Scalene Trigger Points & Trombone Performance: A Comparative Study

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Professor Mark Hetzler, Trombone
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Professor John Stevens, Tuba/Euphonium
Professor John Aley, Trumpet
Professor Uri Vardi, Cello

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This project is dedicated to all musicians—past, present and future—those who seek a more natural way in their playing. A way which will help ultimately uncover the true potential that is waiting to once again be revealed.

ABSTRACT

The purpose of the present study was to investigate the prevalence of anterior, medial and posterior scalene trigger points (STP's) in trombone performers. Additional relationships between musculoskeletal pains, the presence of trigger points, and performance related problems were also examined.

Data was obtained from 100 collegiate and professional-level tenor and bass trombonists throughout the United States. Participants completed an anonymous Performance & Pain research questionnaire, which was generated through the *Qualtrics* Online Survey Software System. Trombonists of all ability levels, of at least eighteen years of age, were invited to participate in the study.

Participants were asked specific questions regarding their previous and current experiences with physical pain from which trombone playing was suspected as a contributing factor, as well as to note additional observations involving their level of perceived exertion during various aspects of performance.

It is the hypothesis of this study that an examination of the physical sensations experienced by trombone performers will reveal a pain/symptom pattern that is consistent with those generated by the presence of trigger points in the scalene musculature. Therefore, identifying and treating trigger points in this area would result in a decrease of pain and a corresponding increase of performance efficiency.

While further research and follow-up data is still needed, the survey results suggest a high probability of STP's in trombonists—a large percentage of the reported symptoms can be attributed to the phenomena of STP's and their pain referral patterns.

Most interesting, however, are the unexpected data findings revealed by Data Cross-Tabulation Chi Square Analysis, which suggest statistical significance between specific pain, tension and playing problems.

CONTENTS

DESCRIPTION

Musicians move to make music, but optimal movement often proves elusive for performers. While a 'perfect movement' cannot truly exist due to the genetic asymmetries of natural human variation, valuable information can be observed in the identification of muscle-tension patterns in musicians.

Due to the static positions and prescribed motion required of the body during instrumental performance, the potential exists for movement dysfunction and resulting pain. Movement compensations can range from subtle to gross, with accompanying pain severity ranging from mild to acute, to chronic. It can be expected that most musicians will encounter at least some degree of pain in his or her career.

While muscle pain complaints frequently confront the medical practitioner, trigger points and their associated pain referral patterns remain poorly understood. Consequently, a focus on drug-related treatments and misdiagnosis are ubiquitous. Travell and Simons, pioneering figures in the phenomena of trigger points, attribute this to the general flaws that exist in today's medical education programs, which do not sufficiently instruct the clinician in functional anatomy, kinesiology and muscle testing techniques.[1] Additionally, they assert that trigger points are the primary cause of pain in approximately 85% of cases, and may play a role in virtually every pain complaint.[2]

A solution might be found in the area of advanced neuromuscular therapy, however, highly trained therapists who can successfully treat trigger points are rare, and many national massage training programs neglect the area altogether.[3]

A clinical approach of the problems associated with the repetitive nature of a specialized movement-based practice is currently lacking, but remains essential for the alleviation of corresponding muscle-tension patterns in musicians. Therefore, the identification of trigger point tendencies in musicians not only has a direct impact on the field of musical performance, but one that extends to neuromuscular therapy, rehabilitation and medical communities as well.

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1 Travell and Simons, The Trigger Point Manual 1983, *Forward* pg. vii

2 Davies, Musculoskeletal Pain from Repetitive Strain in Musicians 2002, pg. 42

3 Davies, The Trigger Point Therapy Workbook 2004, pg. 255

SIGNIFICANCE

The physical requirements of trombone playing can invite the development of STP's in even the most efficient of players. For example, habitual, vigorous breathing and holding the arms in front of the body for extended periods are common causes of such strain.[4] The scalenes are also partially responsible for holding the skull in proper postural alignment, thus a forward head position, a common occurrence in trombonists, can activate and tax the scalene musculature. Additionally, further tension patterns are created in situations where performance ergonomics are less than ideal and become especially evident in students.

The trombonist faces awkward postural situations from their very first experiences with the instrument. Students are often encouraged to share music stands in elementary curriculums, creating an environment where negotiating the instrument while trying to see the music becomes problematic. Students will often contort their posture in order to manipulate the slide around or under the music stand frame, which encourages a poor postural relationship with the horn. With this excess expenditure of muscular effort, trombone students, not surprisingly, slouch, or tilt their head or torsos in compensation—postures that directly stress the scalenes.[5] Unfortunately, trombonists often carry these learned patterns well into their college and professional careers because their neurology has been programed to accept this unnecessary muscle strain from the earliest stages of their development.

Scalene tension and their development of trigger points are not only the result of early postural concerns for the trombonist, but that of conceptual situations as well. A misunderstanding regarding range development and sound production is also common among trombonists, whom frequently tense the scalenes during both mouthpiece buzzing and in altissimo passages, and/or exercises. This type of excessive tension causes even more stress during breathing, which in turn creates more tightness in the upper-back and neck, and an unconscious cycle of attempted physical corrections slowly emerges.

The notion of muscle 'knots' and 'tension' induced by the repetitive stress experienced by musicians is not a novel observation. Interestingly, no current body of research attempts to encompass the relationship between instrument-specific repetitive movements and their resulting trigger points—particularly in wind players. Some unofficial information can be found online, and the articles of Clair Davies constitute an excellent resource on the general topic of trigger points. Davies' articles are especially pertinent for the pianist regarding wrist and forearm pain alleviation.

With voluntary skeletal muscles constituting one the largest organs of the human body, accounting for more than 40% of bodyweight, and muscle pain complaints constituting 85% of patient medical visits, it is surprising that muscle treatment receives so little attention in

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[4] Davies, The Trigger Point Therapy Workbook 2004, pg. 81

[5] Ibid.

modern medical school curriculums and textbooks.[6]

Skeletal muscles are extremely vulnerable to daily 'wear and tear' with unrecognized trigger points constituting a major source of muscular pain and dysfunction. However, they remain largely neglected by the medical community. Bones, joints, nerves and medication receive the primary focus of most physicians.[7]

Current forms of therapy include drugs, exercises, stretching, splinting and rest. These therapies remain largely unquestioned, even thought they fail to solve the problems experienced by many musicians. Therefore, with chronic pain and movement disorders continuing to affect musical careers, it seems worth questioning if the medical community has overlooked something of value outside the boundaries of these more accepted practices.[8]

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[6] Travell and Simons, The Trigger Point Manual, pg. 5

[7] Ibid.

[8] Davies, Musculoskeletal Pain from Repetitive Strain in Musicians 2002, pg. 42

PROCEDURE

The International Review Board's requirements involving Human Research Subject Training and corresponding protocols have been satisfied and the research proposal approved.

