

Surface EMG: Is it reliable, valid and clinically relevant?

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SUMMARY: Surface Electromyography (aka. Surface EMG or SEMG) is not a new technology. It has been used as a research tool and a clinical tool for decades by a number of professions, including chiropractors. So what have we learnt about the reliability, validity and relevance of this clinical resource over the years? This paper summarises findings from a literature search of research papers relevant to the issues of reliability, validity and clinical applicability, and presents SEMG findings from the comparison of two different patient groups in a single private practice utilising an Insight Subluxation Station SEMG and Torque Release Technique Integrator Adjustments.

RELIABILITY/REPRODUCIBILITY/REPEATABILITY

If I make the measurement again will I get the same result?

Earlier research investigated the simple questions of does this technology work, and how can we improve the technology and the protocols? Through time the research agenda moved more into what does this technology tell us and what happens before and after therapeutic intervention? Let's first travel through time and see whether SEMG is reliable?

The question of reliability for any clinical assessment tool is indicative of the stability of the test itself. If we make two separate measurements of the same patient will we get the same readings on both occasions? Assuming that the person's state is identical when both measurements are taken, we would expect that we would consistently get similar readings from a reliable technology.

With any tool a lack of reliability is most likely due to the flaws in the application: For example with SEMG we have possibilities for flaws in our anatomical placement of the sensors, variations in skin preparation, change in the physical environment (temperature, noise, air flow, humidity) and potential instability in patient positioning and posture. Most of these factors can be controlled and standardised.

A number of studies have measured the reliability coefficient of SEMG measurements, not only on a test-retest basis, but also looking at stability across measurements at different times in the day and even on separate days. Most studies have returned impressive measurement of reliability. There has also been significant comparison of SEMG versus needle EMG measurements with SEMG consistently showing as being more reliable.

In 1970 a paper found that the average test-retest reliability for surface electrodes was 0.88 compared to 0.62 for inserted electrodes. (1)

0.88 is a high score for reliability – This means that if I perform this test again there is an 88% chance that I will get the same result. Few examination procedures, especially physical

examination procedures approach this degree of reliability. In other words it could be more accurate to SEMG muscle bundles than to palpate them?

Another study compared the electrical activity in lumbar erector spinae muscles using inserted electrodes and surface electrodes. They found that the standard deviations and coefficients of variation for wire electrodes were greater than those for surface electrodes. They concluded, "Wire electrodes are more sensitive to electrode location and give estimates with less precision than surface electrodes." (2)

Within the "EMG community" debate has continued over whether surface EMG is a better tool than needle inserted EMG, or vice-versa. The compromise has been that maybe they have different clinical applications. Ignoring this SEMG repeatedly shows up as a more reliable tool.

The next study yielded correlation coefficients ranging from 0.73 and 0.97. Again impressive numbers for an examination procedure. (3)

Yet another paper found that electromyographic parameters generally showed good to excellent reliability. (4)

The database of research papers utilising SEMG as part of the study is expansive. One would have to ask why this would be so if the scientific community had not answered the question of whether or not it is reliable. For example, a search on PubMed using the terms "surface electromyography" or "surface EMG" each produces >5,000 hits. That's a lot of research using SEMG as a tool. To put this in context, search of the term "chiropractic" returns less than 4,000 hits: Perhaps SEMG is more of a validated science than one of the professions that use it? What about other examination procedures? The term "straight leg raise" offers <150 hits, and "motion palpation" <500. It would seem somewhat obvious that had the earlier research into SEMG found it to be unreliable, that it would have faded into insignificance as a tool. Of course these numbers tell us nothing of the findings of the studies, but one might conclude that a tool that is used a lot in research methodology has probably gained widespread acceptance.

Another study compared SEMG and needle electrodes for isometric and dynamic contractions during an occupational cervico-brachial working task. Statistical results confirmed that EMG signals, from both surface and needle, are reliable between trials on the same day. These statistical results also confirmed that SEMG was more reliable than needles on day-to-day investigations. (5)

SEMG is a technology used routinely to record assessments of biomechanical activity for ergonomic and medical purposes – that is – a widely utilised and accepted practice in a diverse range of professions. According to another paper surface electrode recordings demonstrated better reliability testing than needle EMG. This finding of greater reliability, combined with the ease of use of surface electrodes suggested that they should be preferred for most studies of EMG analysis. (6)

It's not uncommon in the private practice setting to have a patient observe the abnormal readings on their SEMG, and then claim, that if they were allowed to do it again, they are sure that they could do better. In other words, this finding could change in a matter of minutes! It's a nice fantasy, but correctly implemented SEMG findings don't vary as much as these sceptics would suggest.

Protocol is important when it comes to achieving reliability. As the technology has evolved it has become more portable and compact. One such change is in the ability to scan quickly with hand-

held sensors. But maybe this would lead to poor results? Research indicated that with adequate attention to skin preparation, EMG sensors held in place by hand with a light pressure produce reliable results. (7)

One study provided a thorough description of lumbar SEMG in pain-free normals during a standardized assessment protocol of static isometric and unresisted dynamic tasks. It had been previously observed that lumbar EMG assessment during static tasks were more consistent than tasks involving dynamic activities and this paper confirmed this observation.

Another implication derived from this research was that clinicians may be better served utilizing local norms when using EMG for classification purposes. (8) The development of normative values allows us to now identify a patient exhibiting “abnormal” SEMG activity. SEMG is seen as a powerful tool for measuring change – the change in one person’s readings over time. The use of norms adds the ability to “interpret” a single investigation or compare one patient’s findings to others.

