Beyond the SCM: Anatomy of the Neck and Its Clinical Implications

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Disclosure

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Objectives

1. Identify anatomical structures of the neck and thoracic inlet: muscles, fascia, organs, nerves, arteries, and bones
2. Identify physiological, functional and symptomatic issues associated with tightness in the above structures in infants and children.
Outline

• Anatomical review with self-palpation of neck/supraclavicular structures
• Discussion of symptomology to be aware of with overstretching/compression of neurovascular structures
• Clinical implications, evaluative procedures, treatment suggestions
• Case studies
• Summary & Questions

Anatomy of neck

• Muscle and fascial layers
• Neurovascular anatomy through layers
  - accessory n
  - cervical nerves
  - ant neck & trachea/vagus
  - subclavian a
  - brachial plexus
• Signs of overstretching nerves: phrenic, brachial plexus, vagus, cervical plexus
Cervical Fascia

• Tubes within tubes
• Anteriorly: visceral sheath (trachea, esophagus, thyroid)
• Posteriorly: vertebrae
• Laterally: blood vessels
• Muscles and fascia

Superficial cervical fascia: Loose, disorganized connective tissue. Surrounds external jugular vein.

Self-palpation
Sternocleidomastoid: Manubrium of sternum & medial clavicle to mastoid process of temporal bone & via aponeurosis to lateral ½ of superior nuchal line of occiput. *(Palpate sup to inf)*

Trapezius: Med 1/3 superior nuchal line of occiput, SP C1-C7, T1-T12 to acromium to lat 1/3 clavicle, acromium, scapular spine
Punctum Nervosum: sensory branches of cervical plexus nerves emerge at posterior border of SCM (at C3 level)

Self-palpation: From angle of mandible, go posterior to SCM & Inferior 1 vertebral level to feel for punctum nervosum

Cervical Plexus: sensory innervation to...

- **Lesser occipital nerve**: scalp posterior to ear
- **Greater auricular nerve**: scalp/skin of mastoid process & parotid gland, outer ear
- **Deep transverse cervical nerve**: skin of ant/lat neck
- **Supraclavicular nerves**: skin above & below the clavicle

Spinal Accessory Nerve

- Cranial root: origin medulla
- Spinal root: origin - lat aspect of ventral horn in spinal cord from 6th cervical segment to junction of spinal cord with medulla. The fibers go sup through foramen magnum
- Spinal root joins with cranial root, exiting thru jugular foramen

**Spinal Accessory Nerve**

- Pierces SCM 3 cm from mastoid process (at level of C3, behind angle of mandible)
- Within SCM, SAN receives branches of C2-C3, creating Ansa of Maubrac
- Exits SCM at posterior border at level of hyoid/C4 (Kierner A et al 2000, Dailiana et al, 2001)

Suboccipital nerve: (C1 posterior branch) innervates rectus capitus posterior minor between occiput/C1 (connected to spinal duramater) & vertebral artery

Greater occipital nerve: innervates posterior cranial dura, scalp & pierces trapezius

**Self-palpation: Find Greater Occipital N & C2 Posterior N**

- From sup nuchal line (midline @ EOP), go 1 finger lat, 2 fingers inf
- (If feel pulse of > occ artery, just go medially)
- Find C2 nerve: from C2 spinous process, go laterally & cephalad into laminar groove to feel nerve & bud
Mid-cervical fascia

- Fascia of infrathyroid muscles and pretracheal fascia
- Attachments:
  - Sup: hyoid
  - Inf: upper border of scapula near the scapular notch (origin of omohyoid), post edge of clavicle, scalenus tubercle and cartilage of rib 1, medial clavicle and post sternum.
- Functions:
  - Orient the hyoid muscles
  - Surrounds all veins (brachiocephalic, thyroid, subclavian), thus maintains the patency of veins.

