Home Cervical Traction to Reduce Neck Pain in Fighter Pilots

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INTRODUCTION: Most fighter pilots report cervical pain during their careers. Recommendations for remediation lack evidence. We sought to determine whether regular use of a home cervical traction device could decrease reported cervical pain in F-15C pilots.

METHODS: An institutional review board-approved, Health Insurance Portability and Accountability Act-compliant, controlled crossover study was undertaken with 21 male F-15C fighter pilots between February and June 2015. Of the 21 subjects, 12 completed 6 wk each of traction and control, while logging morning, postflying, and post-traction pain. Pain was compared with paired *t*-tests between the periods, from initial pain scores to postflying, and postflying to post-traction.

RESULTS: In the traction phase, initial pain levels increased postflight, from 1.2 (0.7) to 1.6 (1.0) Subsequent post-traction pain levels decreased to 1.3 (0.9), with a corresponding linear decrease in pain relative to pain reported postflight. The difference in pain levels after traction compared to initial levels was not significant, indicating that cervical traction was effective in alleviating flying-related pain. Control pain increased postflight from 1.4 (0.9) to 1.9 (1.3). Daily traction phase pain was lower than the control, but insignificant.

DISCUSSION: To our knowledge, this is the first study of home cervical traction to address fighter pilots' cervical pain. We found a small but meaningful improvement in daily pain rating when using cervical traction after flying. These results help inform countermeasure development for pilots flying high-performance aircraft. Further study should clarify the optimal traction dose and timing in relation to flying.

KEYWORDS: fighter pilot, neck pain.

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While reports of incidence vary, it is widely accepted that fighter pilots are at increased risk of neck pain. The incidence has been reported as 72% of Royal Norwegian Air Force pilots who responded to a survey.[25] Another survey yielded 97% complaining of neck pain overall and 83% within the last year,[19] while as little as an 18.9% prevalence has been reported in F-16 pilots.[11] Multiple risk factors have been described, including exposure to high $+G_z$, rotation of the neck under $+G_z$, time devoted to physical exercise,[25] use of the joint helmet-mounted cueing system and night vision goggles,[19] flight hours,[24] prolonged flexed posture, fatigue,[11] and the frequency of muscle endurance training.[15,16]

Current recommendations for fighter pilots to decrease neck complaints and injury include stretching and strengthening exercises,[3,9] but validating the effectiveness of such measures has been a challenge. While Alricsson's group found no difference in pain despite significant strength increases, cervical strengthening exercises have been found effective among Danish F-16 pilots.[18] No significant differences in neck strength and position sense have been documented between pilots with and without neck pain.[10] One case study suggested that spinal manipulation is helpful.[14] Formal physical therapy is commonly used in treating cervical pain. In at least one study, 4 wk of individualized rehabilitation (per algorithm) have helped.[26]

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Systematic reviews of randomized controlled trials indicate that therapeutic exercise is beneficial in managing chronic nonspecific neck pain.[4,17] Spinal manipulation and mobilization have given inconclusive evidence for benefit in acute neck pain and moderate evidence of benefit in chronic neck pain in a systematic review of randomized controlled trials.[7] Home exercise with professional medical advice has been found to be as useful as manipulation and medication in acute and subacute neck pain.[6] Computerized mobilization for chronic neck pain has shown improved headache, neck disability index, and range of motion (ROM) in one limited trial.[22]

The use of cervical traction to diminish complaints of neck pain in fighter pilots is a novel approach. While home cervical traction is commonly used to treat neck pain of various causes, it has not been described in the literature for fighter pilots. One study has shown improvement in ROM with home cervical traction in nonpilots.[20] In fact, though, randomized controlled studies of the efficacy of cervical traction are lacking in the literature.[13] A retrospective study in one practice indicated that home cervical traction with an over-the-door halter unit gave symptomatic relief in 81% of patients with mild to moderately severe (Grade 3) cervical spondylosis syndromes.[23] Some studies do indicate potential for traction to help in cervical radiculopathy, but the quality of studies has been weak.[21] One study has indicated that cervical traction was not more helpful when added to "standard" physical therapy for chronic nonspecific neck pain.[5] Finally, a single study has indicated that the best cervical traction force might be 10% of the patient's bodyweight.[1]

While it appears that most fighter pilots report cervical pain during their careers, recommendations for remediation lack evidence. We performed this pilot study to determine whether the regular use of a home cervical traction device could decrease reported cervical pain in F-15C pilots. Our null hypothesis, therefore, was that we would find no differences in daily pain ratings when pilots were using cervical traction regularly vs. when they were not using traction.