Most chiropractors utilise static sitting scans in their everyday clinical practice because this offers a more “consistent finding” and answers the question of interest in what is the resting tone of the paraspinal muscles. Dynamic SEMG has been utilised more by exercise physiologists and Physiotherapists to assess muscles in action during movement.

The next study looked specifically at the technology and the methodology most often used by Chiropractors: This study used a test/retest, with four repeat measures of 15 bilateral paraspinal sites in the unsupported sitting position, conducted on the same day with a five-minute supine rest interval. A comparison was made between chiropractic clients, and those trained to have good postural control. A pilot study found readings taken with two different machines had excellent agreement, ICC 0.98, establishing the Insight Subluxation Station as technically very reliable for SEMG with errors unlikely to result from equipment.

For untrained subjects the value of ICC ranged from 0.56 to 0.96, median 0.86. For trained subjects, ICC ranged from 0.66 – 0.93, median 0.9. Reliability for individuals in both groups was acceptable to excellent. The mean ICC was 0.84 untrained and 0.84 trained. SEMG using the Insight Millennium Subluxation Station was concluded to be a clinical assessment tool with excellent reliability. For individual subjects reliability is very high and for specific measurement sites reliability is good. Voluntary postural control was not found to be a significant factor. (9)

As part of a pilot study the application of sEMG, as recorded with the Insight 7000 Subluxation Station, to the chiropractic clinical setting as an objective measure of change in assessing patient progress was conducted. The study revealed that intra-examiner reliability could be demonstrated through a paired two-tailed t-test which takes variation into consideration, rather than using correlation coefficients which could mask examiner error. (10)

Another study expanded on the question of reliability by including inter-examiner assessments: This study revealed excellent inter-examiner and intra-examiner reliability of static paraspinal SEMG in a large number of subjects (n=91): Intra-examiner and inter-examiner was 0.95 in both cases. (11)

A different study looked at the stability of SEMG measurements over a 12 hour period and suggested that this methodology was feasible for use in future long-term EMG studies. (12)

The aim of another study was to investigate the between-days reliability of SEMG measurement of 6 bilateral trunk muscles and also the torque output in 3 planes during isometric right and left axial rotation at different exertion levels. For both EMG amplitude and frequency values, good (intraclass correlation coefficient, ICC=0.75-0.89) to excellent (ICC \geq 0.90) reliability was found in the 6 trunk muscles at different exertion levels during axial rotation. The reliability of both maximal isometric axial rotation torque and coupling torques in sagittal and coronal planes were found to be excellent (ICC \geq 0.93). This provided further confidence of using SEMG and triaxial torque assessment as outcome measures in rehabilitation and in the evaluation of the human performance in the work place. (13)

Again we might think that SEMG is a limited tool, because today's "forecast" may differ to tomorrows! In other words, we might be concerned that the findings have less to do with the patient's state, and more to do with some other variables. However, the above research indicated that SEMG readings are much more stable than the weather, and findings can actually be relied on between days.

I have utilised SEMG in my own practice for ~twelve years, and at times have been shocked by just how stable the readings can be: Even twelve months apart... Usually when we saw this, the patient would also exhibit further signs of a nervous system that was locked into a pattern, and it was always a clinical challenge to identify a therapeutic program that would break this "habit" and result in more positive healing responses.

The purpose of another study was to compare the reliability of trunk muscle activity measured by means of SEMG during maximal and sub-maximal voluntary isometric contractions (MVC/sub-MVC) over repeated trials within-day and between-days in healthy controls and patients with chronic low back pain (CLBP). MVC and sub-MVC showed excellent within-day reliability in both healthy controls and CLBP patients (ICC mean 0.91). Sub-MVC for both groups between-days showed excellent reliability (ICC mean 0.88) The between-days MVC for both groups showed trends towards lower levels of reliability (ICC mean 0.70) when compared to sub-MVC. Findings of the study provide evidence that sub-MVC are preferable for amplitude normalisation when assessing EMG signals of trunk muscles between-days. (14)

Again we see that reliability between days is acceptable, especially if we can minimise the variables of the test: Less movement and less strain leads to more consistent findings.

VALIDITY/ACCURACY

Does this measure what you think it measures?

The next question is should the measurement be the same? In other words when we are measuring human variables, sometimes they are just that – variable: Human physiology is not a stable state. But, for an examination to be valid we need to use tools which do give us a relevant measure of where a person is at. So we want a tool that is discerning and applicable to our craft.

According to one paper, SEMG muscle scanning measures samples of integrated muscle action potentials from individual neck and back muscles and that this "scanning" technique is widely used to expeditiously assess muscle activity in the diagnosis of musculoskeletal disorders. (15)

The proposed validity of SEMG to chiropractic practice is to read muscle activity or tone. This doesn't have to tell us whether the muscle is weak or strong, whether it is torn or swollen, whether it is atrophied or hypertrophied – it just tells us how tense the muscles are – and that's all it needs

to tell us. How we extrapolate these findings to a pathological or anatomical interpretation is more of a clinical question than a technical one.

