Ahead by a Neck

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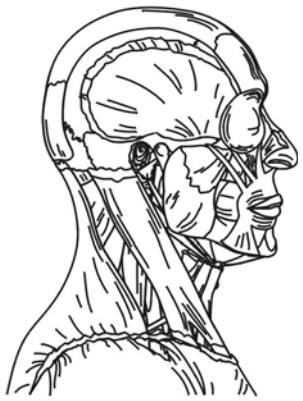
Introduction

The neck is a complex area that develops easily, because of its potential for growth from disuse atrophy (a factor that further means weak muscles). The neck includes several muscles used to move the cervical spine laterally from side to side (40° to either side from a neutral position), to flex from front/flexed to back/extended (126° total movement), in a rotary manner from left to right (approximately 180° total movement), and is involved in the elevation of the shoulder girdle. In total, this accounts for seven different directions in which the neck muscles are involved.



Muscle	Description/Location	Action
Sternocleidomastoid	Fleshy parts on either side of the neck	Prime mover in head flexion (dropping the chin forward); acting alone, each muscle rotates the head toward the shoulder on opposite side and tilts or laterally flexes head to its own side.
Scalenes	A muscle group that consists of three distinct muscles – middle, anterior and posterior scalene. Located more laterally than anteriorly on the neck, and behind the sternocleidomastoid.	Flexion and rotation of the neck (also elevates the first two ribs, to aid in inspiration, because of their attachment to those ribs).
Splenius	Two distinct muscles (splenius capitis and cervicis) located under the trapezius; known as 'bandage muscle' because it covers and holds down deeper neck muscles.	Extends or hyperextends the head; when spelnius muscles on one side are activated, the head rotates and bends laterally toward the same side.
Longissimus Capitis	Located under the trapezius.	Extends head and turns the face toward the same side.
Semispinalis Cervicis	Located under the trapezius; extends from the thoracic area to head.	Extends vertebral column and head and rotates them to opposite side; acts synergistically with sternocleidomastoid muscles of opposite side.
Trapezius	Most superficial muscle of posterior thorax, of the upper back and neck; flax and triangular in shape.	Stabilizes, raises, retracts and rotates scapula; superior fibers elevate scapula or can help extend head; inferior fibers depress scapula and shoulder.

The Need for Neck Training

The most neglected area of the body are the muscles surrounding the cervical spine, which muscles have an effect on spinal health in the same way that lumbar muscle strength has a bearing on low back integrity. While most fitness enthusiasts focus on the showy and larger muscles, such as the pectorals, the neck often is forgotten until a mishap occurs, and only then is direct neck training a consideration. The average person simply will not give much attention to the neck, which becomes injured easily as a result of its weakened state – progressive disuse atrophy and/or excessive forces imposed on the head and neck region. From a general perspective let us consider the various people who would benefit from specific and direct neck training.

Athletes have a need for strong developed necks, for reasons of injury prevention; football and hockey are the most evident, with the number one cause of death in football being the result of neck injuries. In fact, it was reported on February 3, 2006, through the University of Guelph, that whiplash is linked to concussion in hockey players, i.e., players who experience symptoms of a concussion after being injured on the ice also should be examined for whiplash-related disorders.

Jim Dickey, a professor of health and nutritional sciences, concurred. Of injuries among Ontario, Canada players from the recreational level to Junior A, "*whiplash-associated disorders and concussion occurred together in all of the hockey players who sought treatment, regardless of how they were injured"* (usually by collisions with other players or the boards, as well as fighting). The players studied included 183 individuals on 20 teams, ranging from age 15 to 35.

This is somewhat a recent correlation, since although other studies have been conducted on whiplash-associated disorders and concussions few studies have examined the relationship between the two. When viewed objectively, the whiplash-concussion effects hockey players experience at velocities of more than 25 mph (40 km/h) while skating is similar to the effects of a motor-vehicle accident, and the measure of impact on the football and rugby fields should not be underestimated either. The solution to this problem, at least one that will reduce the severity of injury if one were to occur, is to make the neck as strong and developed as possible, through direct exercise stimulus.[1] This should be considered a primary objective in sport strength and conditioning since ample evidence exists confirming that athletes who engage in contact sports for several years will sustain permanent damage to the neck.

