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Changes in Circumferential Neck Measurements During Movements of the Head in Children and Their Relevance to Extraoral Traction

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ABSTRACT

One of the causes of facebow injuries to patients wearing extraoral traction has been the catapult effect of the simple elasticized materials used in the past. A variety of safety or self-releasing modular systems to counteract this catapult effect are currently available. However, the strap extension provided by these modules varies considerably. To reduce the catapult effect to a minimum, it is desirable to fit a system with the minimal travel that will accommodate any changes in distance between the facebow and the back of the head or neck. To ascertain the minimal travel required for the straps, circumferential neck measurements were carried out on 105 children aged between 9 and 14 years. The change in circumference was recorded for 3 different head positions. The mean distance change between the back of the neck and the end of the facebow was 25 mm per side, with a range of 4 mm to 50 mm. This study suggests that on average, modules with a 25-mm extension will be required for cervical traction.

KEY WORDS: Safety release modules, Headgear, Neckstrap, Neckgear, Cervical traction.

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INTRODUCTION Return to TOC

The use of simple elasticized materials to provide extraoral traction has unfortunately, in a few cases, caused injuries to patients because of its catapult effect.[1–8] To counteract this effect, 2 types of safety devices became commercially available. These consisted of a variety of self-releasing modules attached to either a headcap or a neck strap and a plastic neck strap with a series of holes located along part of its length.

The plastic neck strap is suitable only for cervical traction and is used in conjunction with an elasticized neck strap. The self-releasing modules are manufactured in a variety of designs (Figure 1) that provide a range of extensions that vary[9,10] by as much as 11 mm to 65 mm or 0.86 to 2.93 inches and require differing amounts of force to release them.[9,10] These modular systems can be used on either a

headcap or a neck strap, but with some designs there is an assumption that the strap extension can or should be the same for a headcap and a neck strap. To reduce the catapult effect to a minimum, the travel provided by these modules should be limited[10] to allow a comfortable range of head movement without unintentional release of the modules. Ideally, this distance should be less than that required to dislodge the facebow from the extraoral traction tubes (usually about 4 mm). However, this distance will be governed by any change in distance from the end of the facebow to the back of the head or neck during movements of the patient's head while putting on or wearing the facebow. The distance from the upper first molar to the back of the head (headcap) remains fairly constant during movements of the head, as this is a fixed distance. However, the distance between the back of the neck and the upper first molar (neck strap) is likely to vary during movements of the head because of the different anatomy of the region. To be able to select a module with the minimal travel, orthodontists need to know the range of movement they are likely to encounter in their patients. A pilot study carried out on 77 twelve-year-old children, both boys and girls of mixed race, suggested that the distance between the back of the neck and the upper anterior teeth changes with movements of the head an average of 22 mm per side when measured with a set of calipers. The range was 7 mm to 42 mm per side, with a standard deviation of 8 mm per side.

The purpose of this study was to examine any changes in distance that may occur between the facebow and the back of the patient's neck during movements of the head. We repeated the pilot study measurements with a different measuring device to suggest an ideal average minimal travel when selecting self-releasing modules for neckstraps. Finally, we consider, in the light of the results, whether a plastic neck strap could be a suitable alternative safety device.

MATERIALS AND METHODS Return to TOC

This prospective study was carried out on a consecutive sample of 105 patients, 9–14 years of age, seen in a new patient clinic in the orthodontic department for advice or treatment. The sample consisted of 46 boys and 59 girls of whom 75 were white, 24 were Asian, and 6 were black.

A sliding strap was constructed from 2 plastic neckstraps and a single self-release plastic module to measure the distance around the back of the neck from the outer hook on one end of a facebow to the outer hook on the other end of the facebow. The internal spring was removed from a module, and slots were created at both ends to allow one of the straps to slide freely through the module (Figure 2). The second strap was firmly attached to the module. This design allowed the free-sliding strap mechanism to be adjusted comfortably and passively to different circumferences around the patient's neck. To avoid placing molar bands on each patient, the inner bow of a sterile facebow was embedded in warmed, softened wax. The softened wax (Dental Wax beauty pink, Moyco Union Broach, York, Pa) containing the facebow was molded to the patient's upper teeth to provide an accurate and secure fit of the facebow to the top teeth in the correct position (Figure 3). The wax and facebow were removed from the patient's mouth, and the wax cooled until it became hard. The wax-encased facebow was then replaced in the patient's mouth and stabilized both by their thumbs and their lower teeth. The plastic measuring straps were attached to the outer hooks of the facebow in the patient's mouth. The straps were adjusted through the module to comfortably and passively fit around the patient's neck while the patient sat in an upright position in the dental chair (Figure 4). A line was marked at the leading edge of the module on the strap to indicate the reference mark by which any changes in circumference would be measured. The patients tilted their heads downward, and the strap was adjusted to accommodate any change in the circumference. A second mark was placed on the strap at the leading edge of the module while the patients were in this position (Figure 5). The patients extended their heads forward, and the strap was adjusted to accommodate any change in the circumference (Figure 6). A third mark was placed on the strap at the leading edge of the module while the patients remained in this position.