The EMG signal detected on the skin surface includes information from a greater proportion of the muscle of interest than needle EMG. SEMG is therefore more representative than the localized, and thus very selective needle EMG signals used. SEMG is an evolving discipline and should be worthy of a place in routine clinical examinations. (16)

Some have questioned the routine use of SEMG in chiropractic clinical examinations – this scepticism often derives from arguments that SEMG doesn't tell us where a Subluxation is. But, as with any examination tool, we need to be very aware of what that test does tell us and how we can interpret the findings. Intelligent use of SEMG provides information not readily obtained through conventional physical examination.

One study found that it was possible to conclude that changes in muscular length and in contraction intensity alter the electromyographic variables. (17)

Sometimes research has to measure and prove what the rest of us see as obvious: "Research shows that contracting the biceps muscle bends the elbow!" I bet someone actually did study that. But it is important to know that SEMG measures what we think it measures – neural supply and activity to a muscle group with associated change in length and tension.

Distinction between the types of hypertonia is difficult in a clinical setting. A study presented results of a test of the use of a portable SEMG device for the evaluation of hypertonia. Seven children 5-17 years of age with hypertonia due to cerebral palsy were each examined by 6 clinicians, both with and without the use of SEMG. The use of surface EMG resulted in an increase in inter-rater agreement as well as an increase in the self-reported confidence of the clinicians in their assessment. (18)

I had an associate DC working for me at one stage, and he was quite resistant to utilising SEMG as a tool. His ultimate argument was that he didn't need a machine to measure what he could feel with his hands. My counter-argument was that if he used the technology enough, he would actually improve his palpatory skill and reliability. I demonstrated this to him by showing him scans of hypertonic versus hypotonic thoracolumbar spines and then comparing the palpatory sensations of each. He was shocked to discover that he had been incorrectly interpreting that hypotonic regions on SEMG were severely hypertonic in his mind! Woops, two very different clinical and hence therapeutic scenarios.

The next question in terms of validity is can we extrapolate any clinical interpretation or significance from our findings? Is there a relationship between abnormal SEMG findings and spinal pain and/or dysfunction?

One group of researchers studied the reliability and validity of resting electrical activity from tender areas in muscle. In seven subjects with tender areas in their trapezius muscles, needle EMG signals were obtained at various depths over the tender area and at the same depths over the control area, and from surface electrodes. Increased electrical activity occurred from the electrode inserted toward the tender area in all seven subjects, but not from control areas. They suggested that the electrical activity arises from a localized zone and is stable over time. (19)

In other words, we see that tender areas in muscles correlate with abnormal EMG readings, and areas with normal EMG readings are less likely to exhibit tenderness.

The relationship between surface EMG recordings from paraspinalis recording sites and subjective pain ratings was also examined in a group of pre-chronic back pain patients. Results revealed significant and positive relationships between pain and muscle activity in the upper back (Trapezius, T1 paraspinalis sites) and significant but negative relationships between erector spinae activity (L3 paraspinalis site) and pain. (20)

The relationship between SEMG and pain is a complex one – I used to say to patients – “this doesn’t show us your pain, it doesn’t necessarily show us where your pain is, and it may not even show us where your pain is coming from. But the more abnormal your readings are, the greater the chances that you are going to be suffering with pain, and possibly other associated problems...”

Another investigation examined SEMG as an additional tool in the comprehensive clinical evaluation of patients with chronic low back pain (CLBP). Electromyographic signals from electrodes placed in the lumbar area of 30 CLBP patients and 30 non-pain control subjects were compared. Analysis showed a statistically significant difference between the two groups. The muscle activity mean values were threefold higher in CLBP patients than in controls in the static testing, and twofold higher in CLBP patients than in controls in the dynamic testing. The findings indicated that surface electromyography assessment of the paraspinal muscle activity may be a useful objective diagnostic tool in the comprehensive evaluation of CLBP. (21)

Again we see that the static SEMG is more likely to reveal more reliable and now also more significant findings than dynamic SEMG. In other words it may be more valid, and more sensitive as well as being more reliable?

Another group of authors studied the SEMG spectrum of the paraspinal muscles of 350 subjects. They were classified by their history as normal, chronic low back pain, or past history. Most of the variables of the chronic group were significantly different from the normal group. (22)

Whether the abnormal readings are the cause of chronic pain or the effect of chronic pain may be relevant, or it could be irrelevant – in fact it probably doesn’t matter. The fact is that if we see abnormal SEMG readings then we have reason to suspect that this person is at risk of suffering pain, over a prolonged period. And maybe we could hypothesize that if we now do something that returns their abnormal SEMG readings towards normal, they are now less likely to be a chronic pain sufferer.

Do these abnormal findings also correlate with diminished function?

In another study lumbar paraspinal muscles were examined by SEMG in 22 patients with low back pain and 22 healthy volunteers. Surface electrodes were placed bilaterally on the lumbar multifidus and longissimus muscles at the level of the spinous process of the third lumbar vertebra. Continuous muscle activity was observed in the low back pain group. Paraspinal muscle activities restricted lumbar range of motion, and protect from injury for movement. This suggests their role as stabilizers. (23)

This correlates with my own personal observations from the use of SEMG on hundreds of patients. We also utilise inclinometry spinal flexibility assessment, and I have observed strong correlations between either excessively high, or excessively low SEMG readings with significant loss of spinal mobility.

If we take our validity question to the next level: Is there a correlation between abnormal SEMG findings and quality of life and disability?