METHODS

Subjects

An institutional review board-approved, Health Insurance Portability and Accountability Act-compliant, controlled crossover study was undertaken with 21 enrolled male F-15C fighter pilots from the Oregon Air National Guard between February and June 2015. Each subject provided written informed consent before participating. No female instructor pilots were assigned at that base. Inclusion criteria included current status as a full-time F-15C instructor pilot. Exclusion criteria included any history of neck surgery, being currently enrolled in physical therapy for neck pain or injury, history and physical exam evidence of a current herniated cervical disc or cervical radiculopathy, or contraindications to cervical traction use per manufacturer's specifications.[12]

Equipment

The device used was a Saunders home cervical traction unit (DJO Global, Vista, CA). It is a portable, commercially available item capable of providing up to 40 lb of traction force to the cervical spine at a flexion angle of 15° to 25° using a pneumatic pump.[12] It is commonly employed in physical therapy for a variety of cervical complaints.

Procedure

Of the 21 fighter pilots, 12 completed all facets of the study, which involved 3 phases. Intervention included 6 wk with a home cervical traction device used 10 min, three times weekly, with 20–25 lb traction force applied at 15° of flexion. The control period was 6 wk without traction. A period of 6 wk was chosen to approximate NASS suggestions for a reasonable time to see pain improvement.[21] Subjects were randomized in a 1:1 ratio into one of two groups. Group I began with cervical traction use in the first phase, followed by a 2-wk washout in the second phase, during which no treatment or documentation of pain occurred, and concluded with the control period in the third phase. Group II began in the control period, progressed to washout, and ended with cervical traction use. Pilots were asked to perform traction 3 times weekly (18 times total) when the opportunity arose and, although we requested that they attempt to perform it on flight days following flight, this was not a necessary part of the protocol. The devices were stored in the Operations Group building, where traction was performed. Using written logs, participants recorded pain levels using the Numerical Rating Scale (range 0–10). Initial (morning) pain levels were recorded daily. Pain levels were recorded postflying and post-traction when appropriate. Pilots also recorded the duration of and maximum $+G_z$ experienced for each flight during the traction and control study phases. Neck ROM was measured by the same observer using dual inclinometry prior to the first phase of the study, during the midstudy washout period, and at completion of the third phase. Pilot age and total flight hours in high G aircraft prior to the study were collected at enrollment.

Statistical Analysis

Initial and postflight pain levels averaged over each 6-wk study phase, number of flights, and flight duration were compared between the study phases with paired *t*-tests. The differences between initial, postflight, and post-traction (traction phase) pain were made with paired *t*-tests or one-way repeated measures analysis of variance (ANOVA) where appropriate. ROM measurements were compared between the start of the study (baseline), traction, and control phases with repeated measures ANOVA. All multiple comparisons were adjusted with Bonferroni corrections. To determine whether outcomes differed depending on study sequence, pilots who completed the traction-control vs. control-traction sequences were compared with two-sample *t*-tests and one-way ANOVA. Per protocol rather than intention-to-treat analyses were conducted because in this initial study we sought to determine whether traction would be beneficial when used as directed over the entire study.

Table I. Number of Flights and Flying Hours per Pilot by Study Phase.

	ENTIRE STUDY		CONTROL PHASE		TRACTION PHASE		PAIRED *t*-TESTS		
VARIABLE	MEAN (SD)	RANGE	MEAN (SD)	RANGE	MEAN (SD)	RANGE	*t*	DF	*P*-VALUE
Number of flights	29 (8)	10–41	15 (5)	6–23	14 (5)	4–20	0.190	11	0.853
Total flying hours	36 (12)	11–56	18 (8)	7–36	18 (7)	4–27	−0.217	11	0.832
Average hours per flight	1.3 (0.1)	1.1–1.4	1.2 (0.2)	1.0–1.6	1.3 (0.2)	1.0–1.8	−0.695	11	0.501

For all analyses, P-values ≤ 0.05 were considered statistically significant. Data were analyzed with IBM SPSS Statistics v.23 (IBM Corporation, Armonk, NY).

