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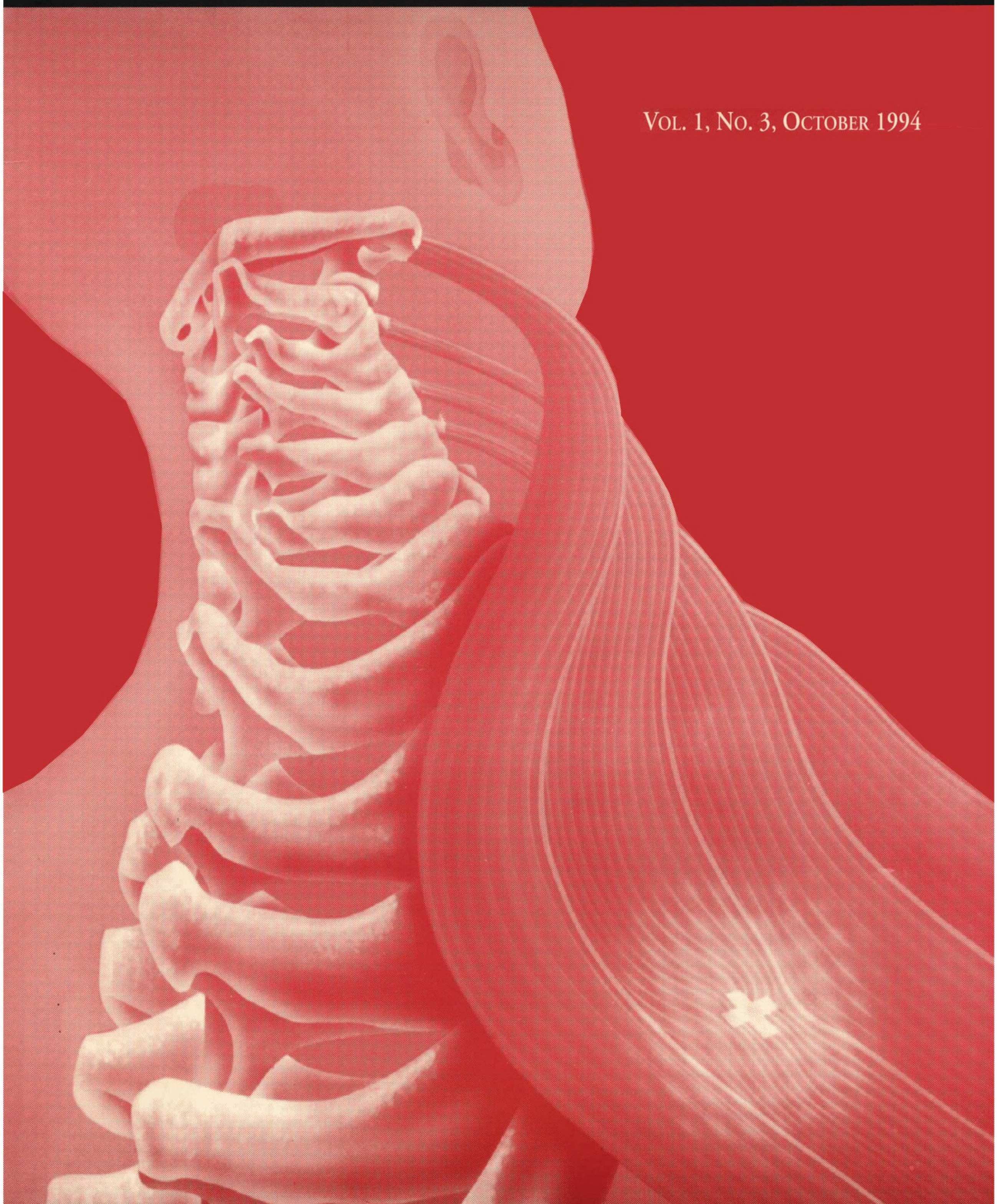

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EMG STUDY USING THE *bodyCushion*™