A study compared neck muscle activation patterns during and after a repetitive upper limb task between patients with idiopathic neck pain, whiplash-associated disorders, and controls. SEMG activity was recorded from the sternocleidomastoid, anterior scalenes, and upper trapezius muscles. A general trend was evident to suggest greatest SEMG amplitude in the sternocleidomastoid, anterior scalenes, and left upper trapezius muscles for the whiplash-associated disorders group, followed by the idiopathic group, with lowest SEMG amplitude recorded for the control group. A reverse effect was apparent for the right upper trapezius muscle. The level of perceived disability (Neck Disability Index score) had a significant effect on the SEMG amplitude recorded between neck pain patients. Patients with neck pain demonstrated greater activation of accessory neck muscles during a repetitive upper limb task compared to asymptomatic controls. Greater activation of the cervical muscles in patients with neck pain may represent an altered pattern of motor control to compensate for reduced activation of painful muscles. Greater perceived disability among patients with neck pain accounted for the greater SEMG amplitude of the superficial cervical muscles during performance of the functional task. (24)

Now we start to see the potential for using EMG as an outcome tool: We see evidence that injury leads to abnormal SEMG findings, and that this correlates with disability; so now if we introduce a therapeutic regimen, and the readings return closer to normal, perhaps we could conclude that we are contributing to body function returning to pre-injury status – sounds like a good plan?

Similarly, a further study explored aspects of cervical musculoskeletal function in female office workers with neck pain. Workers with neck pain had reduced rotation range and increased activity of the superficial cervical flexors during the craniocervical flexion test. During the coordination task, workers with pain demonstrated greater activity in the Cervical Extensor (CE) muscles bilaterally. On completion of the task, the Upper Trapezius and dominant CE and anterior superficial muscles demonstrated an inability to relax in workers with pain. In general, there was a linear relationship between the workers' self-reported levels of pain and disability and the movement and muscle changes. (25)

It appears that the chain of events follows a predictable and reproducible pattern. Abnormal SEMG findings correlate with impaired function, and, with tenderness and pain, and with impaired quality of life.

But can we take a further step, and begin to utilise SEMG as a predictive or prognostic tool? If we see abnormal SEMG readings, does this give us the future magnifying lens to suggest that ignoring these abnormal findings will be detrimental for the that person's future function and feeling?

A prospective study in which patients with idiopathic scoliosis were examined longitudinally by radiographic and SEMG measurements was undertaken. They measured the growth velocity of the spine and the SEMG ratio of the paraspinal muscles to determine their relation to progression of the scoliotic curve. There was an independent association between both spinal growth velocity and SEMG ratio and progression of the scoliotic curve. The combined measurement of spinal growth velocity and SEMG ratio has significant predictive potential and may be valuable in the evaluation and treatment of idiopathic scoliosis. (26)

In this study they found that analysing the SEMG findings, when correlated with another assessment tool, could actually be used as a prognostic predictor. Sounds a lot like clinical practice? We put a mixture of pieces of evidence together, and we discuss with our patient what

we think may happen if they follow our recommendations (or if they don't follow our recommendations).

The paraspinal muscles have been implicated as a major causative factor in the progression of idiopathic scoliosis. Therefore, the objectives of another study were to measure the EMG activity of the paraspinal muscles to determine its relationship to progression of the scoliotic curve. Idiopathic scoliotic patients were selected and identified afterwards on curve progression. Abnormal EMG findings at the apex of the scoliotic curve were found in both groups during sitting and standing. The most interesting finding was that children with progression of the curve also showed abnormal EMG readings at the lower end vertebra of the curve. The EMG "ratios" between the groups were significantly different from each other at the apex and end vertebrae for several test conditions. They concluded that EMG of the paraspinal muscles might be of value for prediction of progression in idiopathic scoliosis. (27)

As a chiropractor we might like to change these words to: "Therefore, EMG of the paraspinal muscles might be of value for prediction of progression in subluxation syndromes..."

Continuing with more research into scoliosis, a prospective study compared the SEMG activities of paraspinal muscles between normal subjects and patients with scoliosis before and after spine fusion. They investigated the functional changes of paraspinal muscles before and after spine fusion using SEMG. SEMG activities showed significant differences between normal control subjects and patients with pre- or postoperative scoliosis. After spine fusion, SEMG showed lower root mean square activity in the thoracic region and higher root mean square activity in the lumbar region. Patients with preoperative scoliosis showed lower median frequency in the thoracic region and higher median frequency in the lumbar region than normal subjects and patients with postoperative scoliosis. The group with preoperative scoliosis showed the least symmetrical paraspinal muscle activity, followed by the postoperative and normal groups. They concluded that patients with scoliosis present unbalanced SEMG activity in the paravertebral muscles, which is diminished by spine fusion, but does not return to the values found in normal subjects. (28)

There are a lot of gems in this research:

- 1) Abnormal spine morphology and function has associated abnormal SEMG findings compared to normal spine morphology.
- 2) A therapeutic intervention can be shown to produce positive changes in SEMG findings.
- 3) Fusing a curved spine doesn't completely resolve these abnormal findings, and may even lead to compensatory abnormalities...

One study may be perceived to be negative for the validity of SEMG: They assessed the reliability and construct validity of various electromyographic indices developed to assess back muscle weakness and muscle fibre composition. They conclude that readings were insensitive to differences in back muscle strength and did not appear to be related to muscle composition. (4)
We must remember that validity tells us whether we are measuring what we think we are measuring.