Middle cervical fascia

Sternohyoid

Sternothyroid

Omothyoid

Self-palpation: Superficial & Middle Cervical Fascia

Superficial cervical fascia

Visceral Sheath: Contains trachea, esophagus & thyroid gland

Visceral sheath:
- Thyroid gland
- Trachea
- Esophagus

Vascular sheath:
- Carotid artery
- Jugular vein
- Vagus nerve

Self-palpation: With back of your fingers, gently feel trachea. Swallow, that movement is esophagus. Just lateral & posterior, feel pulse of carotid artery. Within the vascular sheath with jugular vein & vagus nerve.
Deep Cervical/Prevertebral Fascia (32 & handout)

- Covers longus colli, longus capitus and scalenes
- Deepest part goes from occiput to T3, where it fuses with anterior lig
- Anterior scalene attaches to tubercle of 1st rib
- Finding anterior scalene or subclavian artery can guide us to brachial plexus, pleural dome
Deep cervical fascia

Prevertebral fascia

Longus colli

Anterior scalene

Medial and posterior scalene

Levator scapula

Self palpation of anterior scalene
Sit slouched. Backs of fingers 2-4 between 2 heads of a of SCM. Feel TPs. Follow sternal head to sternum. Post is ant scalene.

Phrenic Nerve
- Mostly C4, some C3, C5
- Mixed motor (diaphragm) & sensory
- Sensory: pericardium, pleura, diaphragm, upper peritoneum.
- Connects to: subclavian n, stellate ganglion, vagus, hypoglossal, and sympathetic nerves of the neck.

* Clemente (1997) Anatomy p.448

Subclavian artery & brachial plexus descend posterior to clavicle, between clavicle & 1st rib.

Consider implications of compression on clavicle when stretching.

Subclavian artery & brachial plexus pass under pectoralis minor.

Consider tension of pectoralis minor.

Muscle Spindle Physiology

- **Intrafusal Muscle Fibers**: fibers of muscle responsible for sensing the muscle length and, the rate of change of muscle length. Sensory organ within intrafusal fiber = muscle spindles
- **Extrafusal Muscle Fibers**: responsible for muscle contraction

*Positional Release Therapy: D'Ambrogio & Roth. Mosby 1997*
Muscle Spindle Physiology

- When muscle stretched, impulses go to spinal cord (via Ia & II neurons)
- Synapse in ventral horn of spinal cord
- Gamma motor neurons send impulses to muscle spindle to contract spindle as a protective mechanism so muscle does not get overstretched or torn
- Alpha motor neurons send impulses to extrafusal fibers to contract

Gamma Gain

- In resting conditions, gamma motor neurons maintain a level of discharge into the intrafusal muscle fibers, such that there is always some muscle tone (not flaccid).
- Gamma motor neurons are like a volume control, creating more or less background tension in the muscle.
- Gamma motor neurons are under control of the bulboreticular formation of the brainstem
- So, if too much gamma gain, person has high resting tension in muscle, or in CNS lesion, spasticity
- If someone has more activated ANS, normal resting muscle tone is higher

What happens with muscle spasm?

- If the muscle is quickly stretched or overstretched, impulses are sent back via Ia afferents to spinal cord at that level, above & below, & to brain.
- Gamma motor neurons send impulses back to intrafusal muscle fibers to further contract muscle to protect it from injury
- If gamma activation continues or is higher than usual, muscle spasm continues
Nocioceptors: Pain receptors

- Found in body’s connective tissues including muscles, ligaments, tendons, joint capsules, the outer wall of all larger blood vessels, visceral fascia (peritoneum) and in the neural fascia (epineurium/dura). (Schleip, R 2003)
- Nocioceptive reflex is spinal reflex, such that if you touch a hot burner, you quickly take your hand off.

