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Restriction of neck flexion using soft cervical collars: a preliminary study

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This study investigates the use of dropped neck flexion as a manoeuvre to test the restrictive abilities of two different types of soft collars, an Airway soft cervical collar and a handmade cervical rough. The range of neck flexion of 40 asymptomatic subjects aged 20–29 was assessed, both with and without collar wear, using a Spinal Rangiometer. Dropped neck flexion is described as possibly being more representative of the type of movement that a patient with neck pain will undergo, and hence a more useful manoeuvre to employ when testing for the restrictive abilities of soft cervical collars. The mean dropped flexion was 64 degrees without collar wear, 58 degrees with the Airway soft collar, and 34 degrees with the cervical rough. Only the cervical rough provided both statistically ($p < 0.001$) and clinically ($> 15°$) significant restriction of dropped neck flexion. The comfort, preparation time, and ease of application of each of these collars is not addressed in this study, and may reflect on use in clinical practice. This preliminary study provides insight and pilot data for future studies in this area.
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KEY WORDS: neck, collars, range of motion, whiplash injuries, chiropractic, manipulation.

Cet étude examine l'utilisation de la flexion cervicale pendante comme manoeuvre pour tester les capacités restrictives de deux différents types de collier souple, un collier cervical souple Airway et un support cervical fait à la main. Le degré de flexion cervicale de 40 sujets asymptomatiques agés de 20 à 29 ans fut déterminé, avec et sans collier, à l'aide d'un goniomètre spinal. La flexion cervicale poendante est décrite comme étant possiblement plus représentative du type de mouvement qu'un patient souffrant de douleurs cervicales subira et est donc une manoeuvre plus utile à employer lorsqu'on teste les capacités restrictives des colliers cervicaux souples. La flexion pendante moyenne était de 64 degrés sans collier, 58 degrés avec le collier souple Airway, et 34 degrés avec le support cervical. Seul le support cervical a démontré des restrictions significatives de la flexion cervicale pendante, tant au niveau statistique ($p < 0,001$) que clinique ($> 15°$). Le confort, le temps de préparation et la facilité d'utilisation de chacun de ces colliers ne sont pas considérés dans cette étude et il est possible qu'ils aient un impact sur l'usage en pratique clinique. Cette étude préliminaire offre un bref aperçu et des données pilotes pour des études futures dans ce domaine.
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MOTS-CLÉS : cou, colliers, degré de mobilité, blessure de type «coup de lapin», chiropratique, manipulation.

Introduction

Soft cervical collars are commonly recommended by health care physicians in the management of acute soft tissue injuries of the neck, either alone or in conjunction with other forms of treatment. The goal of soft collar wear is to restrict neck movements, and thereby provide support and comfort to the patient. To date, however, there is no conclusive evidence to suggest that soft collars actually provide any clinically significant restriction of neck movements.

Cineradiographic, plain film, and goniometric studies have concluded that soft collars are of minimal use in the restriction of neck motion,[1–8] at most restricting neck movements by 5 to 10 percent for the full flexion-extension range.[2] It has also been suggested that the soft collar acts primarily as a placebo in patients with stable spines.[9] Despite this seemingly convincing evidence that soft collars do not provide any significant restriction to neck movements, clinicians continue to recommend them for use in uncomplicated, acute soft tissue injuries of the neck, and patients continue to find them beneficial.

One possible reason for the apparent incongruity between research and clinical use relates to the type of movements that subjects were required to perform in the previously described trials.[1–8] Being concerned with absolute immobilization of the

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injured and unstable cervical spine, investigators instructed subjects to move their neck as much as possible (i.e. active, or forced flexion) during the experimental manoeuvre. Patients with acute neck pain, however, are not likely to move their necks actively or against resistance because of the discomfort associated with neck movements. The results of these studies, therefore, may overestimate the extent of motion that the patient with neck pain will typically execute.

Dropped flexion of the neck may be a more representative manoeuvre to employ when attempting to depict neck movements in subjects with pain. This preliminary trial was designed to test this manoeuvre on subjects wearing different types of soft cervical collars.

Methods

A randomized controlled trial was designed to test the restrictive abilities of soft cervical collars in neck flexion using dropped neck flexion as the experimental manoeuvre. Dropped neck flexion is described as the motion in which the subject relaxes the muscles of the neck and lets the head drop forward to the point where it rests.