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MASSAGE: A SURFACE EMG COMPARISON OF THE EFFECTS OF A *bodyCushion*tm VERSUS A STANDARD MASSAGE TABLE

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Abstract. *The main objective of this study was to examine surface electromyography (sEMG) activity resulting from massage on the body lying on a standard massage table, versus the body lying on a standard massage table overlaid with a "body support system" cushion. Muscle activities during dynamic movements and static postures were measured with sEMG both pre- and post-massage for each of 16 subjects. Eight subjects received massages while lying on a body support system, eight while lying on a regular massage table. Dynamic EMG data was recorded from four different muscle groups during sitting, standing, forward flexion and re-extension of the neck abduction of the arms, and recovery. Static EMG data was recorded from the right and left aspects of ten muscle sites during neutral sitting, standing, and prone postures.*

Massages given to subjects lying on the body support system produced lower levels of both resting and dynamic sEMG activity (measured post-massage). This was significant for the sitting, standing, and prone postures monitored during the static scanning method (post-massage). Interestingly, the prone posture on the standard massage table yielded significant asymmetrical sEMG recordings. The prone posture on the body support system did not.

The pre- and post-massage dynamic sEMG evaluation revealed significant reductions in sEMG levels during abduction of the arms for the upper trapezius muscle site for subjects who received a massage on the body support system. No similar reductions were observed for those who received a massage on the standard table.

The differences in sEMG levels appear to reflect different ergonomic effects of the body support system versus the standard massage table. The body support system seems to better facilitate normalized gamma motor (and therefore muscle) function, thus providing better support to the shoulder and upper back than the standard massage table.

Key words: *sEMG, Massage tables, Ergonomics, Tension.*

INTRODUCTION

Back, neck, and shoulder disorders are prevalent in our society. They are a major medical problem affecting an estimated seven million Americans.[1] Limited or restrained movement patterns coupled with poor or inappropriate body mechanics at the workplace may cause prolonged tension in specific muscle groups. This in turn may lead to fatigue, eventual muscle strain, and a myogenic etiology of pain.

Massage has been shown to be a valuable tool in relieving muscle tension.[2] Vibrational massage applied to the back, legs, and feet of subjects was shown by Matheson and coauthors[3] to lower frontalis surface EMG (sEMG) levels. Link[4] and Lockhart[5] both reported that with massage, sEMG levels in a chronic pain population significantly reduced. sEMG allows a practitioner to quantify the activity of the patient's muscles. Thus, it provides an objective method for evaluating the benefits of massage.

Massage is usually given to a person lying prone or supine. Yet, little is known about the effects of these postures on muscle function. We found no references on sEMG recordings for the prone posture. There is a gentle art to the use of pillows and cushions during massage procedure. These biomechanical aids support the body while it lies prone on an otherwise flat surface. This appears to help "relax" muscles. If so, the aids should facilitate neutralization of the gamma motor system. This in turn should allow skeletal muscle spindles to lengthen, and thereby lower the overall level of muscular tone.

This study used sEMG to assess changes in resting tone and muscle function as a result of brief massages given to two sets of subjects. Both sets of subjects were lying prone, but each set lay on a different surface. The two types of surfaces tested were a flat massage table, and a table simulating a pillow/cushion support system (flat massage table with a body support system over it).

METHODS

Subjects. Sixteen subjects with no significant history of neck or back pain were selected. Each of eight subjects (five females and three males, ranging in age from 34 to 49 years) received a massage while lying on a body support system. Eight other subjects (five females and three males, ranging in age from 36 to 63 years) received a massage while lying on a standard massage table. We compared sEMG measures of the two groups.

Procedures. A brief history of each potential subject was taken. Only those subjects with no significant history of neck and back pain were chosen to participate, and they were randomly assigned to one of two experimental groups. Each subject in Group 1 rested prone on a body support system and received a twenty minute massage given by a certified massage therapist. Each subject in Group 2 rested prone on a standard massage table and also received a twenty minute massage. The massage was a combination of Swedish and acupressure techniques, and was primarily to the upper back and neck regions. sEMG recordings were taken in three postures just prior to and immediately following each massage.