RESULTS

There were 21 pilots who were enrolled; 12 (57%) completed all phases and were included in the study. Reasons for exclusion of nine pilots were nonuse of the traction device ($N = 3$), control phase only ($N = 2$), traction phase only ($N = 1$), and data for one or both phases too incomplete to analyze ($N = 3$). Of the 12 included pilots, 7 completed the traction-control sequence; there were no differences in outcomes between these pilots and the pilots who completed the control-traction sequence, so data were combined for all further analyses (data not shown). The 12 pilots had a mean (SD) age of 39 (5) yr (range 35–49), and 2466 (1020) flight hours (range 1038–4645) in high G aircraft prior to the study. During the study they flew a combined total of 343 sorties, with a combined total of 435 flying hours. There were no differences in number of flights or total or average flying hours between the two study phases (**Table I**).

Initial daily and postflight pain levels are shown in **Table II**. Mean initial pain levels, initial pain levels on days with flying, and pain levels after flying did not differ between the control and traction phases. There was a significant increase in pain levels after flying compared to initial levels on flying days for both the control phase [$t(11) = -3.4$, $P = 0.006$] and the traction phase [$t(11) = -3.4$, $P = 0.006$].

During the traction phase of the study, the number of times pilots performed traction ranged from 9–20 and averaged 15 (3) times. The majority of traction sessions were performed after flying, but ranged from 14 to 80% per pilot, mean 55% (18%). Initial pain levels on days with traction were 1.3 (0.6) and decreased to 1.1 (0.7) on days following traction, regardless of whether the pilot flew on the traction day or not. The difference was small [0.2 (0.2)], but statistically significant [$t(11) = 2.9$, $P = 0.014$]. **Fig. 1** shows initial, postflying, and post-traction pain levels for days in which both flying and traction occurred. Pain levels were significantly elevated after flying compared to initial levels, and then decreased after traction back to initial levels [$F(2, 22) = 6.3$, $P = 0.007$]. The change from initial to postflying was 0.4 (0.5) ($P < 0.05$), and from postflying to post-traction was −0.3 (0.3) ($P < 0.05$). The difference in pain level from initial to post-traction was 0.1 (0.4) ($P = 0.620$). The changes in pain levels post-traction relative to the pain levels after flying are shown in **Fig. 2**. The correlation between the two variables was statistically significant (Spearman's rank correlation coefficient −0.729, DF = 10, $P = 0.007$), suggesting a linear relationship between pain levels and amount of benefit from traction.

Finally, we found a significant increase in cervical range of motion when associated with traction only upon measurement of right rotation (**Table III**). Right rotation did not change significantly from baseline to after control, but did significantly increase after traction. There were no significant differences between baseline and the control phase for any direction. Left rotation was significantly greater than right rotation at baseline [$t(11) = 2.2$, $P = 0.047$] and after the control phase [$t(11) = 4.7$, $P = 0.001$], but not after the traction phase [$t(11) = 1.5$, $P = 0.164$]. Left rotation did increase from baseline to after the traction phase, but the change did not reach statistical significance.

DISCUSSION

Based on a review of the literature, this may be the first study of home cervical traction as a preventive tool to attempt to address fighter pilots' cervical pain. Several surveys, usually retrospective, have attempted to answer the questions of why fighter pilots suffer from neck pain and what measures can help them. Albano's retrospective survey implied that neck strengthening could be helpful, but that study did not document which exercises were performed, how often, or how intensely.[2] It was strictly based on the recall of the pilots. One published study did attempt a supervised neck-strengthening program, but found no meaningful differences in pain reports.[3] Our study approximated the published 10% of bodyweight to estimate an initial traction force, and it appears to have been an effective choice.[1]

Table II. Initial and Postflight Pain Levels Reported During Each Study Phase.

	CONTROL PHASE		TRACTION PHASE		PAIRED *t*-TESTS		
VARIABLE	MEAN (SD)	RANGE	MEAN (SD)	RANGE	*t*	DF	*P*-VALUE
Initial pain on all days	1.3 (0.8)	0.0–2.8	1.1 (0.7)	0.0–2.6	1.48	11	0.168
Initial pain on flying days	1.4 (0.9)	0.0–3.5	1.2 (0.7)	0.0–2.6	1.22	11	0.246
Postflight pain on flying days	1.9 (1.3)	0.0–4.8	1.6 (1.0)	0.0–3.6	1.99	11	0.072
Pain difference between postflight and initial pain on flying days	0.5 (0.5)	0.0–1.3	0.4 (0.4)	0.0–1.3	1.19	11	0.261

Table III. Range of Motion Measurements at Baseline and After the Control and Traction Phases.

