fingers are unsupported but the hypothenar area is stabilized; and the "forearm rest position" (Fig. 3), in which the forearm is supported but the hypothenar area and the fingers are free. Each of these positions was tested with the elbow fully supported and again with the elbow free and forearm support distal to the mid-forearm.

The activity of three specific muscles was evaluated in each of six separate hand and forearm positions. The muscles evaluated included a wrist extensor, the extensor carpi radialis longus (ECRL); an elbow flexor, the biceps; and a shoulder elevator, the trapezius. These functions were chosen because wrist dorsiflexion, elbow flexion, and shoulder elevation are the specific static support activities required to maintain hand and arm position. It was our impression that the activity of these particular groups altered with changes in hand and forearm position and that tremor and fatigue were related to the static activity of these muscles. Multiple electromyography trials demonstrated consistently that the activity of these individual muscles coincided with activity of the entire functional group in the specific position tested. These muscles were identified easily, and placement of electromyography electrodes was simple.

Monopolar 1½ inch Teflon-coated electrodes were placed into the selected muscles. Oscilloscope recordings were made on an EDX-1 electromyography machine set at 100 msec/cm and 1 mV/cm. Photographs of the readout were made with Polaroid 3000 film.

The test subject was sitting in a position simulating a clinical situation. The audio of the oscilloscope was off, with the subject facing away from the screen of the oscilloscope. Because all three electrodes were in place and the test subject did not know which single electrode was active at any one time, this was essentially a blind study.

In order to directly illustrate the degree of tremor as it varies with hand position, a pinpoint light source, constructed from a single strand of a fiberoptic cable, was held in the surgeon's hand in a standard microneedleholder. The fine movements of the pinpoint light source were photographed through an operating microscope at high magnification using time exposure and high-speed Kodak 2475 recording film. The surgeon's hand was placed in the positions described, and the surgeon attempted to trace a circle approximately 1 mm

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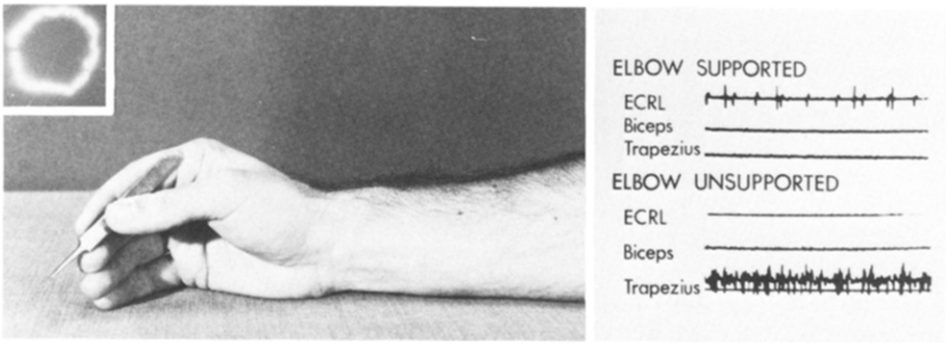

Fig. 1. The full rest position showing electromyography tracings with and without elbow support *(right)*, and photographic tracing of tremor in this position *(upper left)*.

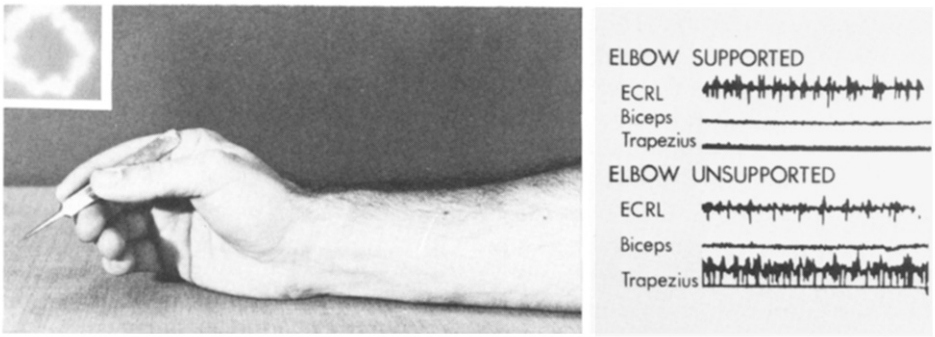

Fig. 2. Hypothenar rest position. Note brisk extensor carpi radialis longus activity on electromyography and increase in visible tremor.