The standard massage table used for the eight subjects in Group 2 was a BODYWORK table manufactured by LIVING EARTH. The table is 29" wide, 73" long. The table includes a 2" single-layered, medium density foam pad. The eight subjects in Group 1 lay on this same brand of massage table topped with a BodyCushion (from BodyCushion, Inc.)—a series of contoured cushions that provide support to the face, chest, and legs.

The electromyographic portion of the study was conducted using a DMS 4000 sEMG with an input impedance of 20 MOhms and a fixed band pass filter of 15-450 Hz. The instrument has a Common Mode Rejection Ratio of >110 db with sensitivity of 0-512 microvolts. Each muscle site was prepared using a vigorous alcohol abrade. The electrodes were then slightly coated with electrolytic paste and placed over each muscle site. Eight pairs of silver-silver chloride electrodes were placed bilaterally over each subject's left and right upper trapezius, lower trapezius, SCM, and C4 muscle groups. The paired electrodes were placed 3 cm apart, parallel to the muscle belly. A single electrode was placed for the ground lead. The sEMG data were recorded in RMS microvolt values for each period movement and posture studied.

Figure 1. Overall Effects of Lying Surface.

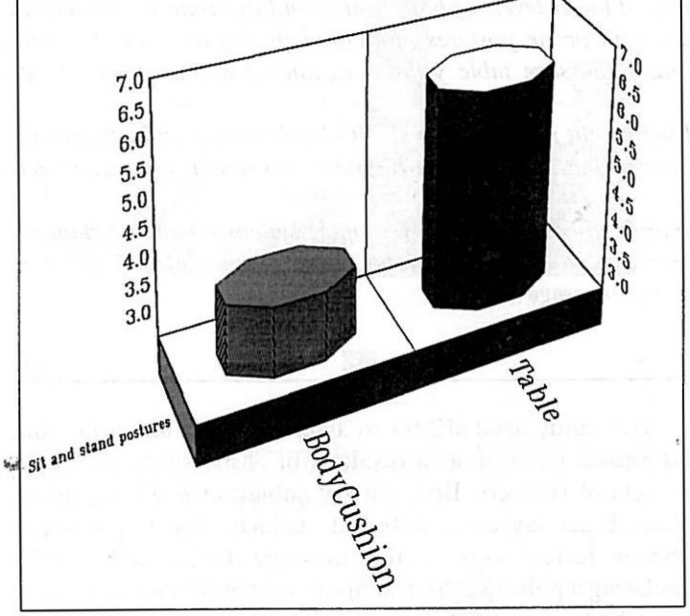
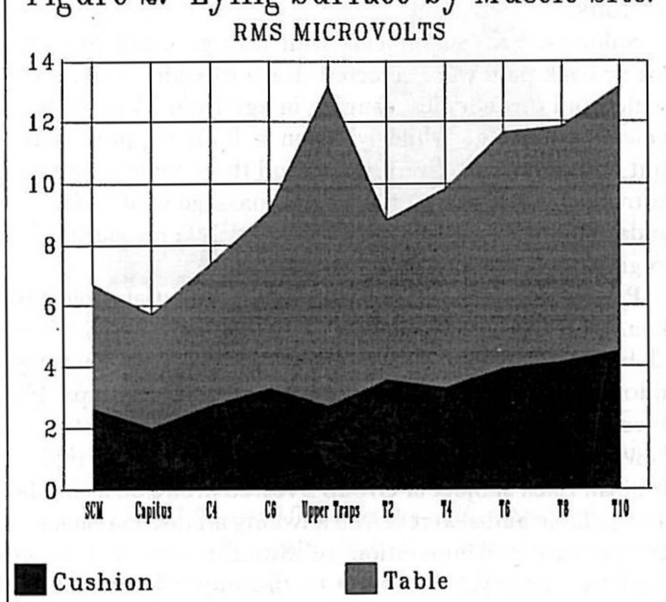