	BASELINE		CONTROL PHASE		TRACTION PHASE		ONE-WAY R. M. ANOVA		
RANGE OF MOTION	MEAN (SD)	RANGE	MEAN (SD)	RANGE	MEAN (SD)	RANGE	*F*	DF	*P*-VALUE
Initial flexion	49 (9)	35–62	51 (8)	40–62	53 (10)	37–64	1.059	2, 22	0.364
Initial extension	59 (14)	31–77	61 (10)	32–73	62 (12)	35–78	1.20	2, 22	0.309
Initial left side bend	39 (8)	24–51	41 (9)	28–57	41 (9)	26–51	1.732	2, 22	0.200
Initial right side bend	41 (8)	28–51	40 (10)	27–55	42 (9)	27–53	1.243	2, 22	0.308
Initial left rotation	86 (7)	73–100	86 (10)	68–100	90 (10)	68–105	3.277	2, 22	0.057
Initial right rotation	80 (10)	62–93	79 (8)	62–93	87 (7) [†,‡]	69–96	10.431	2, 22	0.001

R. M.: repeated measures.
[†] $P < 0.05$ compared to value at baseline (enrollment).
[‡] $P < 0.05$ compared to control phase, Bonferroni multiple comparisons.

Most of our data indicate modest improvements in pain during the traction arm of the study as compared to the control. As noted in the results, the decrease in daily pain reports with use of traction did not reach statistical significance, leading us to retain our null hypothesis. However, we found a modest but statistically significant improvement in pain reports the day after performing traction. We believe that does represent a means of symptom control, but not necessarily prophylaxis. Unlike the Cai group, who found that cervical traction was helpful when pre-intervention pain was at least 7 on the Numerical Rating Scale,[8] we noted a linear relationship between pre-traction pain and post-traction pain relief. This could represent a similar finding in that our data imply that the higher the initial pain, the more likely a pilot will obtain relief.

A clear relationship between severity of pain following flying and the relief afforded by traction became apparent throughout the course of this study (Spearman's rank correlation -0.729, $P = 0.007$). We did not foresee this finding, but believe it to be the most significant aspect of this trial. The potential operational application is simple yet valuable to pilots whose ability to mentally focus is essential to mission success and safety. We see possible benefits, especially during postflight debriefing, if traction is performed just after the sortie.

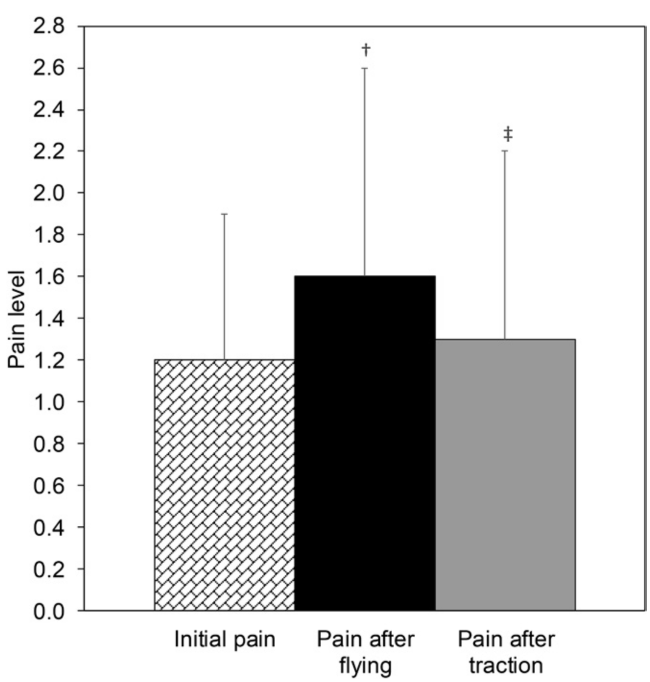

Fig. 1. Initial pain, pain after flying, and pain after traction on days where pilots performed traction after flying. [†]$P < 0.05$ compared to initial pain, [‡]$P < 0.05$ compared to postflying pain, Bonferroni multiple comparisons.

We hypothesize that the increase in right rotation was because F-15C pilots preferentially turn left given the ergonomics of the cockpit. In the F-15C cockpit, the thrust levers are placed on the left console and somewhat aft of the control stick, which is centered. This places the pilot in a position to twist left more easily than right during maneuvering and could potentially predispose the pilot to turn left more often than right given the choice. When the pilot must also look over his or her shoulder to "check six" during maneuvers while keeping the left hand on the thrust levers and the right hand on the control stick, the incentive to preferentially turn left when given the option is even greater. We speculate that this tendency could explain why our measurements indicated that left rotation tended to be greater than right initially.