Forty asymptomatic adults, ranging in age from 20–29 years were recruited during a three week period from the student population at the Canadian Memorial Chiropractic College via a direct approach. A cut-off at 30 years of age was made because the range of motion of all joints may decrease after this age.[10] Subjects were excluded if they had any current neck pain or a history of neck pain in the past six months. Symptomatic subjects were not used because pain is a major confounder when measuring neck movements.

Demographic data and informed consent were obtained, and the subject's neck was measured to determine collar size. Subjects were instructed to stretch and warm-up their neck muscles by flexing and extending the neck five times. The subjects were informed that the manoeuvre consisted of two distinct components of neck flexion, dropped and forced flexion. Figure 1 illustrates these movements.

The collars used were Airway* soft cervical collars and handmade cervical roughs (Figure 2). Both are commonly used in clinical practice, and available from medical and chiropractic supply centres. The Airway collar is a foam-type collar that comes in small, medium and large sizes, and attaches with a velcro strip behind the neck. The cervical rough is made by taking two measured lengths of two inch cotton tubular stocking** and filling each of them with three layers of rolled-up eight inch non-absorbant backing***. The two lengths are wrapped around the subject's neck and secured by tying the loose ends behind the neck.

* Airway Surgical Appliances Ltd., South Nepean, Ontario.
** Orthopedic Stockinet, Conco Medical Co., Bridgeport, Connecticut 06610.
*** Curity Practical Combination Roll, Kendall Canada, Toronto, Ontario.
© Spinal Rangiometer, Maker Inc., Flushing, Michigan 48433, USA.

Subjects were randomized to the order of collar application by drawing an opaque envelope from a box. The box contained six envelopes representing the six possible orders of applying the three collar types (no collar, Airway, rough).

The subject was seated in a high-backed chair and fitted with a Spinal Rangiometer©, which was used to measure the degree of neck flexion. A strap was placed across the shoulders to secure the patient to the chair, preventing trunk movements (Figure 3). The appropriate collar type, depending on the order of randomization, was then fitted to the subject's neck. The subject was given instructions (by an examiner that was blinded to the Rangiometer dial) to let his/her head drop forward until it came to rest. The Rangiometer was read and recorded at this dropped flexion position by a second examiner who was trained in the use of the Spinal Rangiometer. The subject was then instructed to flex the head forward as far as possible and a second reading recorded (forced flexion). This procedure was repeated for a total of three times and the average score recorded. All measurements of neck flexion were obtained by only one examiner to ensure consistency in measurements (See *Outcome measures* for reliability data).

The collar type was then changed and the procedure repeated with the other two collar types in the order of randomization. By randomizing the subjects to the order of collar wear, order bias was reduced, and by measuring neck flexion with and without collar wear, the subjects served as their own controls. Because the subjects were not symptomatic and natural history would therefore not likely be a factor, the investigators considered it appropriate to use the subjects as their own controls.

Outcome measures

The range of motion of the cervical spine in flexion was measured with a Spinal Rangiometer,© which is an easily applied and readable inclinometer that does not interfere with neck motions (Figure 3). This instrument, and another similar to it, have been shown in previous work to be both reliable and valid, and useful as range of motion measuring tools.[11] Zachman et al.[11] determined the interexaminer reliability coefficient (Pearson's r) of the Rangiometer to be 0.64–0.74 with standard errors of estimate of 7–9 degrees for flexion measurements. Moffett et al.[12] reported similar interexaminer reliability data, as well as intraexaminer reliability results. No significant differences were found between three consecutive measurements in 12 subjects, with a 95% prediction interval for the difference between observations of +/− 13.2 degrees for flexion. Based on this data, and on an estimate of the minimal degree of change that could be detected visually without instrumentation (as determined by a panel of peers), the investigators determined that a clinically significant change in measured range of motion would have to be 15 degrees or more.