A *Performance and Pain Questionnaire* was created through referencing the clinical texts of Travel & Simons involving trigger points. Additionally, the physiological requirements involved with trombone performance along with common Kinetic Chain human movement compensation principles, as determined by the National Academy of Sports Medicine, were considered to complete the survey.

Utilizing Qualtrics Survey Software to generate the Performance Pain Survey, a participant sample size of 100 collegiate and professional trombonists was recruited using a combination of social media advertisement and emailed invitations. Emails with research recruitment information were sent to both university trombone studios and professional orchestras. All identifying information settings, such as online data tracking codes and individual computer IP addresses were disabled to ensure anonymity among the participants.

Data was analyzed using a combination of generated reports, graphs, and Chi Square cross-tabulation tables to determine significance and to identify potential relationships between subject-reported symptoms and performance related problems.

HYPOTHESIS

It is the hypothesis of this paper that the physical sensations experienced by trombone performers will reveal a pain and symptom pattern consistent with those generated by the presence of trigger points in the scalene musculature, and that identifying and treating trigger points in this area will result in a decrease of pain and a corresponding increase of performance efficiency.

The null hypothesis (H*o*) assumes no association between the presence of scalene trigger points, specific pain patterns, and the act of trombone playing.

The alternative hypothesis (H*a*) claims some association between the variables of existing trigger points, experienced physical pain, and trombone performance.

LIMITATIONS

Limitations of the study involved challenges associated with general survey taking. Data has the potential to be skewed because question interpretation is subjective. While it was the hope of the research team to encourage more truthful and open responses by controlling participant anonymity, a resulting potential downside is that the information cannot be verified and 'ballet box stuffing' remained possible.

Additionally, the parameters surrounding technical musical terms were absent from the survey and may, therefore, constitute some inconsistencies between participants. For instance, a large majority of participants indicated 'high notes' as problematic, but what constitutes a 'high note' was not mandated by the questionnaire.

Finally, only manual muscle testing techniques can verify the presence of trigger points with certainty. While the collected data provides information regarding the likelihood of the relationship between scalene trigger points and trombone performance, a follow-up verification test is still needed for confirmation.

DATA SUMMARY

The results suggest that the majority (77%) of trombonists surveyed have experienced pain that they associate with the physical act of trombone performance.

Specific symptoms that would suggest the possibility of STP's and corresponding percentages as reported by the study respondents are as follows:

Neck Pain—88%
Forward head posture, slouching, and feeling the need to hold ones shoulders back—78%
Hand Pain—56% [Swelling & Tingling-32%]
Pain in the Upper Back—52%
Shoulder Pain—47% [58% reporting pain specifically in the left shoulder]
Arm Pain—39% [70% reporting pain specifically in the left arm]
Anxiety—29%
Depression—16%
Tendinitis—14%
Sleeplessness—10%

While the raw data provided by the trombonists suggest that the presence of STP's are probable, a statistical analysis shows the pain patterns to be inconclusive, in-part due to the inconsistent and somewhat mysterious patterns of pain that the scalenes generate. For instance, symptoms vary between individuals, pain may be sent to additional areas of the body, and symptoms are frequently misdiagnosed.

However, because the data does suggest that a large percentage of the reported pain patterns do reflect the potential of STP's, the alternative hypothesis (H_a) cannot be rejected.
The following Survey Analysis Graph represents the collected data:

Survey Respondent Analysis

Survey Reporting Dates: 07/14/2012—08/19/2012

Report Subgroup: Filtered By "Consent" Only

1. What is your gender?

#	Answer		Response	%
1	Male		80	80%
2	Female		20	20%
	Total		100	100%

2. Is your primary instrument Tenor or Bass trombone?

#	Answer		Response	%
1	Tenor		87	87%
2	Bass		13	13%
	Total		100	100%

3. How many years have you been playing the trombone?

#	Answer		Response	%
1	0-3 years		0	0%
2	3-6 years		4	4%
3	6-9 years		24	24%
4	10 years +		72	72%
	Total		100	100%

4. Do you mostly practice sitting or standing?

#	Answer		Response	%
1	Sitting		37	37%
2	Standing		63	63%
	Total		100	100%

5. On average, how many hours per day do you play the trombone? Please include rehearsals, performances, etc.

#	Answer		Response	%
1	Less than 1 hour		9	9%
2	1-2 hours		23	23%
3	2-3 hours		21	21%
4	3-4 hours		16	16%
5	4-5 hours		15	15%
6	More than 5 hours		16	16%
	Total		100	100%

6. Which of the following best represents your level of personal daily stress?

#	Answer		Response	%
1	None		1	1%
2	Mild		19	19%
3	Moderate		41	41%
4	Consistent		32	32%
5	High		6	6%
6	Very High		1	1%
	Total		100	100%

7. On average, how many hours per night do you sleep?

#	Answer		Response	%
1	0-4		0	0%
2	4-6		13	13%
3	6-8		81	81%
4	More than 8 hours		6	6%
	Total		100	100%

8. Have you ever experienced physical pain or discomfort on account of playing the trombone?

#	Answer		Response	%
1	Yes		77	77%
2	No		23	23%
	Total		100	100%

9. Have you ever, or do you currently experience any of the following?

#	Answer		Response	%
1	Headaches or migraines?		24	31%
2	Eye-Strain or fatigue?		21	27%
3	Muscle or joint pain, tension or discomfort?		60	78%
4	None of the above		12	16%

10. Do you ever experience pain or discomfort in your NECK?

#	Answer		Response	%
1	Yes		32	42%
2	No		45	58%
	Total		77	100%

11. Indicate any of the following sensations felt in your neck.

#	Answer		Response	%
1	Burning		3	9%
2	Tingling		1	3%
3	Numbness		1	3%
4	Pain		28	88%
5	Weakness		9	28%
6	Other:		4	13%

Other: (Neck Sensation Text Responses)
Tension and stiffness, muscles pulling on the bone in terrible uneven ways
Soreness
Tension
Stiffness

12. Do you ever experience pain, discomfort, or abnormal sensations in your THROAT?

#	Answer		Response	%
1	Yes		16	21%
2	No		61	79%
	Total		77	100%

13. Indicate any of the following sensation felt in your throat.

#	Answer		Response	%
1	Burning		3	19%
2	Tingling		2	13%
3	Numbness		0	0%
4	Pain		6	38%
5	Difficulty Swallowing		6	38%
6	Other:		5	31%

Other: (Throat Sensation Text Responses)
Clicking
Sore
Discomfort from tension
Raspy, grating "kkkkk" sound/feeling while playing
Tightness, closed feeling