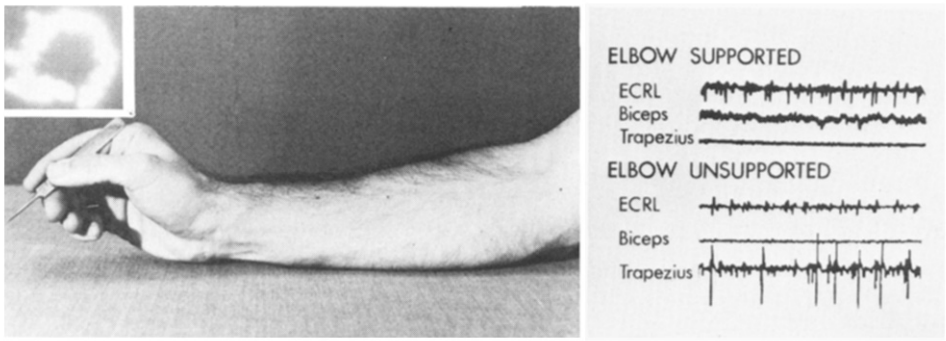

Fig. 3. Forearm rest position. Electromyography shows added biceps activity. Photographic tracing shows increased tremor. Tracing is broader, indicating vertical tremor.

in diameter during the time exposure. The corners of the ocular reticule were used as reference points. The tracings were evaluated subjectively for fine and gross tremor. Fifteen trials were performed on five surgeons.

Results

Electromyographic studies. In the full rest position, provided that the elbow was supported, there was almost no activity in the three muscle groups tested. In the hypothenar rest position, marked activity in the radial wrist extensor was seen. In the forearm rest position, slight biceps activity, in addition to ECRL activity, was evident.

We were somewhat puzzled by the lack of expected activity in the biceps when changing from the hypothenar rest to the forearm rest position. However, it was

discovered that with rather minimal elevation in height of the stool on which the subject was seated, the biceps action was stimulated. If the stool is low, regardless of where along the ulnar border of the forearm the arm is stabilized, support is maintained effectively. If the stool is elevated to a point where the elbow approaches the level of the table top in a sitting position, then biceps activity is necessary in order to provide forearm support in the forearm rest position.

If the elbow is supported completely, regardless of hand position, the trapezius is silent. However, moving the elbow off the table only as far as the center of gravity of the forearm, at the junction of the proximal and middle thirds, requires the use of the trapezius to maintain static elevation of the shoulder girdle.

Photographic study. Typical photographic findings are shown in the inserts of Figs. 1 through 3. The greater the degree of support, the less unwanted movement is seen. This was consistent regardless of operator, order of position tested, type of seating, or amount of rest between trials. No significant difference could be observed between intensity of tremor when the elbow was supported or unsupported. However, subjectively, fatigue in the shoulder elevators was increased markedly when the elbow was unsupported.

In addition to the clearly visible tremor in the horizontal plane, there was also a marked vertical tremor in the unsupported position. This caused the light spot to be out of focus in these positions resulting in a broader photographic tracing of the light spot, as can be seen in Fig. 3. All trials in every surgeon tested demonstrated progression of tremor, as illustrated in Figs. 1 through 3.

Discussion

At the time of the initial description of microvascular technique and instrumentation by Jacobson and Suarez,[1, 2] the limitations placed on technique were due to "the inability of the eye to see rather than the hand to do." Now, with improved optics and illumination systems, the "eye can see" and the limitations on microsurgical performance fall on the ability of the hand to perform ultrafine functions. If high patency rates are to be achieved, then precise suture placement and atraumatic technique must be employed, and fatigue and tremor compromise these technical abilities.

Fatigue and tremor are functions of the intensity and duration of activity of certain muscle groups. By eliminating the action of as many muscle groups as possible which are not involved directly in purposeful movement, one should be able to minimize tremor and fatigue. The results of this study support the contentions that have been made empirically in the past, that the most comfortable, maximally supported positions eliminate tremor and fatigue the best.

Practical suggestions for minimizing tremor and fatigue include the following: (1) The hand table should be large enough, and the operative field situated in such a manner that the operator's forearm and elbow may be supported completely. This eliminates trapezius activity, regardless of hand position, and minimizes biceps activity. (2) Hand supports should be constructed near the operative field so that stabilization extends all the way to the ulnar fingers. (3) The surgeon's seat should be low enough to permit most of the weight of the arm to be supported by the table rather than by the biceps or the trapezius. (4) The surgeon should attend to these important preliminaries before starting the operation, not halfway through it.

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