Motor-vehicle accident victims who sustain injury to the neck have an obvious need for physical exercise for the area. Fortunately, most people who sustain whiplash will get better regardless of any intervention, viz., they will get better even if nothing is done. Unfortunately, for those who do need help, most of the modalities conducted by physiotherapists do nothing for chronic neck pain sufferers.

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[1] In 1975, a research program held at West Point Academy produced an average strength increase in the necks of its athletes of 91.92 percent in a period of only six weeks, and as a result of only twelve neck workouts of approximately eight minutes each.

Manual traction may be provided, and in some cases machine-driven traction, a treatment that can help in some instances since traction reduces the effects of a compression-related injury. When applying exercise, however, the investment of proper equipment often is overlooked, as physiotherapy patients are guided through various passive movements or the use of rubber bands and neck harnesses to which weight plates are added.

From my experiences, with both existing neck problems and those who did not have neck problems but who did eventually, the use of rubber bands or neck harnesses for resistive purposes should be avoided. The quality of tension and the angle of pull when using bands and neck paraphernalia leave much to be desired, and can cause more problems than they solve. Proper exercise involves working muscles in accordance to joint function, in a direct and rotary fashion, and although other muscles and joints can be trained with low caliber equipment with little concern most of the time, the neck is far too delicate for such consideration, and particularly in those injured or striving to optimize strength in the area, i.e., athletes.

The importance of exercise in treating neck injuries will be discussed shortly. But suffice it to say that Dr. Michael Fulton, MD, an expert in the field of spinal function and rehabilitation, believes *"that idiopathic problems with the cervical spine may be nearly as common as they are with the lumbar spine… Both research results and clinical experiences clearly indicate that the cause and effect situations that are responsible for most idiopathic lower-back problems are also responsible for a very high percentage of cervical problems. Damage to the soft tissue that both moves and supports the spine, the muscles, the tendons and the ligaments. Damage frequently caused by the fact that the soft tissue in these areas of the spine is very weak as a result of chronic disuse atrophy."*

The above is vital to grasp since there is a clear relationship between muscular strength and pain, in that an improvement in the former has a positive effect on the latter. This relationship exists since as a person strengthens muscle tissue, and works it properly and through a full (possible) range of movement, there will occur realignment (if damaged) and balancing of the tissues around the joint, which improves nervous communication, joint stability and correct anatomical configuration.

Moreover, strength changes to the lumbar and cervical spine areas often experience several hundred or even several thousand percent increases in function with proper exercise. Such results are not possible with other muscles among normal, healthy individuals, which factor implies clearly that the lumbar and cervical muscles are not 'normal' in the sense that they reduce function to a greater degree and much faster than other muscles and as we age. Animals that walk on all fours have improved leverage and positioning of the lumbar spine, with reduced strain to the area, and experience significantly fewer lumbar mishaps as a result. And those same animals must keep their heads supported constantly, which works the neck muscles regularly. Because of our biomechanics, our lumbar spines are always in a precarious state of potential injury, and our necks atrophy since our heads pivot atop our shoulders, which do not provide much exercise for the neck muscles.

The **general population** may not come to mind as an ideal candidate for neck training, as would be suggested by the absence of neck machines in most fitness facilities (or the lack of use when available), but everyone can benefit from proper neck training. If we consider how many people engage in recreational activities (thus making them athletes of some measure), or those who eventually will encounter a motor-vehicle accident (how many people do you know who have experienced whiplash?), then it is evident the importance of neck injury prevention, just as we consume Omega-3 to help protect against heart disease that 'may happen some day,' or have fire insurance on our home and belongings 'just in case.'

I have been in two minor and one major motor-vehicle accident, and without injury. I was lucky, but many people are not. And when attending amateur sporting events of friends or children, there often is one person who will sustain an injury, whether minor or severe, and sometimes it involves a concussion and/or neck injury. It does not take much for something to happen, and this particularly is true as we age and our functions and tissue integrity decrease. What may not hurt a 30-something can severely injure or kill a 70-something. But the stronger and more functional we become, the greater the forces we can tolerate, and the less the risk for injury or death. There is nothing wrong with developing the body for it to look good, to satisfy our egos and increase confidence, but part of the process of strength training is to protect us from injury. Consequently, why this is not a consideration for the neck is curious. Obviously the neck, low back and rotator cuffs need to be trained for health reasons, since once they are injured our daily lives can be affected

significantly. There is little benefit to having 18-inch muscular arms if you are hunched over in pain, or if your neck is so stiff and locked that you have to turn the entire torso to look left or right. With such injuries, suddenly you are unable to perform some exercises or are forced to use far less weight when training legs, back or chest.