14. Do you ever experience pain or discomfort in your BACK?

#	Answer		Response	%
1	Yes		54	71%
2	No		22	29%
	Total		76	100%

15. Indicate any of the following sensations felt in your back.

#	Answer		Response	%
1	Burning		5	9%
2	Tingling		2	4%
3	Pain		32	59%
4	Weakness		9	17%
5	Numbness		3	6%
6	Aching		48	89%
7	Other:		2	4%

Other: (Back Sensation Text Responses)
Misaligned and tightness

16. Which area(s) of your back do you experience the sensation? (Check all that apply.)

#	Answer		Response	%
1	Right		9	17%
2	Left		8	15%
3	Both		10	19%
4	Upper		28	52%
5	Middle		20	37%
6	Lower		31	57%
7	Other Combination:		1	2%

Other Combination: (Anatomical Zone-Back Sensation Text Responses)
Usually mid lower, but the upper goes with the neck pain

17. Do you ever experience pain or discomfort in your SHOULDER?

#	Answer		Response	%
1	Yes		36	47%
2	No		41	53%
	Total		77	100%

18. Indicate any of the following sensations felt in your shoulder.

#	Answer		Response	%
1	Burning		6	17%
2	Tingling		6	17%
3	Numbness		5	14%
4	Pain		27	75%
5	Weakness		10	28%
6	Limited or Painful Mobility		11	31%
7	Other:		6	17%

Other: (Shoulder Sensation Text Responses)
Protraction
Fatigue when playing for an extended period of time. Always in my right shoulder, never in my left.
Shoulder raising to ear without control
Tension, Muscle Soreness (left over from sports injury; not caused by trombone)
Soreness
Ache

19. Where do you experience the sensation in your shoulder?

#	Answer		Response	%
1	Right		10	28%
2	Left		21	58%
3	Both		8	22%
4	Front		5	14%
5	Back		12	33%
6	Lateral (side)		4	11%

20. Do you ever experience pain or discomfort in your ARM(S)?

#	Answer		Response	%
1	Yes		30	39%
2	No		47	61%
	Total		77	100%

21. Indicate any sensations felt in your arm(s).

#	Answer		Response	%
1	Burning		7	23%
2	Tingling		7	23%
3	Numbness		8	27%
4	Pain		19	63%
5	Weakness		15	50%

22. Indicate which arm and region.

#	Answer		Response	%
1	Right		6	20%
2	Left		21	70%
3	Both		4	13%
4	Upper Arm		7	23%
5	Forearm		15	50%
6	Both Arms		2	7%

23. Do you ever experience pain or discomfort in your HAND or WRIST?

#	Answer		Response	%
1	Yes		43	56%
2	No		34	44%
	Total		77	100%

24. Indicate any sensations felt in your hand or wrist.

#	Answer		Response	%
1	Burning		3	7%
2	Tingling		10	23%
3	Numbness		17	40%
4	Pain		34	79%
5	Swelling		4	9%
6	Weakness		16	37%
7	Other:		4	9%

Other: (Hand or Wrist Text Responses)
Joints around metacarpals pop into place; do not move fluidly
Ache
Tension
Stiffness

25. Which hand or wrist?

#	Answer		Response	%
1	Right		5	12%
2	Left		31	72%
3	Both		7	16%
4	Other Combination:		1	2%

Other Combination (Text Response):
Mostly right, some left

26. Do you ever experience pain or discomfort in your FINGERS?

#	Answer		Response	%
1	Yes		26	34%
2	No		50	66%
	Total		76	100%

27. Indicate any of the following sensations felt in your fingers.

#	Answer		Response	%
1	Burning		1	4%
2	Tingling		6	23%
3	Numbness		14	54%
4	Pain		15	58%
5	Swelling		3	12%
6	Weakness		11	42%
7	Other:		4	15%

Other (Text Response):
Ache
My fingers locking into place when I play.
Trigger finger, middle finger of right hand
Tension

28. Which fingers do you experience the sensation?

#	Answer		Response	%
1	Right		6	23%
2	Left		18	69%
3	Both		3	12%
4	Thumb		13	50%
5	Index		12	46%
6	Middle		17	65%
7	Ring		9	35%
8	Pinkie		8	31%
9	Other Combination:		0	0%

29. Is there any additional area of the body where you are experiencing tension, stiffness, pain or other discomfort?

#	Answer		Response	%
1	Yes (please describe)		19	26%
2	No		53	74%
	Total		72	100%

If Yes, please describe:
Tension- sometimes in throat (glottis area) in attempt to change embouchure. Usually carry excess tension in upper back/shoulders.
Face tension, shoulder stiffness
TMJ discomfort
Rhomboid muscle strain from breathing hard
Lips, jaw
Front dental pain from mouthpiece pressure
Left ankle
My Mouth and cheeks
Connecting the skull to the jawbone: usu. right side experiences tightness/tension, pain, and shifts its normal position left to right.
Abdomen
Left leg and gluteus. Sacroiliac. Right foot. Nerve issues in right leg.
Feet
Some inflammation/swelling on the lower lip, side
Lips after playing a very long time
Hamstring, knee, lower leg, feet
Lip tissue
Lip
Embouchure- too much mouthpiece pressure when going for higher notes
Occasional pain in embouchure from too much pressure / over practicing

30. Do you experience any of the following conditions/symptoms?

#	Answer		Response	%
1	TMJ Syndrome		7	8%
2	Osteoarthritis		7	8%
3	Tendinitis		13	14%
4	Fibromyalgia		1	1%
5	Tennis Elbow		7	8%
6	Frozen Shoulder		2	2%
7	Carpal Tunnel Syndrome		1	1%
8	Tinnitus (ringing in ears)		23	25%
9	Tightness in Chest		7	8%
10	Increased Heart Rate or Nervousness		20	22%
11	Concentration Problems		18	19%
12	Focal Dystonia		1	1%
13	Depression		15	16%
14	Irritability		13	14%
15	Anxiety		27	29%
16	Insomnia		9	10%
17	Other:		6	6%
18	None		23	25%

Other (Text Response):
Embouchure injury: possible dystonia. Some dystonic symptoms that are hard to gain control over.
Scar tissue in torso/back muscles
Possibly TMJ; no formal diagnosis, but some symptoms present & in family
Really bad vision
Reduced stamina
Meniere's disease

31. "My posture could use improvement."

#	Answer		Response	%
1	Not True		22	22%
2	Somewhat True		53	53%
3	True		25	25%
	Total		100	100%

32. "I often feel the need to stand up straighter or hold my shoulders back."

#	Answer		Response	%
1	Not True		41	41%
2	Somewhat True		38	38%
3	True		21	21%
	Total		100	100%

33. "I would benefit from achieving less physical tension in my playing."

#	Answer		Response	%
1	Not True		11	11%
2	Somewhat True		29	29%
3	True		60	60%
	Total		100	100%

34. "I feel that my breathing habits could use improvement."