Of note, three subjects did not use the traction device despite having otherwise completed the study and having received extensive training prior to the study that included instruction on device use and what to do in the case of any problems. Two of them stated that they attempted traction once, felt some pain, and decided not to continue using the device without reporting the pain to the medical monitor. They were interviewed and examined after the study and were found asymptomatic and without physical findings. The third subject did not report a reason for nonparticipation.

The relatively small number of those completing the entire protocol raises the possibility of having created a biased sample in those who would continue to use the device. While we think that unlikely given that several of the noncompletions were caused by unforeseen deployments or other temporary duty assignments, we must acknowledge the chance.

Limitations to this study were clearly led by a less than perfect completion rate. We attribute most of this to the difficulty involved with asking active duty military pilots to complete over 3 mo of a study in the midst of ongoing deployment and temporary duty requirements. This study was intended to neither diagnose nor treat any specific neck injuries, and we could therefore draw no definitive conclusions as to which specific neck problems would best respond to traction.

This study found a small but meaningful average improvement in daily pain rating among F-15C pilots who used cervical

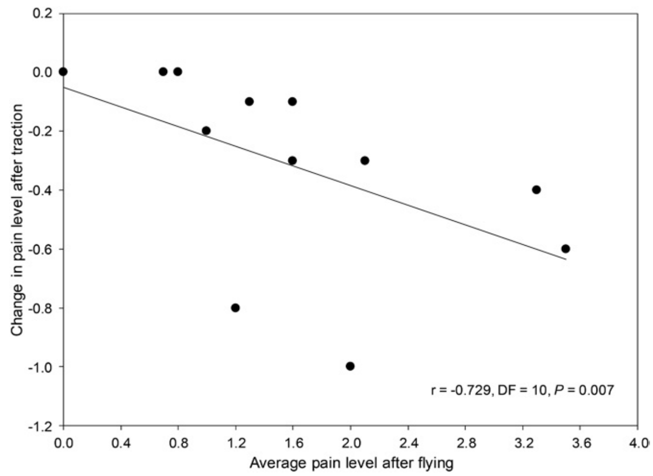

Fig. 2. Scatterplot of change in pain levels after traction relative to pain levels after flying (pre-traction).

traction after flying. The greater the postflight pain, the greater the relief with cervical traction. The literature currently offers little regarding studies of actual interventions to address neck pain in fighter pilots. These results help inform countermeasure development directly related to the health and performance of pilots flying high-performance aircraft. Our results also indicate fighter pilots can safely reduce neck pain using our protocol as it currently stands, but not necessarily prevent it. Going forward, we recommend future research using home cervical traction within the high-performance aircraft community to help better elucidate optimum doses (ideal traction settings, durations, frequencies, and timing in relation to flight). Additionally, a comparison of our results in the F-15C pilot population to other airframes with slightly different missions and equipment would be beneficial, such as those performing ground attack and wearing different headgear. Finally, a future report will describe any impact $+G_z$ might have had on reports of pain.