Peripheral Nerve Innervation

Nervi nervorum – nerve of nerve

2 types:

**Sympathetic fibers:**
- Around arteries, regulating vascularization due to diameter change

**Multinodal fibers:**
- Innervates CT of peripheral n’s, n roots, & ANS/visceral NS
- Nerve monitors its own sensitivity & noception
- Neuropathic pain


Nocifensive Reflexes

- **Nocifensive reflexes:** muscle contracts in response to noiceptor activation (pain) in the involved tissues. (How the body protects inflamed or damaged tissues).
- **Nociautonomic reflexes** are neural connections to the autonomic nervous system that can result in autonomic responses such as vasodilation, bronchodilation, or gastrointestinal stasis. Skeletal muscle, for example, (due to the presence of beta adrenoreceptors) will “engorge” or swell under the influence of these reflexes due to the release of chemicals such as histamine and bradykinin. (Van Buskirk RL 1990)
Inappropriate Stretching

- Gamma gain is high causing increased muscle spasm
- Nociceptive reflex activated: pain & increased muscle spasm
- Nociautonomic reflex activated

*The American College of Sports Medicine recommends that for maximal effect, stretching should NOT exceed the point of discomfort. (Garber et al 2011)

Revisiting nerves and muscles…what are we stretching?
Consider implications of compression on clavicle when stretching.
Signs of Possible Irritation/Compression of Nerves in Neck/Supraclavicular Area

- **Punctum nervosum**: increased sensitivity to skin in and around lateral neck, scalp, head
- **Greater occipital** (posterior branch of C2): increased tension in posterior trap, sensitivity in back of scalp
- **Phrenic**: hiccups, diaphragmatic spasm
- **Accessory**: increased tightness in SCM, trap
- **Brachial plexus**: Tension around shoulder, may contribute to difficulty weight bearing in prone

**Appropriate Stretch: Clinical Practice Guidelines** (Kaplan et al 2013)

- Stretch without stimulating the nociceptors and nervi nervorum (stretch without causing pain) (Van Buskirk RL 1990, van Vlimmerman 2006, Taylor 1997)
- Low-intensity, sustained, pain-free stretches to avoid microtrauma (van Vlimmerman 2006)
- If the baby is crying, neck ROM does not increase, muscle tightness still present, your stretching is not helping.

**Physiology of Stretching**

- Muscle afferents responsible for cardiovascular changes:
  - Group III – mechanoreceptors – sensitive to mechanical forces.
  - Group IV – metaboreceptors – sensitive to metabolic changes.
  - Elicit cardiovascular changes through parasympathetic withdrawal (tachycardia) and sympathetic activation (HR).
- Valsalva maneuver (VM) reduces the venous return, cardiac output (induces a baroreflex responses) and increases BP.
  - (Farinatti 2011, Lima 2011)
The nucleus of the tractus solitaries receives afferents from the carotid baroreceptors via the glossopharyngeal nerve and from the aortic baroreceptors from the vagus nerve (Klingler 2014).

Vagus Nerve

- Sensory from ear, pharynx, larynx, palate, face, epiglottis, esophagus, lungs, abdominal viscera
- Motor to pharynx, larynx, palate, thoracic & abdominal viscera

Vagus Nerve

- Important part of the ANS
- Often involved with dysregulation of the ANS
Signs of ANS dysregulation/vagal nerve

- Digestion issues: reflux, bloating, gas, constipation
- Baby with irritability
- Baby who is easily overwhelmed
- Baby who is not sleeping well
- Baby who does not want to make eye contact, or with vacant eyes, dissociating.
- Baby who is tacitly defensive (pulling away, muscles tightening).
- Baby with breathing difficulties, or noisy breathing.

Nerve Reflexes to consider

- Laryngeal Cough Reflex: Yim et al (2010) demonstrated that irritation of the internal branch of the superior laryngeal nerve (branch of vagus nerve) causes a cough and a color change.
Superior Laryngeal Nerve

- Branch of vagus nerve
- Sensory to larynx, back of tongue, epiglottis & vocal cords
- Motor to cricothyroid muscle, inferior constrictor and laryngeal mucosa
- When tight or aggravated, affects swallowing, speech, produces cough

(Yim et al 2010)

The sensory nucleus of the trigeminal nerve also receives afferents from the Gasserian Ganglion and has efferent connections to the MOTOR nucleus of the vagus nerve (Klingler 2014).