#	Answer		Response	%
1	Not True		15	15%
2	Somewhat True		41	41%
3	True		43	43%
	Total		99	100%

35. "I feel or have felt tension in my neck/throat while playing the trombone."

#	Answer		Response	%
1	Yes		49	49%
2	No		51	51%
	Total		100	100%

36. "I have noticed this tension while playing in..."

#	Answer		Response	%
1	Loud Dynamics		27	59%
2	Soft Dynamics		13	28%
3	In the Upper Register		33	72%
4	In the Lower Register		6	13%
5	Other:		4	9%

Other (Text Response):
Middle register is the most difficult, surprisingly.
Multiple tonguing
When I haven't played in a few days and am starting to play loudly for the first time
For long periods of time [of playing]

37. "I need to take breaks during my practice in order to give my left arm a rest..."

#	Answer		Response	%
1	Never		20	20%
2	Rarely		29	29%
3	Sometimes		35	35%
4	Often		16	16%
	Total		100	100%

38. "My slide technique is effected by tension in my right arm..."

#	Answer		Response	%
1	Never		43	43%
2	Rarely		34	34%
3	Sometimes		19	19%
4	Often		4	4%
	Total		100	100%

39. "The area of my trombone playing that requires the least amount of daily work/maintenance is..."

Text Response
Sound=24
Slide Technique=7
Flexibility=6
Range=5
Legato=5
Articulation=3
Middle Range=3
High Range=2
Embouchure=2
Low Range=1
Technique=1
Staccato=1
Multiple Tonguing=1
Sight Reading=1
Breathing=1
Slurring=1
Soft Low Sounds=1
Endurance=1

40. "The area of my trombone playing that requires the most amount of daily work/daily maintenance is..."

Text Response
High Range=16
Articulation=15
General Efficiency=12
Flexibility=10
Low Range=6
Endurance=6
Multiple Tonguing=5
Slide Technique=4
Technique=4
Intonation=3
Consistency=3
Improvisation=2
Embouchure=2
Sound=2
Accuracy=2
Range=2 (unspecified)
Mid Range=2
Legato=1
Musicality=1
Reading=1
Rhythm=1
Short Articulations=1

UNEXPECTED DATA FINDINGS

Data cross-tabulation has revealed a relationship between the trombonists who experience performance associated pain when compared to three data sub-groups: (1) those who reported feeling tension in the throat/neck while playing, (2) those who practice standing over sitting, and (3) those who feel that their posture could use improvement.

An additional performance related relationship appears to exist between participants who report tension in the throat while playing and those who experience problems in both the upper register and at loud dynamics.

When comparing the aforementioned statistically significant subgroups, the data also shows a 25% increase of reported tension in the upper register among players who mostly practice sitting versus those who practice standing. Interestingly, while tension in loud dynamics corresponds to tension in the throat—as does tension in the upper register—loud dynamic tension appears to be unaffected by seated versus standing practice habits.

Finally, a significant relationship is present between those experiencing problems in both the upper register and at loud dynamics in comparison to feeling that ones general "posture could use improvement," especially regarding "holding the shoulders back."

DISCUSSION

The clarity between causation and correlation remains ambiguous, and is undeterminable by the parameters set forth in this study. That is to say, are trigger points more likely to appear in those who play with tension in the upper register, or is it the presence of trigger points in the scalenes that causes the issue?

Throat tension can be onset by the act of more vigorous breathing, and has been observed in athletes and is an indicator of the possibility of STP's[9] as is the feeling that ones posture needs improvement—particularly regarding holding the shoulders back. Because the breathing habits of trombonists can be compared to those of athletes in terms of involved mechanics and exertive fatigue, the data supports the assertion that there is a possibility of STP's within the subgroups, which could encourage the friction in the air column that results in the experienced tension.

STP's could also be the unsuspecting culprit in the formation of satellite trigger points (see terminology definitions) in other muscle groups, and therefore may be responsible for many of the additional symptoms reported by trombonists who experience pain. For example, one

[9] Davies, The Trigger Point Therapy Workbook, pg. 81

participant specifically assumes that his labored breathing is due to tension in his rhomboid muscles, which are in the upper back between the shoulder blades and the spine. In fact, STP's are known to generate satellite pain and activate trigger points in these larger, more prominent muscles of the upper back.[10]

It appears that the physical effort inherent in trombone playing seems to activate STP's in many players, and is shown to be particularly probable in the following: those who have noticed tension in their throats while playing, those who have encountered difficulty playing in the upper register and at loud dynamics, and/or those who practice while seated.

STP's also seem probable from observing that the areas of high range, articulation and general efficiency were reported as the top three performance areas in need of "the most daily work" by the participants. Tightness in the throat as relates to a disrupted air column not only affects the upper register and loud dynamics, but also has a profound impact on the efficiency and clarity of articulation.

[10] Ibid. Pg. 80

SUMMARY

The purpose of this study was to investigate the prevalence of STP's in trombone performers. Additional analysis included the examination of relationships between physical pains, the presence of trigger points, and performance related problems.

The Performance and Pain Questionnaire was successful in providing responses from 100 collegiate and professional trombonists throughout the United States over the age of eighteen.

The most compelling findings gathered by this study were found in data response cross-tabulation, which revealed an unexpected relationship between trombonists who experience performance associated pain within three data sub-groups: (1) those who reported feeling tension in the throat/neck while playing, (2) those who practice standing over sitting, and (3) those who feel that their posture could use improvement.

Additionally, further analysis showed an additional relationship to exist between the subgroups themselves. Participants who reported tension in the throat while playing also experience problems in the upper register and at loud dynamics. Furthermore, a 25% increase in upper register tension is present in players who mostly practice sitting, as compared to their standing-practice-counterparts. While throat tension seems to be the common denominator in both upper register and loud dynamic issues, tension at loud dynamics appears to be unaffected by seated vs. standing practice habits.

Finally, a significant relationship is present between those experiencing problems in both the upper register and at loud dynamics in comparison to the feeling that one's "posture could use improvement," and a need to "hold the shoulders back," both of which symptoms suggest the presence of STP's.

The hypothesis of this study suggested that the physical sensations experienced in trombone performers would reveal a pain and symptom pattern consistent with those generated by the presence of STP's, and therefore, their identification and treatment would result in a decrease of pain and an increase of performance efficiency. While the collected data provides information regarding a strong likelihood between STP's and trombone performance, proper manual muscle testing verification is needed for verification.

The results of the Performance & Pain Survey suggest a high probability of STP's among trombonists, and for this reason, the alternative hypothesis (H_a), which assumes some relation between the variables of STP's, experienced physical pain, and trombone performance, can not be rejected.

Therefore, the null hypothesis (H_0), which assumes no association between the presence of STP's, specific pain patterns, and the act of trombone playing, can be neither accepted nor rejected until manual muscle testing verifies the presence of STP's in trombonists via a follow-up study.