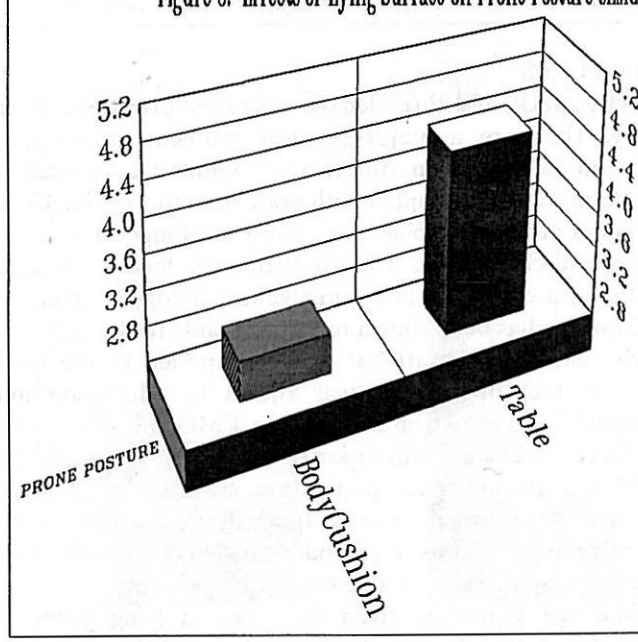
Figure 2. Lying Surface by Muscle Site.



Each session started with a dynamic assessment. sEMG was used to monitor the upper and lower trapezius muscle sets during quiet sitting, standing, and abduction (pre, peak, post). For the abduction study, subjects were asked to raise their arms slowly to a 90° position, hold them there briefly, and then return them to a neutral position. This was immediately followed by sEMG monitoring of the SCM and C4 muscle sites during quiet sitting and standing postures, and forward flexion/re-extension of the head. For the forward flexion of the neck position, subjects were asked to flex their necks forward as far as it was comfortable, and then slowly extend back to neutral posture.

Next, a static assessment was made. sEMG was monitored using the muscle scanning procedure, developed by Cram,[6] in the following neutral postures: sitting, standing, and prone. In the sitting posture, subjects placed their hands on their laps. In the standing posture, subjects placed their hands at their sides. In the prone posture, subjects lay with their faces supported in the "face cradle." The muscle scanning procedure was conducted using "post style" electrodes 2.0 cm apart. The right and left aspects of 10 muscles were sampled: capitis, SCM, C4, C6, trapezius, T2, T4 T6, T8, and T10. During the prone posture, the SCM site was inaccessible and therefore not measured.

Figure 3. Effects of Lying Surface on Prone Posture sEMG.



Following the dynamic and static sEMG evaluations, subjects remained prone with their faces supported in the face cradles. Each received a 20-minute massage. Immediately following each massage, the entire procedure outlined above was repeated in reverse order (i.e. the static muscle scanning procedure in the prone posture was first, followed by the sit and stand postures, and then followed by the dynamic sEMG measurements).

RESULTS

The data from this study were analyzed using an analysis of variance (ANOVA) with a fixed effects model. Due to the nature of the dependent and independent variables, separate statistical analyses were conducted for:

- static scan data for the prone posture
- static evaluation during the sit/stand postures

Figure 4. Prone Posture by Muscle Site.