Tissue response to trauma

Aggressive stretching/positioning may perpetuate microtrauma and inflammation (Ercole 2008).
Habitual posture/chronic tissue deformation

Scarring of soft tissue leading to trigger point/nodule

Localized tissue ischemia or edema

Connective Tissue Tightness Mechanism

WHOLE BODY ASSESSMENT

Beyond the SCM: What else do you notice?

• Elevated shoulder
• Flared ribs
• Internally rotated shoulder
• Trunk flexion
• Elevated pelvis
• Increased hip external rotation and abduction
• Tibial internal rotation
• Tightness through metatarsals/metacarpals
SURROUNDING THE NECK

Fascial tightness

Upper trap is prominent while SCM is being stretched

Fascia has contractile ability

- Straubesand et al (1996) verified the ability of human fascia to actively contract and identified the presence of myofibroblasts or smooth muscle cells embedded within the fascia itself (Yahia LH, et. al (1993), Straubesand J, et. al, 1996).
- Subsequent experiments performed by Schleip in 2006 verified the presence of Type III and IV sensory endings, autonomic nerve fibers and contractile cells in fascia

Alternatives to Manual Stretching

- Myofascial release
- Joint Blocking
- Elastic Taping
- Positional release
- Neural manipulation
FASCIA BASICS

- Fascia is comprised of:
  - connective tissue that surrounds and links bones, muscle, vessels and nerves
  - smooth muscle cells, giving it the ability to contract
  - Fascia also glides on itself; this allows for glide/shear between the structures it surrounds
    - (Klingler 2014, Stecco 2013)

- Studies now show that fascia has a mechanical role in movement and force generation
- Additional myofascial units may be recruited over time if the original injury is not treated immediately (fibrosis)
- Tension causes the fascia to shorten and solidify anywhere along the line of pull
- Fascia will begin tightening down before changes are noticed in the muscle itself
  - (Klingler 2014, Stecco 2013)
WHAT IS MYOFASCIAL RELEASE?

• A gentle sustained pressure to treat soft tissue dysfunction causing increased tissue heat to increase viscoelasticity (Stecco 2013, Mattein 2009, Stern 2006).

• Soft tissue dysfunction can include (Stecco 2013):
  – limited AROM/PROM,
  – soft tissue adhesions, soft tissue tightness, and/or postural or alignment dysfunction.

• Does not add tension to the neurovascular bundle under or within the tissue being stretched.

MYOFASCIAL ASSESSMENT/TREATMENT

• Maintain body mechanics

• Use the flat of your hands, not your fingertips

• Lightly traction the skin in all directions (like a compass) to determine area of restriction

• Approximate maximally restricted tissues to allow realignment

ELASTIC TAPING
ELASTIC/FLEXIBLE TAPING

- Principles of elastic taping make it a suitable modality for relaxing tight muscles/fascia.
- Depending on the degree of tightness and the patient’s tolerance, use relaxation techniques specific to the manufacturer.
- Consider taping larger muscles due to skin sensitivity at the neck.

ELASTIC TAPING

- Trim to fit patient’s size.
- For muscle techniques: “Insertion to Origin in a lengthen position.”
- Consider relaxing: cervical extensors if have a capital extension moment, traps, pectoralis, latissimus, arm, trunk extensors, trunk fascia, leg.
- Educate parents on cues of adverse reaction: stress cues, changes in eating/sleeping patterns, inconsolable.

JOINT BLOCKING

- Uses positioning and body weight for a slow, low load “joint mobilization.”
- Use to treat pelvic malalignment.
- By correcting pelvic malalignment, you create normalized tissue length lower in the chain allowing for increased slack in the soft tissues higher in the chain.
- EXAMPLE: to correct an upslip, place a small towel roll under the upslip ischial tuberosity with the baby in supine. Can repeat as needed until neutral alignment is reached.
“Pseudotumors”: Tender Points/Fascial tightness

• With fibrosis, there are vascular changes, often edema, then ischemia, so these areas need special consideration.