FURTHER DISCUSSION

The symptoms experienced by trombonists as collected in this study provide a mean calculation value of 67% in regard to specific STP's pain patterns. The most problematic performance related problem was throat & neck tension during playing in the upper register, as reported by 72% of participants, and at loud dynamics, as reported by 59% of participants; both performance issues are also statistically significant when comparing throat & neck tension, and an additional postural issue associated with STP's—the need to hold one's shoulders back for improved posture.

Additional individual data responses which confirm the suspicion of STP's is as follows:

- "I would benefit from achieving less physical tension in my playing"= 89%
- "I feel that my breathing habits could use improvements"= 84%
- "My posture could use improvement"= 78%
- "I often feel the need to stand up straighter or hold my shoulders back"= 59%
- Tinnitus (ringing in ears)= 25%

Hand pain is yet another indicator of STP's and was reported in 34% of participants, 69% of which was identified in the left hand, specifically the thumb (50%) and pinkie (31%). Pain of this nature and in this specificity is especially indicative of STP's.

The sum data, particularly when viewed in combination, strongly suggests the presence of STP's in trombone performers and further demonstrates the need for follow-up manual testing. All of these symptoms are specific to the problems generated by STP's and contribute to the frequent misdiagnosis and confusion among patients seeking care.

Many of the symptom patterns caused by STP's are not inclusive to the neck and may be felt in satellite areas of the body, as demonstrated above. However, the potential for onset can arise from faulty neck mechanics as directly relates to the poor posture often seen in trombonists.

It must be remembered that the function of the neck is more than a simple supporting foundation designed to hold the weight of the head; the cervical spine and corresponding musculature form a remarkable structure that allow head movement in all planes of motion as well as stabilization in various positions within these planes.

The natural contour of a healthy spine smoothly arcs in three parts, beginning with (from top to bottom) a slight anterior curve at the neck (cervical), a posterior curve through the upper back (thoracic) and a return to an anterior position in the low back (lumbar). However, with the typical faulty postures commonly found in trombonists, the alignment of the head itself may not change while the alignment of the neck architecture, in fact, does.

Because the entire spine and head naturally seeks balance, the result of one problematic area can easily extend to the other curvatures as well. This creates 'False Fulcrum Forces' (FFF) on the body, which in turn causes excessive pressure on joints, compression in the spine, and general muscular tension and inflammation in the body. Additionally, the spine is not the only area affected by such postural alterations. The mechanical compensation to excessive rounding of the upper back directly is a collapsed chest, which causes cardiopulmonary inefficiency and shoulder protraction (inward-type tilting). Such alternations directly hinder the breathing structures, and it is safe to suggest that chronic problems of the neck may indeed result from faulty posture of the entire torso. Not surprisingly, this postural 'cause & effect' has a significant impact on the efficiency of trombone playing.

Moreover, the neck is very vulnerable to stress and injury. Occupational and recreational activities that demand altered positions of the head will likely result in alignment and muscle imbalance issues. A demonstrating example as seen in trombonists is the slight tilting of the head towards the left shoulder, likely caused by the physical construction of the instrument. The left shoulder may rise slightly to provide a base of support for the instrument to rest, while the left ear tilts downward in compensation. The entire corresponding core musculature then asymmetrically contracts while the pelvis shifts—one hip rising higher than the other. The adjustments continue downward as the performer may then lock the knees and/or shift his weight primarily to one leg. Practicing from this position informs the nervous system that this faulty body posture and the act of trombone playing are related.

Another example assumes a healthy posture in the neck, but faulty stabilizing structures in the core musculature of the trunk. In such instances, time spent strengthening the lower abdominals and stretching the lower back will directly improve upper-back and chest positioning, which will encourage a much more conducive physiological environment for trombone performance.

Additionally, both of the above scenarios can co-exist which further exacerbate the problem. For instance, faulty head positioning may be compensatory to thoracic-kyphosis, which results from postural deviations in the low back and/or pelvis. In this case, core conditioning and a routine of postural retraining and breathing exercises would prove especially helpful in symptom alleviation and the improvement of performance.

CONTRIBUTION TO THE FIELD

The identification of specific instrumental performance related trigger points has the potential to provide musicians with customized injury prevention and accelerated improvement programs, thus classifying it as a unique system for diagnosing performance problems and prescribing holistic corrective practice techniques.

Additionally, the facial structure that synergistically comprises the wind player's embouchure may be just as susceptible to the development of trigger points as the larger, more obvious muscles of the back and neck. Such performance related problems as Dystonia and Temporoalmandibular Joint Dysfunction (TMJ)[11] are currently classified as 'untreatable', even 'career-ending,' but their treatment may be as simple as proper trigger point therapy.

The alleviation of trigger points resides in the application of Myofascial Compression Techniques, substantiating it as a very appropriate treatment for most kinds of common pain that can also be taught as an effective means of self-treatment.[12] For example, compression techniques can be applied before, after and during practice sessions and through clothing. Application is simple and can be supplemented with other movement therapies more familiar to musicians, such as the Alexander and Feldenkrais techniques.

The benefit of corrective trigger point therapy is that it uncovers a main cause of the muscle-pain problems, addresses both acute and chronic pains, and therefore, can be used as a successful program of pain management and injury prevention.

Trigger point identification in the scalene musculature of the trombonist constitutes only one of many research possibilities in the development of a more clinical and successful treatment of pain management, prevention, and musical performance related issues as relates to the muscular compensations associated with instrumental performance.

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[11] Davies, The Trigger Point Therapy Workbook, pg. 50

[12] Davies, The Trigger Point Therapy Workbook, pg. 256

SUGGESTED SOLUTIONS

Successful treatment of a problem frequently begins with early detection and systematic correction—or better yet, total prevention. The following physiological scenarios and anatomical descriptions are specifically relevant to trombone playing and the development of STP's, and may be helpful in achieving proper self-diagnosis, increased awareness, and forms a basic template for which beginning corrections can be founded.

I. Self-Diagnostic Confirmation Testing

There are four examination methods that are useful in the self-confirmation of STP's. Failing one test is enough to warrant corrective action. Additionally, restlessly moving the arms and neck is a subtle confirming indicator of STP's.

Test no.1: "Adson's Test"

- While seated with the feet flat on the floor, weight evenly distributed through the SITS bones with a healthy spinal posture and active core engagement, place the hands (palms up) gently on the upper thighs.
- Find the wrist pulse of one side with the opposing hand.
- Slowly, yet actively, fully turn the head to the shoulder on the side which you are monitoring the pulse.
- At full neck rotation, begin to actively dip the chin as far down as possible into the soft triangular feeling 'nook' that is formed by the boney structures and muscles behind the collarbone.
- If the pulse becomes faint or lost, STP's are confirmed.