Of course, not all neck problems are the result of injury, but can be caused by 'trigger points,' or those tight knotty spasms of muscle around the upper back and trapezius that serve to pull on and seize up the neck. These often are caused by stress, and can be reduced through means of relaxation, remaining calm when feeling under pressure, through direct exercise of the trapezius and surrounding neck muscles, and trigger point manipulation (deep tissue massage of the spasm; check the Backknobber at www.pressurepositive.com). And some neck problems can be treated through means of traction, such as the device sold through www.neckpro.com. Both trigger point manipulators and traction devices are part of a total neck program, however, unlike traction and chiropractic or massage/trigger point manipulation, increases in neck function, and the ability to resist strain and injury are the result of direct and targeted exercise. Moreover, as with traction, exercise of the spine can improve cervical disk hydration if implemented properly and with the correct equipment.

A Look at the Research

I work primarily with those who require rehabilitation, often from motor-vehicle accidents. The people I see filter through a clinical psychologist who specializes in pain management and biofeedback – to help people cope with their pain and change in lifestyles as a result of injury. Understand that most people who encounter an injury, whether through a motor-vehicle accident, a sporting incident or otherwise, do get better even without physical intervention. However, some people do not get better, even after 1-2 years of chiropractic and physiotherapy modalities. It is because of the poor results offered through traditional means that I am being sent these clients.

Ironically, specific and direct exercise of the lumbar and cervical spine, and their associated muscles, are not considered 'traditional' in many instances. Although a few dozen of both chiropractic and physiotherapy clinics exist in my city, with a 100,000+ population, none of them have invested in a lumbar extension or 4-way neck machine, although research clearly has indicated the value of specific and isolated exercise for these areas. For example, G. Bronfort, DC, PhD, et al, conducted a study entitled A Randomized Clinical Trial of Exercise and Spinal Manipulation for Chronic Neck Pain, *Medicine & Science in Sports & Exercise* Vol. 31, No. 1, pp. 18-24. 1999, whereby chronic neck pain patients were randomized to three groups:

1. Chiropractic only;
2. Chiropractic plus exercise;
3. Exercise only (MedX Cervical Extension Machine);

Of the six outcome measures, the patients in the group that received exercise only were rated best in four, tied for best in one, and second in another (patient satisfaction). Chiropractic alone finished last in all outcome categories, and it was concluded that adding passive modalities to proper exercise contributes nothing to the outcome except cost. Also bear in mind that the groups that received exercise did so on a biomechanically-correct exercise machine, and not through use of rubber bands, neck harnesses or manual resistance. This is vital to understand and recall from what has been stated previously, in that many inexpensive and traditional exercise methods for the neck place an unnatural strain and pull on the muscles and cervical joints, which may not be a factor with some people who have unusually strong necks and are not prone to such strain, but which can cause injury and pain in many others and are contraindicated in those proceeding through rehabilitation for a *chronic* neck injury.[2]

In another study published in SPINE (2002 Nov 1;27(21):2383-9), entitled Two-year Follow-up of a Randomized Clinical Trial of Spinal Manipulation and Two Types of Exercise for Patients with Chronic Neck Pain, Evans, R, et al came to some similar conclusions. With 191 patients with chronic neck pain, an 11-week randomized clinical trial

[2] *Acute* neck injuries should not be treated, except with rest and possibly traction prescribed through a qualified health care professional.

sought to compare the effects of spinal manipulation combined with 'low-tech' rehabilitative exercise, MedX cervical rehabilitative exercise, or spinal manipulation alone in patient self-reported outcomes over a two-year follow-up. Patient self-report questionnaires measuring pain, disability, general health status, improvement, satisfaction, and OTC medication use were collected after 5 and 11 weeks of treatment and 3, 6, 12, and 24 months after treatment, and the data were analyzed taking into account all time points using repeated measures analyses (178 of the patients completed the 11-week intervention phase, and 145 provided data at all evaluation time points over the two-year follow-up period).