• In order to release these areas, often the muscle/fascial/neural/vascular structure needs to be shortened to decrease gamma bias, and inhibit the nociceptors, the nocifensive & nociautonomic reflexes

Positional Release Techniques

These techniques are the opposite of direct stretch, such that the muscle or joint is moved towards comfort to allow muscle spindles to rest & reduce nociceptive activity. They all use tender points (TPs) and position of comfort or ease. Differences:

• Strain-counterstrain: uses TPs and reports of decreased pain to assess efficacy of treatment (Jones 1997)
• Functional positional release: uses TPs, but relies on decreased muscle hypertonicity, not pain
• Facilitated positional release: indirect MFR, uses TPs, position of ease, then distraction, shear, etc to further decrease tension
• Total motion release for tots: indirect treatment in position of ease

Total Motion Release for Torticollis
Positional Release Techniques
Research

Strain/counterstrain
• Systematic Review/meta-analysis: reduction of pain TPs, no harm, only adults (Wong 2014)
• Decreased Hoffman reflex in patients with Achilles tendonitis (Howell 2006) & plantar fasciitis (Wynne 2006)

Neural Manipulation

• Neural Manipulation (NM) is a gentle hands-on therapy which helps to free up the nerves and the connective tissue around the nerves (dura mater), the bones around the brain (cranium) so that the nervous system functions better. (Barral & Croibier 2007)

NM & UE Nerves

• NM can release compressed brachial plexus' & UE nerves, thus allowing greater shoulder girdle mobility & UE to develop strength
• Gibson quotes Hilton, British anatomist and surgeon of the early 1800's, "The same trunk of nerves whose branches supply a joint also supply muscles that move the joint and their articular insertions, as well as the skin covering the joint" (Gibson, 1955).
NM/VM Neck & Thorax

By releasing:

- Left vagus nerve: help with protective muscle spasm L lateral neck
- T1/T2, ribs 1 & 2: help with retraction of L ribs, scapula

By releasing C2 (greater occipital nerve, help to release trapezius, C1, C2 and posterior cranial duramater

By releasing:

- L Accessory N: help to release and lengthen L SCM, trapezius
- L Phrenic N: help to release C3-C5, anterior ribs and diaphragm
- L brachial plexus: help to free clavicle, 1st rib, anterior shoulder tension
Neural Manipulation Research

• Most studies have been performed with “neural mobilization”, which is stretching the nerve through active movement along the nerve’s pathway. (This might be what we are doing with direct manual stretching of the neck).

• With Barral & Croibier’s neural manipulation, the neural restriction is first released gently in the “direction of ease”, where the tissues want to go, and only when the nerve is ready to lengthen, do you lengthen the nerve. One never fights with a nerve or tight tissue, otherwise the nerve tightens to protect itself.

Neural Mobilization/Stretching Research in Adults

• Much clinical research has been done by Barral, Croibier (2007, 2009) and therapists trained in this technique; however, EBP is lacking both with adults and children.

• Chhabra’s study of 37 subjects with cervico-brachial pain concluded that neural tissue mobilization was a more effective treatment approach than cervical lateral glide (Chhabra et al., 2008).

• By using high-resolution ultrasound, Coppitiers and colleagues (2009) confirmed that the median nerve was longitudinally lengthened with six different neural stretching exercises.

• In a systematic review of 10 articles pertaining to neural mobilization, Ellis and Hing (2008) found current research to be lacking in the quantity and quality needed to support the use of neural mobilization.

WITH YOUR NEW RANGE

• Strengthen cervical flexors depending on age and tightness:
  – Find the pacifier in either SL or supine depending on strength
  – Visually attend to a toy at eye level then bring toy slowly down to chest area
  – In sitting maintain a neutral pelvis while playing with toys at or below waist level
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Resources

To learn more about Neural Manipulation, contact www.barralinstitute.com

To learn more about TMR tots, contact https://tmrseminars.com/