Test no.2: "Finger-Flexion" Test:

- Holding the arm upright with a 90-degree bend in the elbow (as in 'raising your right hand'), attempt flexion of the fingers towards the palm. A successful test, absent of TP's, will allow the pads of the fingers to come in full contact with the edge of the hand (the area where callus would form).
- An inhibited range of motion in any finger indicates a positive test.

Test no.3: "Scalene Relief" Test:

This test utilizes the source(s) of referred pain caused by the clavicular pressure against active STP's.

- Place the forearm across the forehead while raising and pulling the shoulder forward to lift the clavicle off the underlying scalene musculature and brachial plexus. Slightly tip the chin to the chest. Hold this positioning for several seconds—pain/symptom relief will follow within a few minutes, if not immediately, and confirms STP's.

Test no. 4: "Scalene Cramp" Test:
This test will elicit pain from active STP's in referred locations or behind the neck. Such sensations confirm STP's.

- Fully rotate (turn) the head to one side.
- Dip the chin into the triangular 'hollow' area behind the clavicle.

II. Scalene Location and Self-Myofascial Manipulation

The **Anterior Scalene** is almost totally hidden and can be found behind the sternocleidomastoid. The **Medial Scalene** is behind the Anterior, located more on the side of neck, and the **Posterior Scalene** lies almost horizontally behind the middle scalene in the soft triangular depression just above the collarbone and below the front edge of the trapezius.

Scalenes will generally feel tighter than the softer surrounding tissue of the sternocleidomastoid and other neck muscles. Treatment sessions should last for approximately 6-10 strokes, each session being repeated 6-10 times/day. A useful application for the trombonist is to 'bookend' one's practice session with Self-Myofascial Release. Effective self-massage involves locating the sternocleidomastoid, gripping it between the fingers and thumb, and pressing it gently towards the windpipe. From this position, the other fingers are free to palpate the scalene in search for hard feeling tissue absent of a pulse, and then press the muscles against the neck vertebrae with the fingers.

A scalene trigger point is encountered in the anterior scalene if this sensation is painful, along with referred pain in the arm and shoulder. The release technique also elicits a cringing type of pain that may seem like nerve or tendon tissue is being manipulated instead of muscle. This is one of the reasons that make proper therapy especially difficult for even well trained specialists.

The massage stroke should be approximately one inch long. As the skin on the neck moves with fingers, this process should be repeated for the entire length of the sternocleidomastoid, from the ear to the collarbone.

For medial scalene manipulation, the stroke technique is repeated on the side of the neck, again, ensuring that any area where a pulse can be found is avoided.

To reach the posterior scalene, the middle finger presses under the front edge of trapezius, the muscle near the collarbone attachment. Using downward pressure, drag the finger toward the throat in a parallel direction to the collarbone. Additionally, pressing back into and against the trapezius is helpful to reach the posterior scalene from another angle.

III. Potential STP Activations:

- A tilted shoulder girdle is a common posture that encourages STP's. If one is using a gig bag, it is recommended to use both straps as to avoid elevation of one shoulder. This is also ideal over carrying a hard case, which causes the same issue.

- Weight bearing asymmetry in the leg causes one hip to raise, compression the spine in a 'mini-scoliosis' and the head will naturally tilt in order for the eyes to seek level vision. While playing, always ensure that weight is equally distributed to both feet.

- Awkward leaning and body positioning assumed while seated causes the same issues as above. Also, avoid attempting to assume 'militaristic' posture while in rehearsals or performances. This often encourages more rigidity than is necessary, which can also produce STP's. Aim to feel the SITS bones in contact with the seat, not the hamstrings.

- Awkward head positioning/tilting in order to see the music around the bell is a potentially common catalyst of STP's in the trombonist. Avoid tilting the head and changing posture to see the music. Practicing short passages, by memory, only utilizing the notation while 'resting' proves helpful.

IV. Stretching Exercises:

The following stretching exercises are more effective after the application of heat to the neck. This is essentially the utilization of the Scalene Cramp Test (above) as a means of active stretching.

Step 1: Lay supine (on the back).

Step 2: Activate shoulder positioning by placing one hand under buttock.

Step 3: Reach overhead, across head to opposite ear with the other hand.

Step 4: Gently pull head to tilt ear towards the shoulder. Concentrate on relaxing and releasing muscular tension, as the breathing remains free and fluid.

The head rotation positioning determines the scalene emphasis. Take 5-6 slow breaths in each position, and continue to progress the stretch as the muscles release their tension.

Anterior: Looking up

Medial: Neutral

Posterior: Looking Down

V. Passive Body Asymmetry Corrections:

1. Improving Sleep Positioning:

- Slightly elevate the head of the bed during sleep.
- Use a soft pillow so the head & neck can remain in a neutral position for rest.
- Ensure that the shoulders rest on bed, not the pillow.
- Maintain body warmth: IE. Electric blanket, extra covers, space heater, etc.
- Apply moist heat over STPs area on the front of neck for 10-15 min before bed.
- Sleeping on the stomach or a soft mattress is not recommended. However, the condition can be improved by placing a firm pillow under stomach to neutralize force angles on the spine.

2. Improving Seating & Lighting Ergonomics:

- Rest the elbow when sitting/reading, writing, etc.
- Ensure lighting shines directly on reading material from overhead, not the side.
- Avoiding any head tilting (as in playing).

3. Relief of Respiratory Overload:

- Practice synchronizing the breathing structures to alleviate scalene overload:

  Step 1: Place one hand on the abdomen and one on the chest to confirm an equal and simultaneous rise and fall of each breath. Repeat 1-5 minutes.

  Step 2: Place one hand on each side of the ribs just below the armpits, and confirm that the ribs expand to the sides—swinging up and out during inhalation. Repeat 1-5 minutes.

4. Other Playing Specific Considerations:

- Glottal closure and throat tension during playing can be indirectly addressed by excessively breathing through the mouth while actively dropping the shoulders.
- While standing, shift the bodyweight more toward the balls of the feet. This will encourage the head to automatically shift back over shoulders, acting as counter weight. Restoration of the cervical and lumbar spinal curves and expansion of the chest naturally follows. Additionally, slightly bending the knees during standing performance/practice will help alleviate the low back pressure caused by tight hip flexors.
- **Doorway Pectoralis Stretch:** Bracing the forearm in a door frame, perpendicular to the floor with a 90-degree flexion in the elbow, gently lean and stretch the large muscles of the chest.
- If the upper back feels rigid massage and gentle stretching is recommended.
- If the posture of upper back is habitually faulty, but normal alignment can be assumed, efforts should be directed toward corrective postural solutions.

- Massage and palpation (touch) in the very early stages of neck pain can be an important preliminary and preventative step in successful treatment. If the pain is local and specific to the trapezius muscles, avoid heat and use massage only.
- Though untraditional, leaning on the back of the chair while playing will prevent arching of the low back. This positioning should be used versus rigid playing posture.