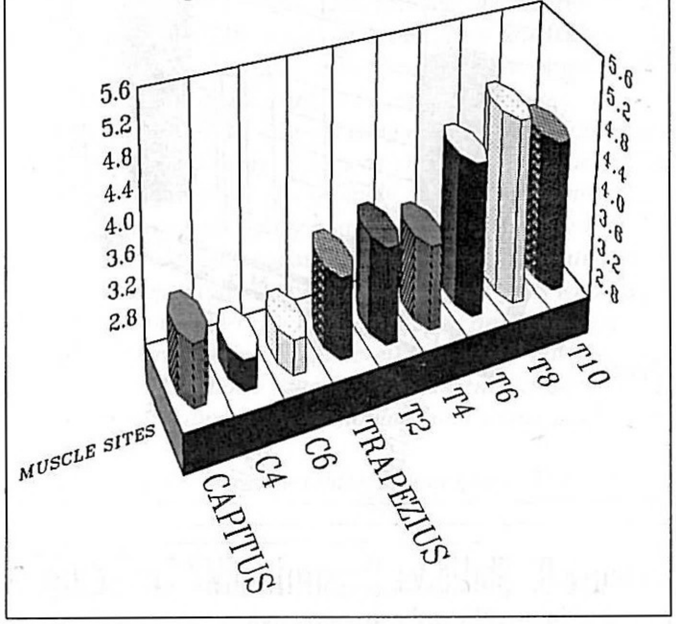
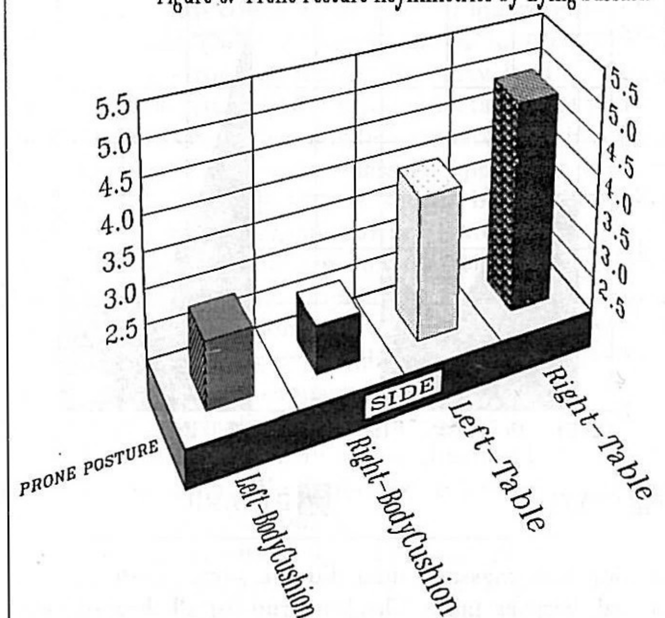


Figure 5. Prone Posture Asymmetries by Lying Surface.



- dynamic evaluation for the neck muscles
- dynamic evaluation for the upper and lower trapezius.

All analyses considered period (pre vs. post) and surface (massage table vs. BodyCushion). The static scan data also included:

- muscle site (SCM to T10)
- side (right vs. left)
- posture (sit, stand). The dynamic cervical evaluation data also considered:
- muscle (SCM vs. CPS)
- side (right vs. left)
- movement\posture (sit, stand, forward flexion vs. extension).

The dynamic trapezius data also included:

- muscle site (upper vs. lower)
- side (right vs. left)
- posture/movement (sit, stand, pre-abduction, abduction, and post-abduction).

Static Data. The static scanning data analysis for the sit and stand postures indicates a highly significant main effect for surface ($F=14.74$, $P<0.001$). Figure 1 shows that significantly lower sEMG values resulted when the BodyCushion was used ($X=3.75$; $SD=2.37$) compared to the standard massage table ($X=6.48$; $SD=4.28$). In addition, a significant interaction between surface and muscle group ($F=3.62$, $P<0.0004$) was noted. The sEMG levels for all ten muscle sites measured post-massage for both surfaces appear in Figure 2.

The static scan data analysis for the prone posture indicates a highly significant surface effect ($F=5.57$, $P<0.03$), a significant muscle effect ($F=2.21$, $p<0.031$), as well as an interaction effect between surface and side ($F=8.32$, $P<0.01$).

The main effect for surface in the prone posture is shown in Figure 3. This shows significantly less sEMG activity when subjects were lying on the BodyCushion ($X=2.85$; $SD=2.13$) compared to lying on the standard massage table ($X=4.51$; $SD=3.38$).