Reliability of the measuring examiner was assessed by having her complete repeated measures on four subjects, and was acceptable (intraclass correlation $R = 0.954$). The Rangiometer was pre-tested for validity by comparing angles measured from

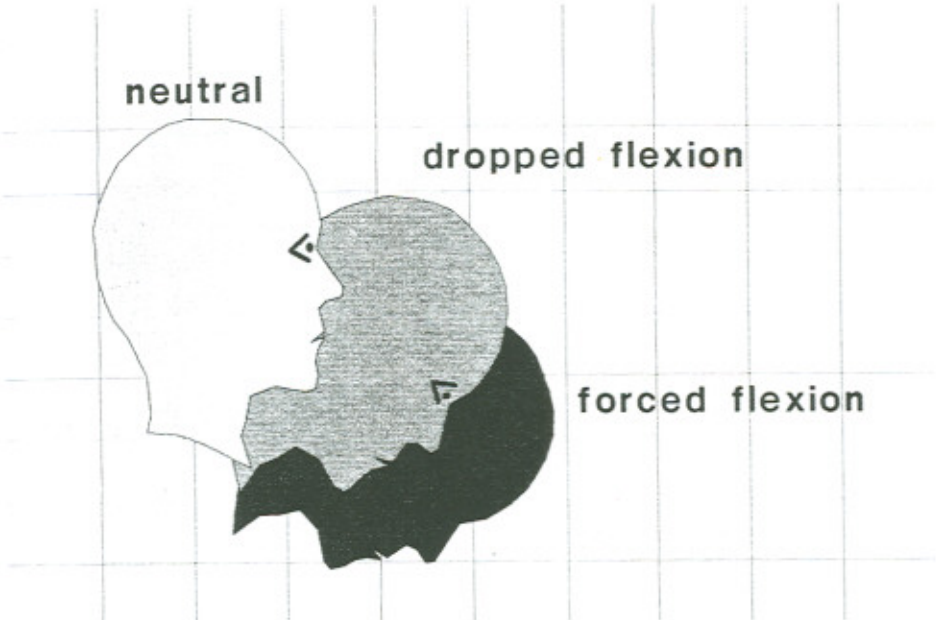


Figure 1 Schematic representation of neutral, dropped, and forced flexion movements of the cervical spine.

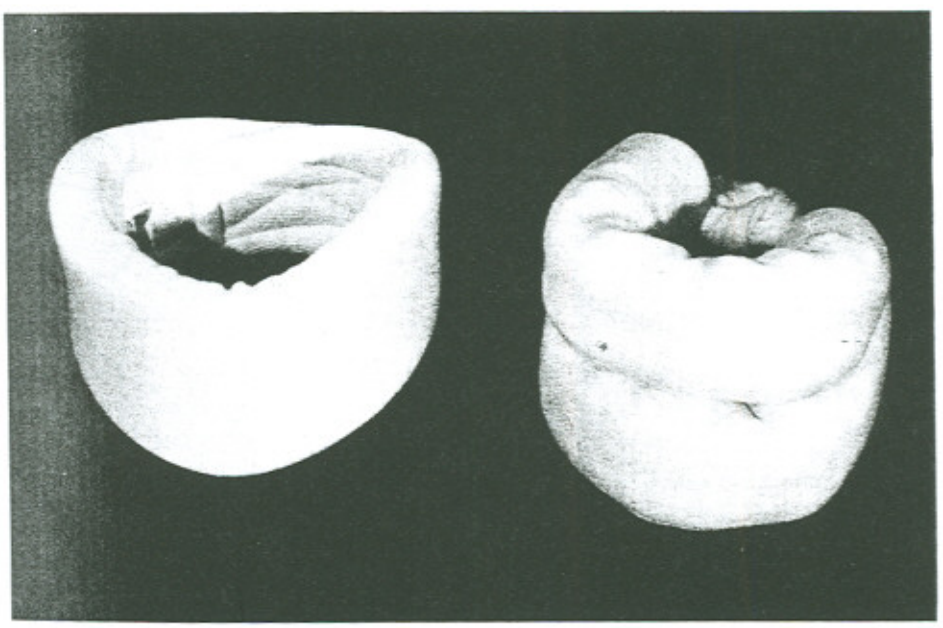


Figure 2 The soft cervical collars used in this study. (Left) the Airway soft cervical collar, and (right) the handmade cervical rough.

a gold standard (protractor) to angles measured with the Spinal Rangiometer (concurrent validity). A Pearson's correlation on these values was also acceptable ($r = 0.999$). No attempt was made to validate the measured neck flexion values by comparing them to radiographically determined values, as these two measurement methods have been reported previously to be comparable for assessing overall flexion-extension movements.[7]

Analysis

A repeated measures analysis of variance was used to simultaneously compare the data of the three collar types for any significant differences, using 0.05 as maximum acceptable level of type I error probability. Tukey HSD paired comparison tests were then calculated to contrast differences between groups two at a time. Means and standard deviations were also calculated.