The results concluded (particularly as time progressed) that there was an advantage for spinal manipulation combined with low-tech rehabilitative exercise and MedX rehabilitative exercise as opposed to spinal manipulation alone over two years, and are similar in magnitude to those observed after one-year follow-up. In effect, treatments that included supervised rehabilitative exercise are superior for chronic neck pain sufferers. This study did not show the superiority of MedX technology to low-tech methods in regard to outcomes, but the issues of safety on that point are discussed in the next section of this report.

Finally, in a study by Brian W. Nelson, MD, et al, entitled Can Spinal Surgery be Prevented by Aggressive Strengthening Exercise? A Prospective Study of Cervical and Lumbar Patients (*Arch Phys Med Rehabil* Vol 80, Jan 1999), the objective was to determine whether patients recommended for spinal surgery could avoid surgery through an aggressive strengthening program while using MedX rehabilitative equipment. Over a 2.5-year period, and with 60 patients who were informed they required surgery, 46 completed a 10-week strengthening program (38 were available for follow-up). Only 3 eventually required surgery after completing the program, whereas the remaining patients' outcomes were 'excellent' in 17 subjects (44%), 'good' in 14 (36.8%), and 'fair' in 4 subjects (10.5%), grouped in accordance to strength increases, range of motion and pain reduction. The authors concluded further: *"the average cost of the exercise rehabilitation program in this study was $1,950,"* whereas *"an average worker's compensation lumbar fusion costs $168,000, 86 times more expensive."*

The potential for change, as well as the cost-effectiveness of a MedX investment becomes obvious at this juncture, which takes into account the quality of equipment, but also how it is applied. One problem I have discovered in this industry is the reluctance of some physiotherapists to motivate clients to train hard, or hard enough to produce significant change (I firmly believe that few physiotherapists understand what hard, effective exercise is). Many of my clients claim they often used 2-3 pound dumbbells for upper body exercises as well as some passive exercise methods in water, even after being with a physiotherapist for 6-12 months. Some physiotherapists told these people to avoid any heavy lifting, whereas within a workout or two I was having them shrugging with 20+ pound dumbbells and performing scapula adduction exercises with at least 50 pounds. It is no wonder they made little improvement beforehand – their tissues were atrophying from disuse simply by using loads too light to *maintain* what function remained after injury.

An associated problem is (if you have a client train with sufficient intensity of effort and load) that you must do so cautiously and make certain mechanics are ideal, to prevent re-injury. When training the neck, it is difficult to keep the body aligned, the neck isolated, and a 'knowable' load on the tissues at a proper angle, and with direct rotary resistance throughout a range of motion when working with rubber bands, neck harnesses or using manual resistance techniques. I certainly would not want to try it, in fear of not being able to measure the forces properly, or what could be the trigger to future problems. Consequently, it became a necessity to invest in the MedX Core 4-way neck machine to insure confidence and competency in what I was doing for chronic neck injuries.

Moreover, besides encouraging patients to implement a sufficient intensity of effort, there is the issue of exercise volume and frequency. The lumbar muscles are not like many other muscles, and they tend to respond best to less frequent exercise and volume, such as one set every 5-7 days initially, and eventually once every 12-14 days thereafter (and every 3-4 weeks in some rare instances), and once a person reaches a high state of lumbar function and strength. The muscles surrounding the cervical spine also have been investigated. Large strength gains have been found in the cervical muscles using heavy enough loads that permit only 6RM.[3] However, 8-12RM also have been found effective[4],

[3] Maroon JC, Kerin T, Rehkopf P, McMaster J. A system for preventing athletic neck injuries. Phys Sportsmed 1977;5:77-9.

and which is a repetition guide suggested for preventing injuries in the necks of wrestlers,[5] and a prescription recommended for rehabilitation in response to cervical injury.[6] Moreover, Legget[7] and others found that some subjects experienced cervical discomfort if the RM load resulted in fewer than eight repetitions, which suggests that the cervical musculature may be too 'delicate' for heavy loads – or at least, for rehabilitation purposes and not without proper equipment and mechanics. Coincidentally, perhaps, cadets at The West Point Academy, in 1975, performed 12 repetitions on each position of a 4-way neck machine, which training produced an average strength increase of 91.92 percent in only six weeks and twelve workouts.