There is NO doubt that SEMG measure muscle tonicity – I'm not sure why the authors felt the need to try and correlate this with strength or fibre composition – I guess that the medical model always tries to attach a pathology to a dysfunction – but this can be a misleading and disappointing paradigm...

CLINICAL RELEVANCE

Does what we do make a difference to the measurements?

It would appear that SEMG is a reliable examination tool. It would also appear that it is valid to the practice of chiropractic because:

- It can measure muscle activity around the spine – the anatomy of most interest to the chiropractor.
- There is correlation with abnormal findings and symptomatic subjects.
- Abnormal findings seem to correlate as a predictor of deterioration in morphology or function
- It is a functional assessment helping us to correlate whether the symptomatic changes that we see in practice, are matched by functional changes.
- One might hypothesize that improvement in SEMG readings would indicate positive state changes in a patient's neuromusculoskeletal system.
- It is a neurological measure – moving beyond an anatomical, biomechanical or symptomatic assessment of a patient – SEMG is ultimately a measure of the nerve supply/activity to a muscle group. Chiropractic claims to be a profession that interfaces with neurological wellbeing, so it would seem very relevant to use neurological assessments to test this in every day practice.

So, is there evidence that chiropractic intervention is able to alter and even improve SEMG readings?

One study examined the effects of chiropractic adjustment on the muscles of the back. Vertebrae that are hypomobile may be held in that state by the erector spinae muscle group; adjusting such vertebrae should result in less muscle tension. By measuring the change in electrical activity, such relaxation can be observed. Hypomobile vertebrae were found by motion palpation. The patient was then placed prone and surface electrodes were placed over the upper trapezius, upper erector spinae (T3-T5), and lumbar erector spinae (L1-L3) muscle groups on both sides of the body. The patient was adjusted using full spine toggle recoil thrusts, and post-adjustment readings were taken. Results from this study showed that significant changes in muscle electrical activity occur as a consequence of adjusting. On average, a 25% reduction in muscle activity was observed across the 20 subjects tested, while no significant reductions were observed with the control group of 14 subjects. Significant reductions in side-to-side imbalances were also observed. (29)

One argument against the use of SEMG in chiropractic practice is that it doesn't tell us where a subluxation is, or in other words, it doesn't diagnose where someone needs to be adjusted. Why should it? There are many established chiropractic methodologies which achieve this outcome. But SEMG can act as an outcome tool, telling us whether our intervention is producing the desired results significantly beyond the realm of increased joint play or range of motion, or reduction of a symptom.

Another study systematically tested if spinal manipulative treatments (SMT) and the audible release associated with SMT cause activation of spinal muscles. SEMG activity was observed consistently after the onset of each of the fast SMTs, whether the treatment resulted in an audible release or not; for slow SMTs, there was never any visible electromyographical activity of the target muscles, whether the treatment resulted in an audible release or not. The results suggested that

fast treatment thrusts elicit muscle activation, whereas slow force application does not. The timing of the onset of the EMG response suggested that activation may be produced by a reflex response originating in the muscle spindles. It also appears that the audible release does not (by itself) evoke muscle activation or a joint proprioceptive reflex response as had been speculated in the literature. (30)

Chiropractic has maintained throughout its' history that the vectors and attributes of the adjustment differ from all other physical therapy modalities. On the other hand, other professions have tried to suggest that the specificity, force or speed are irrelevant on the basis that it is where you work and not how you work on the body that matters. The above study suggests that the former position may be more accurate. The bottom line is that a fast adjustive force does initiate change in the SEMG readings...

In another study ten young, asymptomatic male subjects underwent clinically relevant SMT along the length of the spine to test the magnitude and extent of reflex responses associated with the treatments. Each treatment produced consistent reflex responses in a target-specific area. The reflex responses occurred within 50-200 msec after the onset of the treatment thrust and lasted for approximately 100-400 msec. The responses were probably of multireceptor origin and were elicited asynchronously. This was the first study in which results showed a consistent reflex response associated with SMT. Because reflex pathways are evoked systematically during SMT, it was found there is a distinct possibility that these responses may cause some of the clinically observed beneficial effects, such as a reduction in pain and a decrease in hypertonicity of muscles. (31)

It would be easy to localise and minimise the findings of this study, saying that the reflex responses are ONLY local. Perhaps this is an avenue for future research? Do these reflex responses trigger change at the dorsal horn of the spinal cord, the cerebellum, the mid-brain, and even the pre-frontal cortex?

Previous studies demonstrated the existence of a reflex response, measurable by SEMG, after manually delivered SMT. This reflex response had been characterized as consistent, reproducible within individual subjects, and non-local because it extends beyond the site of manipulation. The next study characterized the reflex responses associated with SMT with an Activator by using SEMG to record the responses of 16 muscles before, during, and after treatment. Approximately 68% of the SMT thrusts resulted in a detectable reflex response. When a reflex response was observed, it always occurred close to the treatment site ipsilaterally and was detected in muscles that had either their origin or insertion at the vertebral level that was adjusted. They concluded that SMT delivered in this manner results in a reflex response that is both quantitatively and qualitatively different from a manual SMT. (32)

There are many methodologies and tools available to the chiropractor to deliver an adjustment. And sometimes there are arguments about which is the best. Perhaps a more mature position would be to recognise that each approach may offer a similar and yet different benefit, and that the existence of ALL the approaches offers a more comprehensive regimen to the consumer.