5. Tools:

- **Neck Traction:** Lie on the edge of the bed and allow the head to tip backwards over the side. Breathe and relax in this position for up to 15 minutes per day.
- **Back Wave:** An excellent spinal curvature and postural corrective tool.[13] Use 5-15 minutes per day.
- **Foam Roller:** Rolling the calves, quadriceps, latisimus dorsi & hip flexors are beneficial for trombone playing.
- **Chair Blocks:** During seated practicing/playing, explore manipulating various elevation angles of the chair legs utilizing wooden blocks. This passive postural alteration helps re-train habitual tendencies by changing the compression forces on the body and encourages healthier playing ergonomics.

Anatomy of the Trunk -"Core Considerations"

Rectus Abdominis:

- Primary Action: Flexion of the vertebral column by approximating the thorax and pelvis anteriorly.

- Weakness: Decreased ability to flex vertebral column causes anterior pelvic tilt & lordotic posture. Pain/limited mobility while forward bending, kneeling etc.

Obliques:

- Primary Action*:* Flexion and rotation of the vertebral column; support and compress the thoracic spine; respiration assistance.

- Weakness: Anterior pelvic tilt (belly bulges and butt sticks out); decreased respiratory efficiency.
- Cross-sectional weakness results in rotation and lateral deviation of vertebral column.

[13] www.gaiam.com

- Internal Oblique's: (lower)
  - Specific Action: Compress & support of the lower abdominal viscera in conjunction with the transverse abdominis.
- Internal Oblique's: (upper)
  - Specific Action: Flexion of the vertebral column; support and compression of the viscera and depression of the thorax; respiratory assistance.

Transversus Abdominis (TVA):

- Primary Action: Flattened abdominal wall and compression of the viscera. The TVA has no action in lateral trunk flexion except that of stabilization.
- Weakness: Bulging of anterior abdominal wall, which indirectly tends to increase lordosis.
  - Lateral bulge occurs during supine flexion & prone hyperextension and during static postures (IE. Standing & Sitting).

Core Strength and Weakness combinations in order of frequency:

1. Upper Strong, Lower Weak
2. Upper and Lower both Weak
3. Upper and Lower both Strong
4. Lower Strong, Upper Weak

Suspected Problematic Combinations in Trombonists:

- Weak TVA & Rectus, Tight Low Back, Cross Sectional Oblique Imbalance.

Muscles of Respiration

Respiration consists of ventilation and diffusion. *Ventilation* is the movement of gases into, and out of, the lungs, while *Diffusion* is how gases are transported to and from body tissues. The action of respiration is comprised of the muscles of the thorax and bony structures of the ribs, scapulae, clavicle, sternum and thoracic spine. Muscular effort is required during inhalation, while an autonomic action known as *Elastic Recoil* causes the exhalation.[14]

The mechanics involved during inhalation causes an enlargement of the thoracic cavity and thus creates a lowering of intra-thoracic pressure. Excessive muscle involvement during exhalation can be caused when breathing demands are increased, such as during heavy lifting, exercise, blowing, coughing or forceful playing.

The abdominal muscles are the primary expiratory muscles, but also play a role in inhalation; numerous variations of breathing mechanics exist depending on individual habits and

[14] Vining, What Every Trombonist Needs To Know About the Body, pg. 55

activities. The muscles of the upper airway, such as the intrinsic and extrinsic muscles of the larynx, play a critical role in allowing the free flow of air both to and from the lungs via their relaxation. Labored breathing, the presence of STP's, playing at loud dynamics or in the upper register while tension exists in the throat directly inhibits the purity of a healthy air column and has a negative impact on effective trombone playing.

Breathing Solutions

The active pursuit of improved relaxation is an extremely healthy practice, especially for the trombone (or other brass) player. Increased levels of relaxation decrease the need for oxygen consumption of the skeletal muscles and slow the pulse rate. Anxiety is a common indicator of STP's and was present in 29% of study participants.

Diaphragmatic breathing exercises as practiced in the yogic tradition are especially helpful in achieving higher levels of breathing efficiency and relaxation. Emphasizing the abdominal muscles during breathing may help with accessory muscle overuse. *Ujjayi Pranayama* is a yogic practice of breath stretching that involves slight glottal constriction.[15] Closing the lid of the larynx (epiglottis) while breathing creates a hissing sound, though the vocal chords remain unengaged. Learning to control the epiglottis in this way can help the trombonist realize when excessive tension is being used, and to actively release throat constriction caused by glottal interference.

Listening to quality of the breath can also be an informative tool regarding the state of one's posture: if the breath quality sounds strained, labored, short, aggressive, flat, shallow or fast, bringing it back to a smooth sound will be useful in correcting any negative or unhelpful exertion.

1. Application:
Step 1: Sit upright in a comfortable position.
Step 2: Start producing the *Ujjayi* sound steadily with no breaks between breaths.
Step 3: Give the sound an even quality throughout the entire length of the breath.
Step 4: Continue to lengthen and deepen each breath.
Step 5: Breathe evenly into the ribcage, not segmentally.

Note: A deconditioned abdominal structure causes the front pubic bones to drop, creating an anterior pelvic tilt, which produces hyper-lordosis of the low back, collapses the chest and hinders breathing for the trombonist.

[15] Maehler, Ashtanga Yoga, pg. 9

2. Improving Strength & Endurance of the Respiratory Muscles:
Strength is needed for sudden respiratory movements, such as coughing and sneezing and brief spells of extreme exertion. *Endurance* is needed for prolonged exercise or to overcome an increase in airflow resistance. Strong, well-conditioned muscles are more efficient, requiring less oxygen for a given amount of work than poorly conditioned muscles—the stronger the abdominals, the greater their ability to compress the abdomen and thus generate additional pressure during exhalation, which may be a useful tool for adding security in the upper register, and for creating longer phrase architectures.

It is clear that optimal breathing capacity is an extension of a posture that is built upon a balanced core muscular system. Imbalances in any musculature resulting from tightness, weakness, or paralysis may adversely affect the volume and pressure of air that can be utilized. For example, weak & protruding abdominal muscles are not able to generate the maximum expiratory pressures needed to meet the increased demands of breathing brought on by exertion, such as in playing a wind instrument. Weakness in the upper back erector spianae, along with the middle and lower trapezius muscles, interferes with the ability to straighten the upper back, thus limiting one's ability to raise and expand the chest. These problems associated with kyphosis, kypho-scoliosis, osteoporosis and other postural deformities directly contribute to the problems many trombonists encounter.

SUGGESTIONS FOR FURTHER RESEARCH

Recommendations for future research as relates to the findings in this study are as follows:

1. Scalene-Trigger Point and Trombone Performance: Manual Muscle Testing Verification.

2. The Investigation of Ground Foot Forces (GFFs) as Relates to the Nervous-System Programming of Postural Compensations and the Development of Corresponding Trigger Points.