Set volume has always been in dispute, whereas some studies indicate that one set is not as good as multiple sets, or vice versa. There also is confusion as to whether that means one set per muscle or one set per exercise. The Legget research mentioned above noticed significant neck strength improvements with only one set of variable-resistance exercise performed to volitional muscular fatigue. However, better results were produced when exercise increased to two sets once a week or one set twice a week.[8]

The reason for the neck strength improvement with more volume or frequency is hypothetical from my perspective, but I suspect it is an issue of conscious and subconscious factors with safety and hesitation. Fundamentally, and rightly so, people are more hesitant to train the neck vigorously (even when motivated, I doubt many people, particularly chronic neck rehabilitative patients, reach full muscular fatigue). As a consequence, the added volume when trained once per week acts as both a mental and physical warm-up, and increases muscle inroad stimulus (and a resultant adaptive response). When trained twice a week for one set, the increased rate of frequency serves a similar purpose, as an added stimulus for better results. This is not to say that more sets and frequency are better, or all the time, but that this one study noticed a benefit in cervical muscle strength when doing so. These factors must be taken into consideration when working with neck rehabilitation cases, since, as stated, these people do not tend to exercise as hard as normal, healthy individuals, because of hesitancy of re-injury and pain associated with movement.

It may be questioned as to whether three weekly sessions would be better, for either a rehabilitation case or an able-bodied athlete. In regard to rehabilitation, I have found pain and discomfort to preclude three or more sessions per week, although there may be benefit during the initial 1-2 weeks when intensity of effort is very low and light 'pumping' work on a neck machine may improve healing initially by increasing blood flow and full range movement to the area. In regard to athletes, no *recent* research has been conducted specifically on neck training three or more times per week. However, and to return to the West Point Study of 1975, a group who did perform neck training three times per week produced an average strength increase of 56.72 percent in six weeks, as compared to the two-times-per-week group who gained 91.92 percent on average. Not all factors remained equal, in that the three-times-per-week group was unsupervised, unlike the other group. Nonetheless, the average difference in strength gain is significant enough to suggest that training the neck (and likely any other muscle group) three times per week produces diminishing returns.

Furthermore, The West Point Study conducted a sub-study, whereby two unsupervised groups (12 subjects in each) performed neck training over eight weeks, whereby one group performed a total of eight workouts (twice per week), and the other group twelve workouts (three times per week). The first group increased average neck strength by 41.6 percent, whereas the second group increased average neck strength by 39.8 percent. These findings suggest two things: 1) Supervision definitely makes a difference in the outcome, particularly when compared to the above noted group that increased by 91.92 percent in only six weeks; and 2) Training the neck three-times-per-week did not produce better results in this sub-study either.

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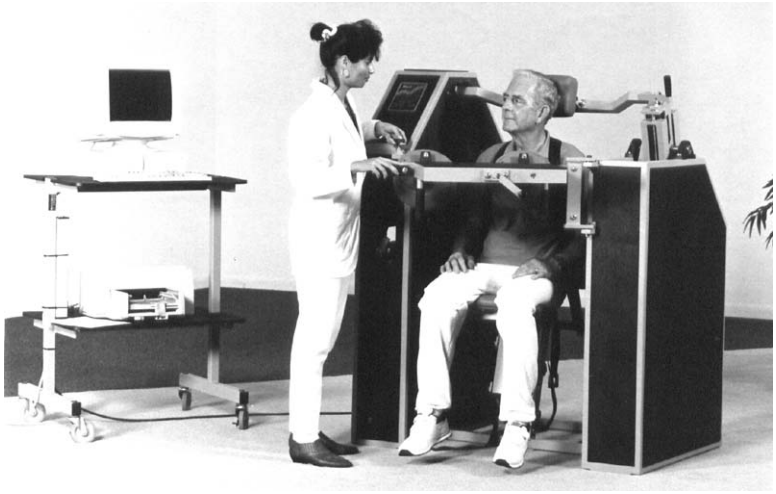
[4] Leggett SH, Graves JE, Pollock ML, et al. Quantitative assessment and training of isometric cervical extension strength. AM J Sports Med 1991;19:653-9.
[5] Wroble RR, Albright JP. Neck and low back injuries in wrestling. Clin Sports Med 1986;5:295-325.
[6] Vegso JJ, Torg E, Torg JS. Rehabilitation of cervical spine, brachial plexus, and peripheral nerve injuries. Clin Sports Med 1987;6:135-46.
[7] Legget.
[8] Pollock, ML, PhD, et al. Frequency and Volume of Resistance Training: Effect on Cervical Extension Strength. *Arch Phys Med Rehabil* 1993; 74:1080-6.