Figure 3 Subject positioned in a high-backed chair with the Spinal Rangiometer fitted onto the head. A strap across the shoulders prevents trunk movements during neck movements.

Results

Twenty male and twenty female students from the student population at the Canadian Memorial Chiropractic College were examined. The age of the subjects ranged from 20–29 years, with the mean age being 25.7 years.

Figure 4 shows the range of motion (ROM) obtained for each of the forty subjects with both dropped and forced flexion. The ROM while wearing the cervical rough is consistently lower than while wearing the Airway collar. As well, the Airway collar values almost directly overlap the no collar values.

The mean degree of dropped and forced flexion for each collar type was calculated along with their standard deviations (Table 1). The mean values obtained without collar wear were 64 and 73 degrees for dropped and forced flexion respectively.

TABLE 1
Mean dropped and forced flexion values in degrees (standard deviation) for each collar type

	Collar Type		
	No Collar	Airway	Rough
Dropped Flexion	64 (14)	58 (15)	34 (17)
Forced Flexion	73 (11)	69 (12)	47 (14)

The mean values obtained for the Airway soft cervical collar were 58 and 69 degrees for dropped and forced flexion, respectively. For the handmade cervical rough, the mean dropped and forced flexion values were 34 and 47 degrees, respectively. All values have been rounded to the nearest integer to avoid implying false accuracy of measurements.

The amount of restriction provided by each collar type is described as the percent restriction. This is defined as the dropped flexion value with collar wear divided by the dropped flexion value without collar wear, subtracted from one, and multiplied by 100. The cervical rough provided 47 percent restriction whereas the Airway cervical collar provided only 9 percent restriction (Figure 5).

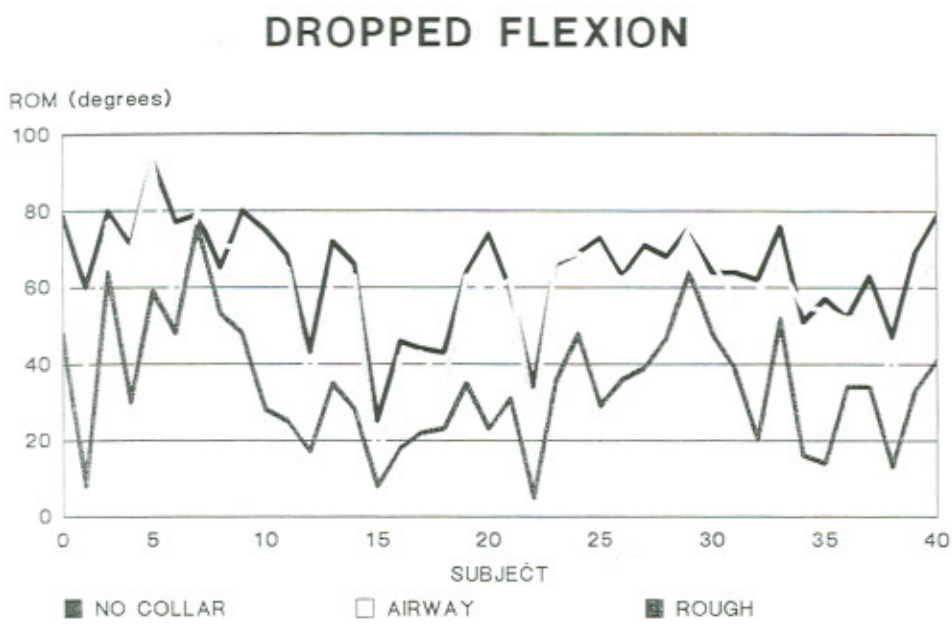
A repeated measures analysis of variance on the dropped flexion values revealed that there is a statistically significant ($F = 219.93$, $p < 0.001$) difference in the dropped flexion values for the three collar types. However, Tukey HSD paired comparisons revealed that the difference in dropped flexion values between no collar and the Airway collar was not significant ($p = 0.229$). The differences between no collar and the cervical rough, and between the Airway and the cervical rough were significant ($p < 0.001$). Only the cervical rough, however, achieved clinical significance, providing greater than 15 degrees of restriction to dropped neck flexion.