The muscle effect is presented in Figure 4. The highest levels of activation during prone lying are in the paraspinal muscles in the thoracic region. The interaction effect is displayed in Figure 5 and Table 1. Post hoe analysis indicated a larger degree of asymmetry during prone lying on the massage table compared to the BodyCushion.

Dynamic Data. The analysis of dynamic sEMG activity for the cervical muscles indicated a significant movement/posture by muscle site effect ($F=6.02$, $p<0.001$). Figure 6 ostensibly shows that the SCM muscles are more active during the forward flexion phase of the movement. No main or interaction effects for side or surface were noted.

The analysis of dynamic sEMG activity for the trapezius muscles indicated a significant muscle by posture/movement interaction ($F=49.5$, $p<0.0000$). Figure 7 reveals that the upper trapezius was recruited significantly more during abduction compared to the lower trapezius. In addition, there was a highly significant three way interaction for period by muscle site by surface ($F=7{,}9219$, $P>.01$). Figure 8 shows that there was a significant decrease (compared to the standard massage) in electrical activity in the upper trapezius after a BodyCushion massage. The mean sEMG levels (muscle tension) decreased 23% from the pre-massage period to the post-massage for the BodyCushion, compared to a 5.0%o increase for the standard massage table. [It should be noted, however, that the electrical activity measured for this muscle pre-massage/table was lower than that measured pre-massage/BodyCushion.]

Static vs. Dynamic Scanning. A post hoc analysis for the sit and stand postures was conducted to compare the levels of sEMG activity recorded using the static scanning procedure to those collected during the dynamic procedure. The overall

Figure 6. Effects of Dynamic Movement on Cervical Muscles.

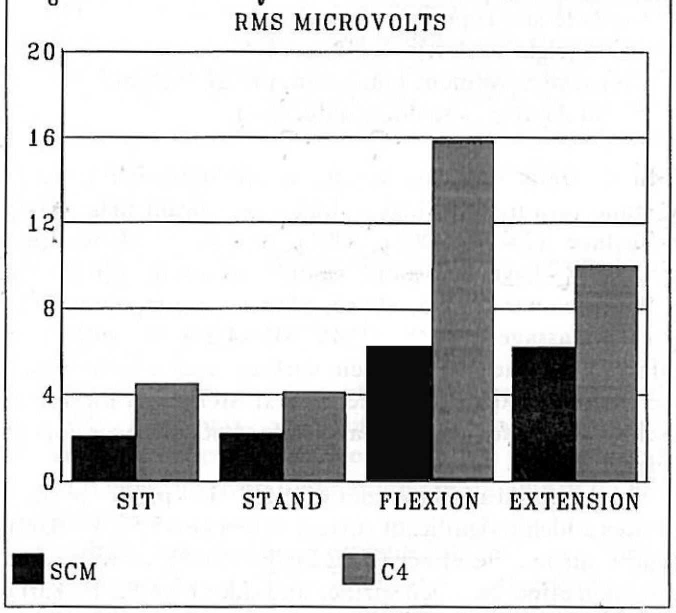


Figure 8. Effects of Lying Surface On Abduction Recruitment.