Neck Training Technology

Because the neck muscles are not subject to hard work in our daily lives, they progressively atrophy from disuse. However, and as a result, they also respond very rapidly to direct, full-range exercise, with significant results in strength and hypertrophy in a matter of weeks. The extent to which the muscles increase in strength can vary from week to week, as well. To explain, when testing neck strength, whether with healthy or injured individuals, it would be noted that flexion (produced by the anterior neck muscles) produces far less force output than extension (produced by the posterior neck muscles). And yet, that ratio alters, since the anterior neck muscles often will increase strength at a faster rate, perhaps because they are the most neglected and atrophied. The posterior neck muscles tend to get more work by keeping the head upright, and incidental stimulation whenever training the upper back muscles, including the trapezius, when performing shrug or row exercises.

Significant and full realization of neck development and strength requires proper equipment – i.e., a 4-way neck machine, with the first of its kind developed through Nautilus by Arthur Jones, in the early 1970s, who later sold the company to head MedX Corporation. Mr. Jones' transition was initiated to create highly-technical rehabilitation and testing equipment, which includes a cervical extension machine, pictured at right. The difference in quality between the old Nautilus machine and the new MedX machine is significant. The MedX Cervical Extension features a unique double-selectorized low-friction and low-momentum weight stack with a stroke length of only 1.5 inches during a full-range dynamic contraction. This short stroke length reduces internal friction and lowers the risk of impact forces.



MedX Medical Cervical Extension Machine

Its resistance selection is in ¼ ft. lb. (4 oz.) increments. The range of movement is selectable in 3-degree increments through the 126-degree range. An adjustable body-mass counterweight compensates for body torque, and the product is provided with the latest in computer technology for measurement and strength evaluation of the muscles of the cervical spine.

Although this machine has resulted in major technological and rehabilitative breakthroughs, it is limited to testing and affecting extension only. Fortunately, and while implementing many of the same features of a double-selectorized low-friction and low-momentum weight stack with a short stroke distance, MedX developed a Core 4-way neck machine, shown on the second page of this report.

Made of the same quality construction as the medical machines (the original neck and back machines from the early 1980s still are functional and in excellent working condition today), there are several features of the MedX Core 4-way neck machine that cannot easily or cheaply be duplicated by other manufacturers, and so it is wise to comparison shop carefully while taking into consideration far more than price alone. First, MedX machines have extremely low friction, which is essential for the neck since that muscle group exercises against much lower loads than other body parts, and any measure of friction is both noticed quickly and will hinder smooth movement.

Most other neck machines' weight stacks work up and down on guide rods, and to eliminate friction sufficiently with such a design, a pair of linear bearings would have to be inserted in every plate, and not just the top plates, which would be technically complicated and expensive. A more affordable solution would be composite bearings (plastic with Teflon or other low friction compounds), but this still would at least double the friction of the linear ball bearings. To work around this MedX uses a patented weight stack that completely eliminates the guide rods.

The issue of friction should not be underestimated. Because of this machine's low friction rate, the eccentric phase of the movement feels far more challenging that with other neck machines, others of which feel 'spongy' as the friction transfers from the moment arm to weight stack. The MedX Core 4-way neck feels equally challenging at the start, middle and end of the range of movement, although there is a significant difference in forces because of the cam design. This particular feature is necessary to provide the correct resistance profile to match the profile of the neck's strength curve.

Another feature of the MedX neck machine not found elsewhere is a low inertial weight stack, which means a reduction of the effects of inertia during the start and end points. In effect, the weight stack moves less than half the distance of the standard 12-inch stroke found in the remainder of the MedX exercise line. Together with the reduced friction, these features ensure that the resistance presented to the trainee is close to the ideal as possible for the entire range of motion.