The objective of another study was to determine whether mechanical force, manually-assisted (MFMA) SMT affects paraspinal muscle strength as assessed through use of SEMG. The results of this preliminary clinical trial demonstrated that MFMA SMT results in a significant increase in

sEMG erector spinae isometric MVC muscle output. These findings indicated that altered muscle function may be a potential short-term therapeutic effect of MFMA SMT. (33)

Here we are seeing signs of bigger changes than just a local response to an impulse. We are seeing change in muscle performance/strength. This means that there is more than just input perception of the impulse, there is also an output reaction to the reflex...

The SEMG reflex responses associated with mechanical force, MFMA SMT were analyzed in another prospective clinical investigation of 20 consecutive patients with low back pain. Consistent, but relatively localized, reflex responses occurred in response to the localized, brief duration MFMA thrusts delivered to the thoracolumbar spine and SI joints. Patients with frequent to constant low back pain symptoms tended to have a more marked SEMG response in comparison with patients with occasional to intermittent low back pain. This was the first study demonstrating neuromuscular reflex responses associated with MFMA SMT in patients with low back pain. Noteworthy was the finding that such mechanical stimulation of both the paraspinal musculature (transverse processes) and spinous processes produced consistent, generally localized SEMG responses. (34)

We have seen previously that pain suffering patients tend to have more abnormalities in their SEMG readings – that is they are further from the norms. Now we see that this same population experiences bigger reflex reactions to a chiropractic adjustment. Is this change toward normal though?

Another paper examined the effect of SMT on SEMG activity in areas of localized tight muscle bundles of the low back. Electrodes were placed over the 2 sites of greatest paraspinal muscle tension as determined by manual palpation. SMT was administered to 8 participants using Activator protocol; the other 8 were treated using Diversified protocol. SEMG activity decreased by at least 25% after treatment in 24 of the 31 sites that were monitored. There was less than 25% change at 3 sites and more than 25% increase at 4 sites. The results of this study indicated that SMT induces a virtually immediate change, usually a reduction, in resting SEMG levels in at least some patients with low back pain and tight paraspinal muscle bundles. In some cases, SEMG activity increased during the treatment protocol and then usually, but not always, decreased to a level lower than the pre-treatment level. (35)

In other words SEMG readings approach towards normal after an adjustment.

A pilot study was conducted to evaluate the application of SEMG, as recorded with the Insight 7000 Subluxation Station, to the chiropractic clinical setting as an objective measure of change in assessing patient progress. Thirty patients under the care of 19 different supervised interns in a clinical teaching setting, were, over a four week period, administered a wide range of adjustments in accordance with a planned regimen of care. Findings revealed that all patients experienced a gradual to significant decline in SEMG activity in either the right and/or left side, in 14 of the 15 paraspinal muscular segments evaluated. This suggested a long term effect in SEMG activity changes, as opposed to a short term physiological response. (10)

Confirming the previous study we see that the delivery of chiropractic adjustments seemed to initiate reflex changes in the paraspinal muscles, and in this case we can see a progressive improvement through time, as opposed to a fleeting reflex relaxation.

So it would appear that we can make the claim that chiropractic adjustments do lead to a beneficial effect on what have been documented to be abnormal SEMG readings. The next question is does this correlate with proportionate positive changes in a person's state of wellbeing?

A preliminary study was conducted to evaluate changes in digital skin temperature, SEMG, and electrodermal activity in a group of twenty subjects receiving Network Spinal Analysis (NSA) care. Data, simultaneously derived from all three parameters, were considered to be indirect correlates of sympathetic nervous system activity. Care was administered to the NSA recipient group immediately after the baseline period, whereas controls received no intervention following baseline. SEMG readings were relatively constant over the five intervals following baseline in the NSA group, while controls showed significant increases in SEMG at the second through fifth intervals relative to the first interval following baseline activity. It was concluded that the increase in SEMG activity in the control groups may have reflected an increasing level of anxiety due to the duration of the recording period. Since the NSA group expressed constancy in SEMG activity during the same period, a "sympathetic quieting effect" was postulated to occur in subjects receiving NSA care. (36)

It has been my personal observation that it is rare to see big improvements in state of wellbeing measures without a proportionate improvement in functional indicators, including SEMG. On the other hand it isn't rare to see big improvements in functional indicators without a significant change in self-reported symptomatic history. However in these cases, there is often measurable improvement in broader issues of quality of life beyond the presenting complaint: For example, the SEMG readings are dramatically better, their chronic low back pain is perceived to be just as bad, but their quality of life has improved.

A case study described a woman, previously diagnosed with a lazy (reproductive) system, who became pregnant after commencing subluxation-based chiropractic care. A 31 year old woman presented to have her nervous system evaluated after her husband's encouragement. They were under medical treatment for infertility as they had been attempting to become pregnant for over 12 months. The initial chiropractic examination revealed increased aberrant autonomic and motor nervous system function detected on the thermography scans and SEMG scans, respectively. By the third month of care she reported having normal menses for two months and drug-free ovulation by month four. Nine months after chiropractic wellness care, the practice member conceived and proceeded to experience a successful full term pregnancy. After receiving wellness chiropractic care for the detection and correction of vertebral subluxations using Torque Release Technique (TRT), the practice member showed marked improvement in autonomic and motor system function as demonstrated on her SEMG and thermography scans. (37)

I am yet to read a study which documents significant deterioration in SEMG readings, AND a measurable improvement in some other bodily function or health outcome.