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REFERENCES

1. Akinbo SR, Noronha CC, Okanlawon AO, Danesi MA. Effects of different cervical traction weights on neck pain and mobility. Niger Postgrad Med J. 2006; 13(3):230–235.
2. Albano JJ, Stanford JB. Prevention of minor neck injuries in F-16 pilots. Aviat Space Environ Med. 1998; 69(12):1193–1199.
3. Alricsson M, Harms-Ringdahl K, Larrson B, Linder J, Werner S. Neck muscle strength and endurance in fighter pilots: effects of a supervised training program. Aviat Space Environ Med. 2004; 75(1):23–28.
4. Bertozzi L, Gardenghi I, Turoni F, Villafañe JH, Capra F, et al. Effect of therapeutic exercise on pain and disability in the management of chronic nonspecific neck pain: systemic review and meta-analysis of randomized trials. Phys Ther. 2013; 93(8):1026–1036.
5. Borman P, Keskin D, Ekici B, Bodur H. The efficacy of intermittent cervical traction in patients with chronic neck pain. Clin Rheumatol. 2008; 27(10):1249–1253.
6. Bronfort G, Evans R, Anderson AV, Svendsen KH, Bracha Y, Grimm RH. Spinal manipulation, medication, or home exercise with advice for acute and subacute neck pain: a randomized trial. Ann Intern Med. 2012; 156(1, Pt. 1):1–10.
7. Bronfort G, Haas M, Evans RL, Bouter LM. Efficacy of spinal manipulation and mobilization for low back pain and neck pain: a systematic review and best evidence synthesis. Spine J. 2004; 4(3):335–356.
8. Cai C, Ming G, Ng LY. Development of a clinical prediction rule to identify patients with neck pain who are likely to benefit from home-based mechanical cervical traction. Eur Spine J. 2011; 20(6): 912–922.
9. Coakwell MR, Bloswick DS, Moser R Jr. High-risk head and neck movements at high G and interventions to reduce associated neck injury. Aviat Space Environ Med. 2004; 75(1):68–80.
10. De Loose V, Van den Oord M, Burnotte F, Van Tiggelen D, Stevens V, et al. Functional assessment of the cervical spine in F-16 pilots with and without neck pain. Aviat Space Environ Med. 2009; 80(5): 477–481.
11. De Loose V, Van den Oord M, Burnotte F, Van Tiggelen D, Stevens V, et al. Individual, work-, and flight-related issues in F-16 pilots reporting neck pain. Aviat Space Environ Med. 2008; 79(8):779–783.
12. Empi. Saunders cervical traction user's guide. Clear Lake (SD): Empi, Inc.; 2010:2.
13. Graham N, Gross A, Goldsmith CH, Klaber Moffett J, Haines T, et al. Mechanical traction for neck pain with or without radiculopathy. Cochrane Database Syst Rev. 2008; 16(3):CD006408.
14. Green BN, Dunn AS, Pearce SM, Johnson CD. Conservative management of uncomplicated mechanical neck pain in a military aviator. J Can Chiropr Assoc. 2010; 54(2):92–99.
15. Hämäläinen O, Vanharanta H, Bloigu R. +Gz-related neck pain: a follow-up study. Aviat Space Environ Med. 1994; 65(1):16–18.
16. Hämäläinen O, Vanharanta H, Bloigu R. Determinants of +Gz-related neck pain: a preliminary survey. Aviat Space Environ Med. 1993; 64(7): 651–652.
17. Kay TM, Gross A, Goldsmith CH, Rutherford S, Voth S, et al. Exercises for mechanical neck disorders. Cochrane Database Syst Rev. 2012; 8: CD004250.
18. Lange B, Toft P, Myburgh C, Sjøgaard G. Effect of targeted strength, endurance, and coordination exercise on neck and shoulder pain among fighter pilots: a randomized-controlled trial. Clin J Pain. 2013; 29(1): 50–59.
19. Lange B, Torp-Svendsen J, Toft P. Neck pain among fighter pilots after the introduction of the JHMCS helmet and NVG in their environment. Aviat Space Environ Med. 2011; 82(5):559–563.
20. Myśliwiec A, Saulicz E, Kuszewski M, Wolny T, Saulicz M, Knapik A. The effect of Saunders traction and transcutaneous electric nerve stimulation on the cervical spine range of motion in patients reporting neck pain – pilot study. Ortop Traumatol Rehabil. 2012; 14(6):515–524.
21. NASS Evidence-Based Guideline Development Committee. North American Spine Society evidence-based clinical guidelines for

multidisciplinary spine care: diagnosis and treatment of cervical radiculopathy from degenerative disorders. Burr Ridge (IL): North American Spine Society; 2010. [Accessed 28 Jan. 2016]. Available from https://www.spine.org/Portals/0/Documents/ResearchClinicalCare/Guidelines/CervicalRadiculopathy.pdf.

22. River Y, Levital T, Belgrade M. Computerized mobilization of the cervical spine for the treatment of chronic neck pain. Clin J Pain. 2012; 28(9): 790–796.
23. Swezey RL, Swezey AM, Warner K. Efficacy of home cervical traction therapy. Am J Phys Med Rehabil. 1999; 78(1):30–32.
24. Tucker B, Netto K, Hampson G, Oppermann B, Aisbett B. Predicting neck pain in Royal Australian Air Force fighter pilots. Mil Med. 2012; 177(4):444–450.
25. Wagstaff AS, Jahr KI, Rodskier S. +Gz-induced spinal symptoms in fighter pilots: operational and individual associated factors. Aviat Space Environ Med. 2012; 83(11):1092–1096.
26. Wang WT, Olson SL, Campbell AH, Hanten WP, Gleeson PB. Effectiveness of physical therapy for patients with neck pain: an individualized approach using a clinical decision-making algorithm. Am J Phys Med Rehabil. 2003; 82(3):203–218.