Next, the MedX Core 4-way Neck Machine's moment arm is adjustable in five different positions to enable an easy change for variations in starting position, either from person to person or from exercise to exercise, whether performing an extension, flexion or lateral flexion movement. At the end of the moment arm is a contoured and comfortable pad to absorb higher pressures common with extension and flexion exercise. This head/face pad pivots, which is helpful for trainees working without an instructor or clinician as it allows the positioning of the adjustable seat and the support pad to be slightly less sensitive, i.e., you do not have to be 'exactly' positioned for the movement to feel proper. Conversely, a fixed pad could restrict the range of movement if the user was even slightly off axis, thus causing a binding or uneven pressure to the pad. In any case, the benefit of a pivoting pad certainly is experienced when performing the lateral flexion exercise.

As important, the machine's support pad helps to brace the body, whether positioned against the back, side or chest, depending on the exercise. Also part of the machine's architecture are various hand grips and foot pegs, which serve to further stabilize the upper body while disengaging the lower extremities from the floor, thus providing a neutral position for the pelvis. For further details on this invaluable machine, visit www.CoreSpinalFitness.com.

Strength Testing

Strength testing can be done on the MedX Core 4-way Neck machine, by way of a hand-held force gauge[9] (placed at the back of the moment arm at the head pad; see photo at left), and with the neck tested isometrically. Clients/patients slowly exert for five seconds, until reaching a maximum effort; that effort is held for two seconds, and then pressure is eased off for another five seconds. To establish some degree of 'exact positioning,' while reducing the effect of stored energy, gravity (the weight of the head), and even pain associated with excessive flexion, extension or lateral flexion in rehabilitation clients, I test all four positions with the head in an upright, neutral position, which is approximately 60-degrees in the case of full range cervical extension.

[9] Force gauges are available through several sources, although I recommend www.CSCForce.com, since they specialize in digital and mechanical force gauges in several industries, including rehabilitation and human function measurement and assessment.

Cervical extension normative data for males and females are available through the University of Florida Center for Exercise Science and MedX Corporation, although such data for lateral flexion and forward flexion currently do not exist. Nonetheless, comparisons can be made, at the very least, with extension values. Through a full range of 126-degrees of cervical flexion, and by testing hundreds of 'un-injured' individuals, the following has been established at the point of about 60-degrees (when the head is approximately upright):

Males	Females
Below Average: 290 inch-pounds isometric torque	Below Average: 150 inch-pounds isometric torque
Average: 350 inch-pounds isometric torque	Average: 190 inch-pounds isometric torque
Above Average: 410 inch-pounds isometric torque	Above Average: 230 inch-pounds isometric torque

Knowing the above[10], we can make comparisons in the following manner: When exerting against a force gauge, the subject produces a reading in pounds and ounces. The length of the moment arm on the MedX Core 4-way Neck machine is 7.375 inches. If a person would to exert 30 pounds of force, times (x) this amount by 7.375 inches, which gives a reading of 221.25 inch-pounds of isometric torque. Conversions can be made to metric accordingly.

Here are two examples of starting data while producing force during extension; one from a woman who experienced a neck injury from an automobile accident and one from a high-school wrestler who soon will be competing at the Commonwealth Games. The woman, age 40, produced a force of 20.5 pounds; a week later she produced a force of 19.3 pounds, to confirm the reliability/quality of effort produced on her initial test. Thus, an average of about 20 pounds was produced, or 147.5 inch-pounds of isometric torque. This places her below average in strength, by one standard deviation. This is important to note since, as stated, there is a strong correlation between strength and pain, whereby the stronger the tissues become in an injured body part (the more functional the area becomes), the less pain experienced.

In the example of the wrestler, who naturally has a thick and short neck, and who performs various exercises including the wrestler's bridge, he produced a force of 53.7 pounds at approximately 60-degrees. This equates to 396 inch-pounds of isometric torque, or about one standard deviation above normal.

[10] With males, there is about a 60 inch-pound difference among those below average, average, and above average. Therefore, if a person can produce 60 inch-pounds more torque than average, he is one standard deviation above normal; if he can produce 120 inch-pounds more torque, then he is two standard deviations above normal.