Another case study described the chiropractic care and progress of a female patient with a history of infertility; examining the relationship between D.N.F.T. specific care and the patient's clinical improvement and ultimate success in becoming pregnant. A 32-year-old female with a history of infertility sought chiropractic care in November of 2001. She had attempted to become pregnant since August 1999, with no success. SEMG showed significant muscle asymmetry, with a marked elevation of muscle tension on the left side in the area of L3. D.N.F.T. chiropractic analysis and correction were performed over the next six weeks and during this time, the patient's secondary

complaints of low back pain and headaches improved dramatically. A re-examination was performed on December 28, 2001. SEMG showed a substantial improvement in muscle symmetry, as well as a reduction in the muscle tension previously noted at L3. The patient's fertility specialists noted that her estrogen levels, endometrial thickness, and cervical mucus levels were all at more favorable levels than at the time of the first in vitro attempt. A second attempt at in vitro fertilization was made on February 17, 2002, and the patient had a positive pregnancy test on March 2, 2002. She remained under chiropractic care and was in her 34th week of pregnancy at the time of the paper. (38)

There is a lot of useful evidence in this single case study:

- 1) Substantial baseline of infertility
- 2) Associated spinal symptoms (for those that need this correlation)
- 3) Functional assessment findings
- 4) Third party confirmation of physiological and anatomical improvements
- 5) Improvement in symptomatic picture and functional assessment
- 6) Successful resolution of the disorder

Another case study demonstrated the importance of chiropractic care as an integral part of the healing process of a patient with a Traumatic Brain Injury (TBI). A 55 year old female patient presented to the office with a history of two automobile accidents which had both caused a number of physical symptoms including whiplash, loss of range of motion in her right arm, SI joint pain, shoulder pain, hand pain, parasthesias in the upper and lower extremities, and loss of balance. Complicating the healing process was the onset of depression and suicide attempt after the death of her husband, six years after the second automobile accident. TRT protocols were used to evaluate and adjust spinal subluxations as it provides a low force adjustment. Adjustments were performed twice weekly over the documented seven months of care. Within one month of care, the patient noted a decrease in symptoms and an improvement in her quality of life. Periodic re-evaluations demonstrated an improvement in physical findings as well as improvement in the function of her autonomic and motor systems as documented by thermal and SEMG scanning. The results of this case study indicated that patients with traumatic brain injury may benefit from including chiropractic care while healing from their physical and emotional stresses. (39)

Obviously this area of study necessitates further research – Chiropractic improving brain function is an exciting and promising field. It certainly won't be a new phenomenon that brain function improves after chiropractic, but it could be a paradigm shifting stimulus to see a change in the public and medical perception of chiropractic.

A case series presented the improvement in attention experienced by 9 adult patients undergoing Network Spinal Analysis. Nine adult patients were presented (4 male, 5 female) with a mean age of 40.4 years (range 22-58 years old). All patients were evaluated with the Test of Variable of Attention (TOVA) before receiving NSA care and at 2 months into care. Neurospinal integrity was evaluated with palpation, as well as SEMG. Cognitive process of attention was objectively evaluated using a continuous performance test, the TOVA Test. They evaluated their patient cohort before and after Network care using SEMG and variables from the TOVA Test. Before care, all patients had an abnormal ADHD score with a mean of -3.74. After 2 months of care, all patients had a significant change in ADHD score and 88% completely normalized the ADHD score. 77% and 66% of patients experienced significant change in reaction time and variability score,

respectively. All patients experienced a significant reduction in SEMG pattern of activation. The paper discussed possible mechanisms by which spinal care may have enhanced the function of the prefrontal cortex, thereby resulting in improved attentional capacities. (40)

ADHD has been described as the number one paediatric crisis facing our communities. There is also massive controversy of the use of psychoactive medications as the frontline approach to this disorder. To offer an approach which may resolve associated dysfunctions would be enormously beneficial to a large segment of the population.

Another case study described, discussed and tracked the subjective and objective changes of a 3½ year old autistic girl following chiropractic adjustments over a 10 week period. A 3½ year old female child with reduced social interaction and language skills and learning difficulties presented for chiropractic care. The child had been diagnosed with autism 1 year earlier. The child received full spine adjustments where indicated to reduce vertebral subluxation, using the TRT protocol and Integrator instrument. Strong verbal and physical apprehension to initial care was observed, however no signs of this were present after 5 visits, along with further improvements in social interactions, language skills and increased symmetry in SEMG and thermal scanning over the 10 weeks of care. The subjective and objective improvements observed by both practitioner and parents following chiropractic care indicated a link between subluxation and autistic behavioral patterns. (41)

In conclusion, it would appear that the use of SEMG in chiropractic practice is particularly relevant and useful. More studies monitoring the correlation between improvement in SEMG measurements and quality of life would appear to be warranted.

CASE SERIES

Comparison of SEMG findings in two patient populations is now presented: Patients before and after initial course of Chiropractic care, and reactivated patients before initial course of chiropractic care and then again after receiving no adjustments for more than six months.

We now present some data from my own practice files: Patients were assessed utilising an Insight Subluxation Station SEMG and adjusted using TRT assessment protocols and Integrator instrument adjustments. We will compare the SEMG “scores” between the following two patient sub-groups:

Patients After Initial Course Of Chiropractic Care – The SEMG readings of 144 consecutive patients (average age = 46.9, age-range = 8-83, 56 male, 88 female) in a single private practice who underwent an SEMG investigation prior to receiving chiropractic care and after completing an average of 12 (range = 5-28) chiropractic adjustments over an average of 18 weeks (range = 5-76).