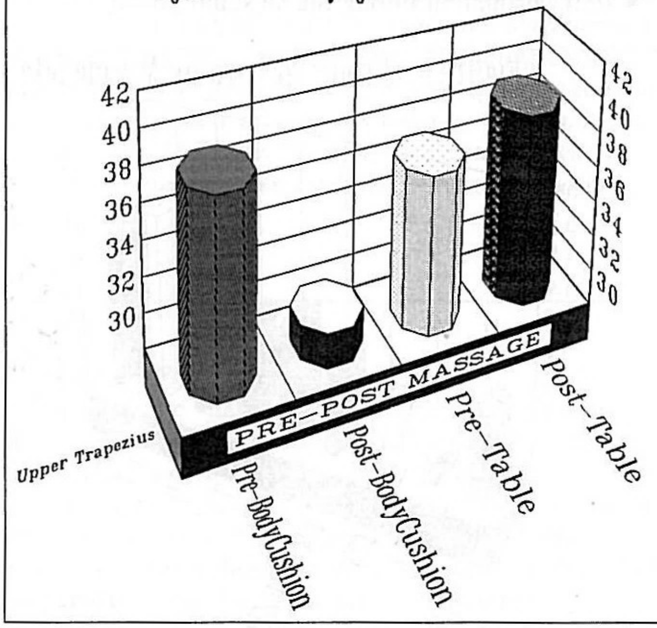


Figure 7. Effects of Dynamic Movement on Shoulder Muscles.

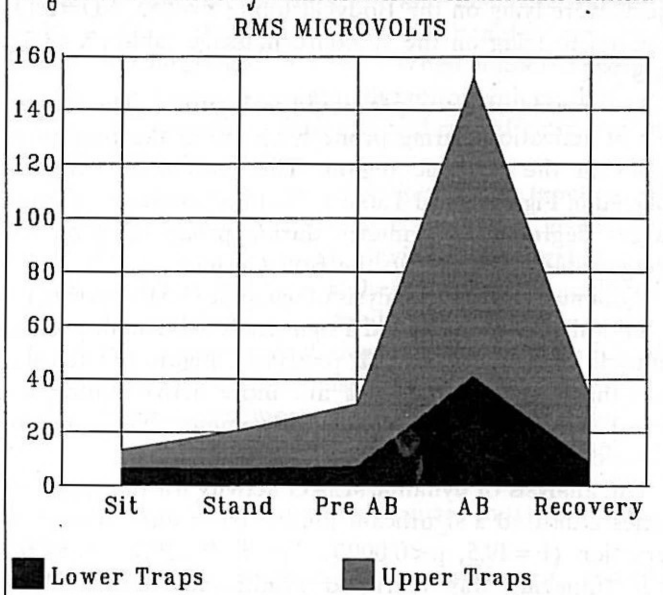
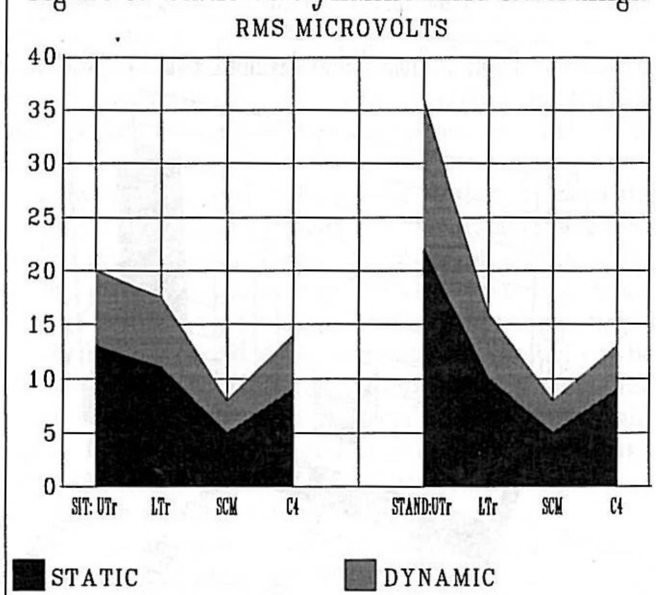


Figure 9. Static vs. Dynamic sEMG Recordings.



sEMG levels during the dynamic procedure were much higher (statistically significant) than those during the static scanning procedure ($F=13.03$, $p<0.002$). In the sitting position, sEMG levels were 5.2 microvolts for the dynamic recording procedure compared to 4.6 microvolts for the static scanning procedure. Differences in sEMG activation were even more striking during the standing position, when the dynamic sEMG yielded 6.8 microvolts compared to 4.4 microvolts for the static scan. Also, a significant three way interaction term for static/dynamic by posture by muscle site was noted ($F=5.17$, $p<0.004$). The upper trapezius was significantly more active when using the dynamic procedure (Figure 9).