3. The Identification of Instrument-Specific Trigger Points.

4. The Prevalence of Trigger Points in Musicians with Diagnosed Focal Dystonia, Pre-Dystonia and Temporoalmandibular Joint Dysfunction Syndrome (TMJ).

5. A Comparison of Exertive Muscular Forces and Throat Tension Between Trombonists who Practice Sitting Versus Those Who Practice Standing.

6. A Measure of Muscular Exertion Among Trombonists who have Experienced Issues in Loud Dynamic and Upper Register Playing.

Closing Statement

The muscles of the human body work in total synergy, and deficiencies in any portion of the movement chain can have a profoundly negative effect on the art of trombone playing—especially in the pursuit of high-level performance attainment. Faulty movement repetition is one of the most common causes of injury, but does not receive the proper study it deserves. Professional athletes obtain more coaching and clinical attention in this field than their professional musician counterparts, and it is not surprising that their bulk of scientific research is devoted to helping advance performance. Though the Alexander and Feldenkrais techniques are helpful for the musician, it is time that the area of musical performance receive a more clinical scientific approach as to both prevent and heal injuries. A sound body of supporting evidence may well influence the area of music pedagogy for future generations and extend the playing careers of many.

All research begins with a question—an observation of a problem, and an attempt at uncovering a solution. The discovery and treatment of STP's for the trombonist is one attempt at opening a door to recovery and performance enhancement, but more importantly, at rediscovering the joy of performance that was once absent of physical limitation and pain.

TERMINOLOGY

Trigger Point: A hyperirritable spot, usually within a taut band of skeletal muscle or in the muscle's fascia, that is painful on compression, which can give rise to characteristic referred pain, tenderness, and autonomic phenomena. Trigger points may be expressed as *Active* or *Latent*.

Active Trigger Point: A trigger point that is the cause of local or referred pain.

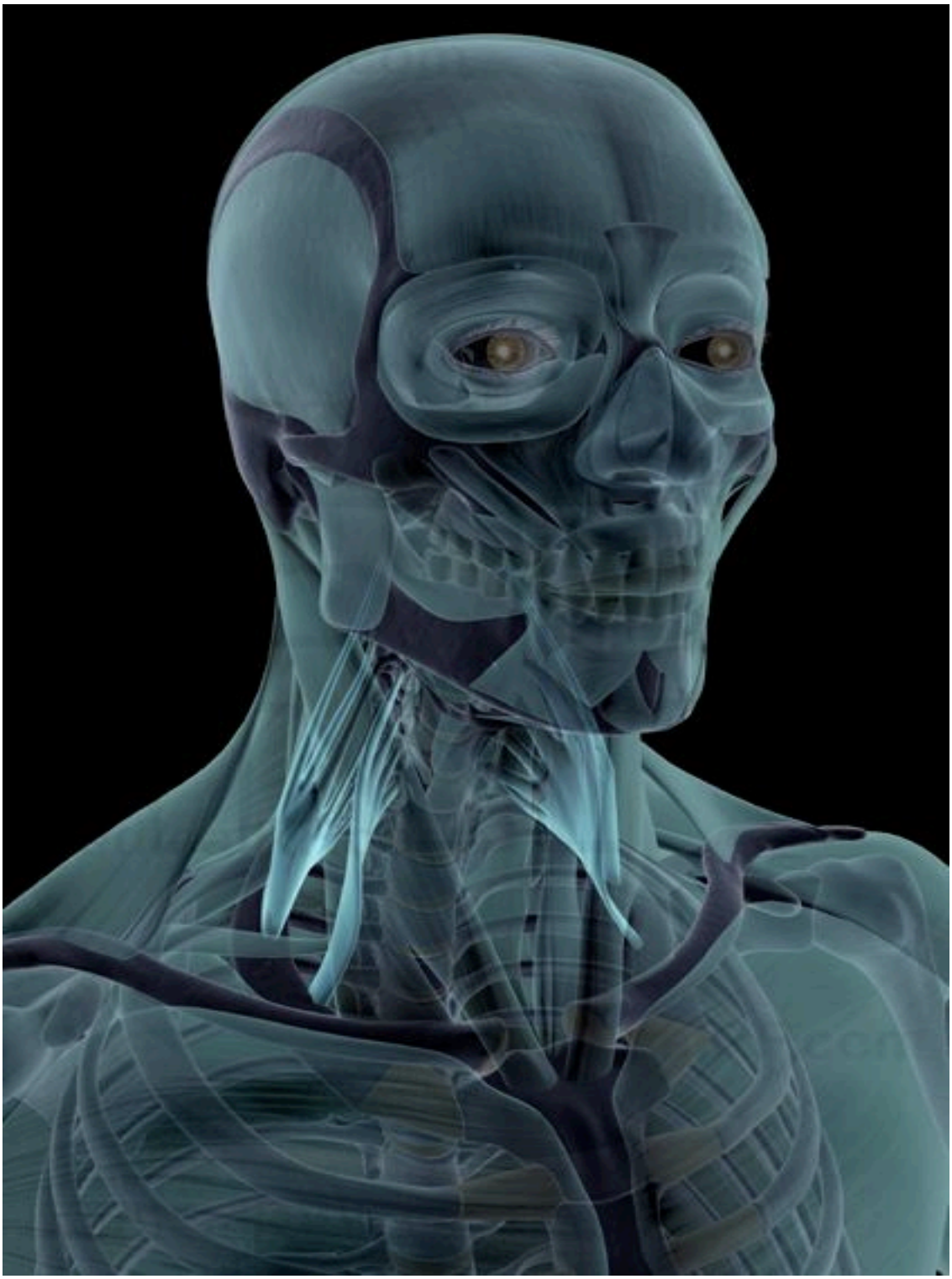
Latent Trigger Point: A trigger point that is silent in terms of pain, but may cause restriction of movement and weakness in the affected muscle. Latent trigger points may be dormant for years after the recovery of an injury, but minor overstretching, overuse or chilling in the specific muscle can activate acute onset of pain.

Satellite Trigger Point: A trigger point that is created in the pain referral zone of another muscle.

Scalene(s): A small group of three muscles (anterior, medial, posterior) found on each side of the neck, with attachments to the C2-C7 vertebrae and the top two ribs. While they serve to both stabilize and flex the neck, their main job is to raise the top two ribs during inhalation. Although the scalenes are active during each inhalation, they can become stressed during labored breathing, such as strenuous exercise and playing a wind instrument.

Myofascial Compression Techniques: A series of self-applied massage techniques designed to restore tissue elasticity, fluidity, and movement functionality, resulting in pain reduction, injury prevention and performance enhancement.

ANATOMICAL ILLUSTRATION [16]



[16] "Scalene Image" http://www.medicalrf.com

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