A power analysis completed on the results revealed that greater than 80 percent power was achieved and therefore chance of a type II error is minimal.

Discussion

This study shows that dropped neck flexion is restricted by approximately 50 percent with the use of a handmade cervical rough. The Airway collar provided only nine percent restriction, a value which, although somewhat larger than previously reported figures,[2] is within the error of measurement and not statistically or clinically significant.

The considerable amount of restriction provided by the handmade cervical rough has not been reported in previous studies. Using dropped flexion as a manoeuvre as opposed to forced flexion may explain this restriction because with forced flexion a normal subject can use muscle power to flex beyond the passive restraint of a soft collar. Another possible explanation for the amount of restriction provided by the cervical rough is



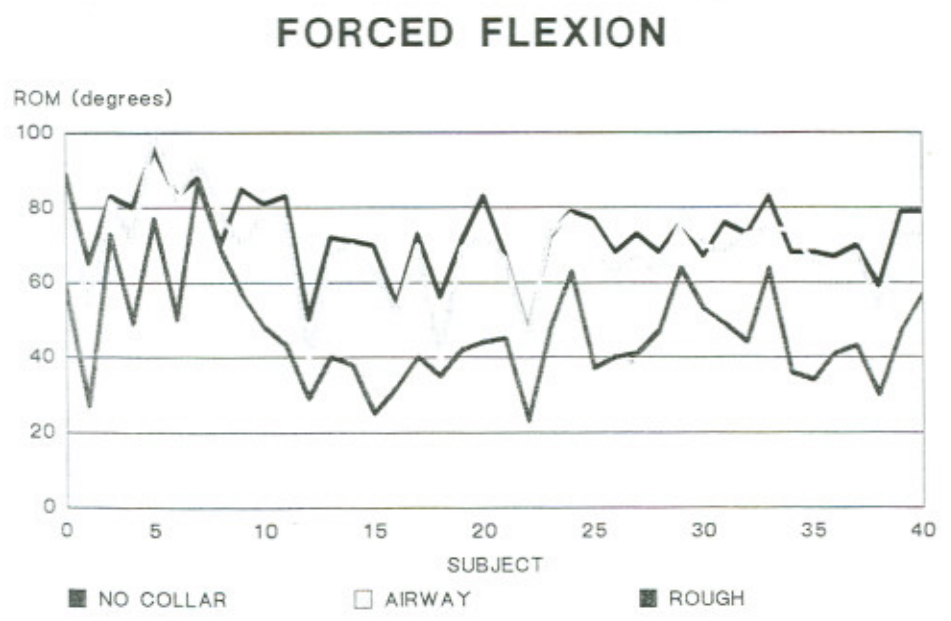


Figure 4 Dropped (top) and forced (bottom) flexion scores with no collar, the Airway collar, and the cervical rough for all subjects.

that the cervical rough stuffing may be more dense and therefore more restrictive to neck movements.

By including forced flexion in the manoeuvre, not only was a distinct separation of the types of movements better understood by the subjects, but the values could be compared with previous reports. The value of 73 degrees for unrestricted forced or active flexion is consistent with the literature on normal cervical spine active ranges of motion.[10] Sixty-nine degrees of forced flexion was allowed while wearing the Airway collar, only three degrees less than with no collar wear. This finding is consistent with the previously stated conclusions that foam-type soft collars provide little, if any, restriction to active or forced neck movements.[1–8] Forced flexion while wearing the cervical rough allowed 47 degrees of motion (35 percent restriction). This again suggests that the increased density of the cervical rough stuffing contributes to the restrictive abilities of this type of collar.