Reactivated Patients – The SEMG readings of 100 consecutive patients (average age = 48.2, age-range = 10-91, 46 male, 54 female) in a single private practice who underwent an SEMG investigation prior to receiving chiropractic care; and after completing an average of 10 (range = 0-44) chiropractic adjustments over an average of 115 weeks (range = 27-397); discontinuing care and then reactivating after six or more months without an adjustment.

SEMG Score – Readings from the Insight Subluxation Station are converted to a “severity score”. Readings are recorded at bilateral paraspinal points at the levels of C1, C3, C5, C7, T1, T2, T4, T6, T8, T10, T12, L1, L3, L5 and S1. Each reading is compared to normative data and given a

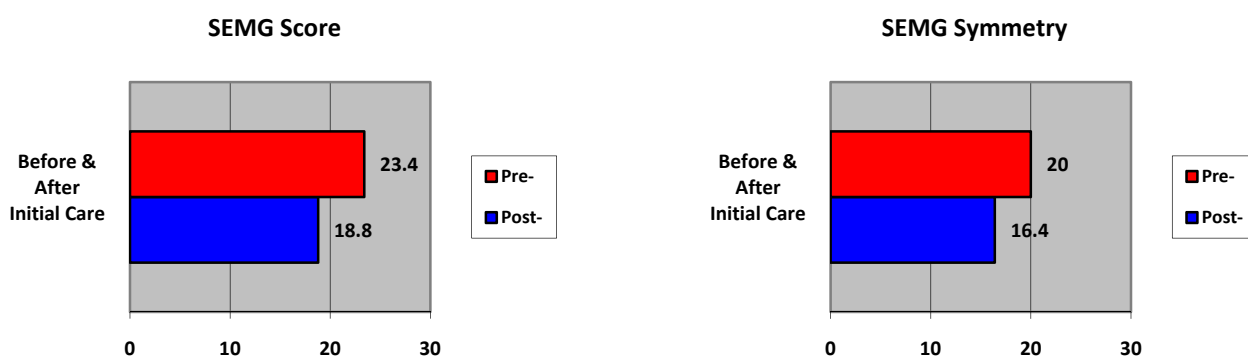
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score based on how many standard deviations that score deviates from the norm: One standard deviation gives a score of one, two standard deviations gives a score of two etc. These scores are then totalled to give an SEMG severity score. In simple terms this gives a rating of how far that person's readings deviated from the norms. The asymmetry between left and right readings is scored similarly. All SEMG analyses were performed by a single, highly experienced user in the same physical environment.

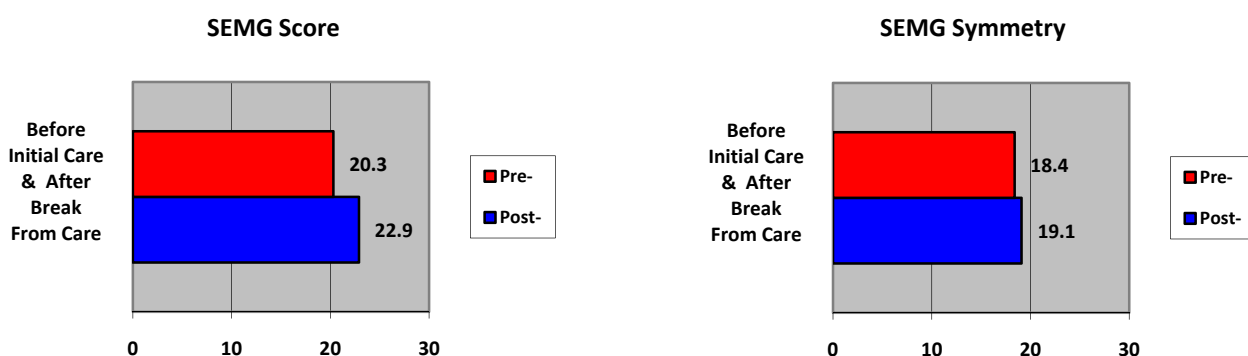
Results:

Results from the two populations are recorded below in chart form: The findings show an improvement of 4.6 points (20%) on SEMG score and 3.6 points (18%) on symmetry score in the initial care group; and a deterioration of 2.6 points (13%) on SEMG score and 0.7 points (4%) on symmetry score in the reactivated group. The actual scores suggest that any gains experienced during an initial care period are at least lost and probably actually deteriorate while not receiving care.

Patients before And After Initial Course Of Chiropractic Care



Reactivated Patients Before Initial Care And After Discontinuing For More Than Six Months



Conclusions:

In this population of patients (n = 144) that completed an initial phase of chiropractic care consisting of an average of 12 adjustments over an average of 18 weeks and underwent a re-examination, they experienced 20% improvement in their SEMG readings and 18% improvement in SEMG symmetry. In another population, the patients (n=100) who had undergone an initial examination, had received an average of 10 adjustments over an average of 115 weeks and

underwent a re-examination after not receiving care for greater than six months (n = 100), experienced 13% deterioration in their SEMG readings and 4% deterioration in SEMG symmetry.

These findings suggest that there is a therapeutic effect of the chiropractic adjustments in reducing abnormal SEMG readings, and that the natural prognosis for SEMG readings if not under chiropractic care is one of deterioration.

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