DISCUSSION

The main finding of this study is that massages using a body support system for subjects yielded lower levels of sEMG activation post-massage than did the same treatment on a standard massage table. This was true for all three postures monitored using the static scanning method (sitting, standing, and prone). It was also true for upper trapezius muscle activity measured post-massage with dynamic sEMG procedures (Figure 8).

Study findings were especially striking for the static scanning data in the prone posture. Here the subjects' torsos were fully supported by the massage table and/or BodyCushion and were free from gravitational influences. In other words, the postural muscles monitored during the static scan procedure had no apparent anti-gravitational function to perform. Nevertheless, the sEMG data presented in Figure 4 show that the paraspinal muscles in the thoracic region continued to be quite active. This suggests that these muscles have a difficulty adapting to the prone posture. This is probably due to the structure of the rib cage.

When a subject was supported only by the flat surface of the massage table, significant asymmetries occurred between the right and left sides of the paraspinal muscles. In contrast, when the BodyCushion was used, significant asymmetries were not detected. This sEMG finding may reflect anatomical differences (i.e., asymmetrical breast size) that telegraph through to the paraspinal muscles. Or it may be related to some asymmetrical way the subject positioned himself on the table. In either case, statistically significant asymmetries appear to be more an artifact of the flat surface rather than a physical characteristic of the subject.

The paraspinal muscles, then, do not appear to readily adapt to prone lying on a flat surface. This find suggests that since palpatory evaluations are often conducted with patients lying prone or supine on flat surfaces, the practitioner should use caution in deriving interpretive meaning from perceived asymmetries. A palpated asymmetry may be more related to the patient's lying on a flat surface than it is to an idiosyncratic pathology. Also, mobilization techniques based upon "flat table" findings may be misdirected toward forcing an accommodation of the patient's soft tissues to the flat surface.

Lying on the BodyCushion, however, appears to facilitate the release and normalization of muscle tension as measured by sEMG. In other words, it takes less muscular effort to lie on the BodyCushion than on the standard massage table.

Further research using sEMG should be directed toward assessing the similarities or differences resulting from palpation using a flat surface vs. a body support system. Variations in sEMG activity due to different lying surfaces should also be studied in greater depth.

The dynamic sEMG evaluation revealed a significant reduction in sEMG activity (collapsed across all postures & movements: sitting, standing, pre- and post-abduction) for the upper trapezius muscle site after subjects received BodyCushion massages. The group who received massages on the standard table actually experienced increases in sEMG levels from pre- to post-massage periods. These increases may be due to the unnatural way in which the standard massage table offers support to the bones associated with the upper trapezius muscle. The gamma motor system may be unable to "normalize." So, increased muscular recruitment may increase the sensitivity of the muscle spindle. On the other hand, the BodyCushion appears to facilitate a more normalized resting tone that generalizes to a more normalized movement pattern following massage.

On a technical note, the static sEMG recordings seem to have provided a more sensitive outcome measure and yielded more interesting results in this study than did the dynamic sEMG procedures. Dynamic measurements during quiet sitting and standing preceding and/or following dynamic movement were significantly higher than those monitored during quiet sitting or standing using the static procedure. The smaller differences during the sitting posture might be attributable to a slightly wider electrode spacing for the dynamic study (3.0 cm vs. 2.0 cm for the static study). However, the 200% increase for the standing posture in the dynamic study is striking, and reflects an entirely different motor (preparation) set.

In conclusion, the results of this study suggest that ergonomic support offered to the shoulders, rib cage, and lower spine reduces the supplemental muscular effort required for the prone lying task. Ergonomic support appears to neutralize gamma motor activity, thereby reducing the overall muscle effort required. Such support to the shoulders, rib cage, and spine during prone lying seems to reduce activation of back muscles during movement in other postures. When a massage practitioner uses proper ergonomic support for his prone-lying client, he may **more effectively reduce and** normalize the client's muscle activity **in the neck, shoulder, and upper back regions.**

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