There is much discussion in the literature as to what entails

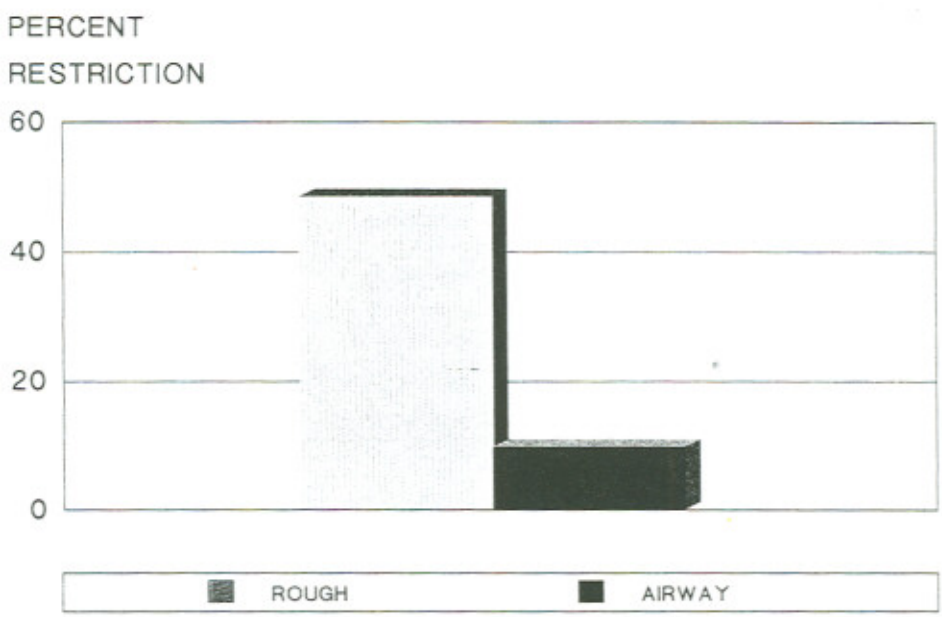


Figure 5 Percent restriction provided by the handmade cervical rough compared to the Airway soft cervical collar.

proper management of acute soft tissue injuries of the neck. Historically, rest, soft collar application, and sedation or analgesia represent the standard treatment.[13] Recently, in an eight week follow-up study, Mealy et al.[14] suggested that early mobilization of the neck, beginning 24 hours after presentation, provides greater improvement in terms of ROM and pain intensity compared to a standard treatment of rest in a soft collar for two weeks. However, even more recently, in a five month follow-up trial, Pennie and Agambar[15] compared a standard treatment of rest in a soft collar for two weeks followed by unsupervised mobilisation to an active physiotherapy treatment of traction, exercises, and neck care advice. They found no differences between groups.

Although it is not clear from the literature, whether soft collars should or should not be recommended, recent trends in the management of acute, uncomplicated soft tissue injury of the neck suggest a brief period of rest and support, followed by early, active intervention.[13] The results of this study show that the soft cervical rough can provide this needed support by restricting dropped neck flexion.

However, before recommendations can be made for the use of the cervical rough in clinical practice certain issues need to be investigated further. Only one range of motion, neck flexion, was studied in this preliminary trial. Flexion was chosen as the motion of interest for two reasons. Firstly, hyperflexion injuries are arguably thought to be the most problematic type of neck injury.[16,17] Secondly, for the purposes of this preliminary study, it served to simplify the methodology and statistical analysis with minimal sacrifice to clinical usefulness. It is well recognized that injuries to the cervical spine can cause pain in all ranges of motion, and these collars must be tested in the other ranges of motion.

Other issues to consider before recommendations can be made include: 1) the sample studied was asymptomatic and within a limited age range (20–29 years); 2) chiropractic students may have a preconceived knowledge, or expectation bias, about the function of soft cervical collars, and therefore may behave differently than the general population when tested; and 3) patient and doctor compliance issues, such as comfort, appearance, time of preparation and ease of application of the collars. These issues may affect the generalizability of these results, and further studies dealing with these issues need to be completed before general recommendations can be made.

Conclusion

Dropped neck flexion is a manoeuvre that is reproducible and feasible for use in other population samples. It may be a more appropriate type of manoeuvre to use when testing for the restrictive abilities of soft cervical collars given the type of patient population for which they are generally recommended, i.e. acute, uncomplicated soft tissue injuries of the neck.

The results of this preliminary study suggest that the handmade cervical rough is a more efficacious soft collar for restricting dropped neck flexion, compared to the Airway soft cervical collar. Further study is required before recommendations can be made for use in clinical practice.

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