The patients then returned to the upright position. The last measurement was to determine the amount of compression present in the soft tissues around the back of the neck. The strap was returned to its original snug position around the back of the neck and the original reference mark checked. The strap was then pulled through the module until it became tight around the neck, compressing the soft tissues. The last mark was then placed on the strap at the leading edge of the module.

The strap was removed, and the various measurements were made with the marks created while it was on the patient. A single operator made all measurements with the same metal ruler to the nearest millimeter. The measurements were all made from the reference mark to the other 3 marks. The strap was cleaned and the marks removed with an alcohol cleaning solution between patients. A single operator used the same strap on all patients. Facebows were autoclaved between patients.

Changes to the strap extension can occur with lateral movements of the head, but these are small, because the neck strap is free to slide around the neck with this type of head movement. These small measurements were not recorded in this study, as they would be within the range of those recorded in the vertical dimension.

RESULTS Return to TOC

The distance between the back of the neck and the outer hook of the facebow was found to change with movements of the head. The mean distance change between the head forward and head down position (the largest change) was 51 mm around the back of the neck (or 25 mm per side). The range was 30 mm to 78 mm (or 15 mm to 39 mm per side; Table 1) with a standard deviation of 10 mm (or 5 mm per side).

The mean change between the head in the upright position in the dental chair and the head down was 22 mm around the back of the neck (or 11 mm per side; Table 1). The range was 4 mm to 50 mm (or 2 mm to 25 mm per side) with a standard deviation of 10 mm (or 5 mm per side).

The mean change between the head in the upright position in the dental chair and the head forward was 29 mm around the back of the neck (or 14 mm per side; Table 1). The range was 10 mm to 58 mm (or 5 mm to 29 mm per side) with a standard deviation of 10 mm (or 5 mm per side).

The mean soft tissue compression measurements around the back of the neck were 15 mm (or 7 mm per side). The range was 8 mm to 25 mm (or 4 mm to 12 mm per side) with a standard deviation of 3 mm (or 1 mm per side).

DISCUSSION Return to TOC

Extraoral traction is a very useful and cost-effective device for gaining extra anchorage in a variety of treatment situations. The safety aspect of the device has been discussed in several articles in recent years because of a few reports of injuries to patients from the standard facebow used with simple elasticized traction.[1–3,6,8,–13] These injuries have been caused essentially in 2 ways. First, the elasticized traction has acted like a catapult in some situations, and the dislodged standard facebow has unfortunately recoiled back with the ends of the inner bow, hitting the patient. Second, the facebow has come out of the buccal tubes at night while the child was asleep, and inadvertently the child has rolled onto the facebow and been injured by the ends of the inner bow. Some of the injuries have been severe. What is often not appreciated when selecting safety devices is that soft tissue injuries from the ends of the inner bow have a peculiarly high morbidity rate because of the presence of the oral bacteria on the ends of the facebow, rather than just the trauma.[1,2,4,14] Because of this very significant problem, it has been recommended that facebows be prevented from coming out of the buccal tubes.[15]

The results from this study are fairly similar to those of the pilot study, confirming that the distance between the back of the neck and the outer hook of the facebow does change with movements of the head. This will make it impossible for the stiff plastic neck strap design to consistently retain the facebow in the buccal tubes, as it cannot accommodate the change in distance from the facebow to the back of the neck. This leaves the orthodontist with a choice of one of the self-releasing modular systems to provide the traction.

Because the distance between the upper molars and the back of the head is fixed, the minimum strap extension required for the headcap (high pull) will be in the region of 10 mm per side, to allow the patient just enough extension to attach the strap to the outer hook of the facebow. However, for cervical traction (neck strap) the strap extension will need to be greater to accommodate the change in distance between the end of the facebow and the back of the neck. The results from this study suggest that on average, the strap extension will need to be 25 mm per module (per side). The compression of the soft tissues in the back of the neck will tend to add slightly to this distance. However, modules with the same strap extension are often provided for both the headcaps and the neck straps, and the orthodontist may be limited to using modules with a 25-mm extension for both situations. The force required to release the module is more difficult to resolve, as this will be affected by several factors, such as consistent design quality of the modules, axial or nonaxial distraction force, and the length of the outerbow.[16] Until more data are available, it is suggested that the modules have an adequate retentive capability to prevent recurrent nuisance release, but that they can fairly easily be manually released by the orthodontist when they are tested at chairside. To try to maintain a consistent force throughout the extension of the strap, some modules are manufactured with nickel titanium springs (Ortho Kinetics Corp, Vista, Calif).

What may be overlooked is that self-releasing modular safety systems were not designed to, and do not, consistently retain the facebow within the extraoral traction tubes. They were targeted at the catapult or recoil problem associated with the use of simple elasticized traction materials. Because on average, most patients will require 25 mm of travel per side and most extraoral traction tubes are 4 mm long, there will be about 20 mm of travel (plus neck soft tissue compression) available for the facebow to be dislodged from the buccal tubes. Standard facebows have been shown to come out at night with either elasticized materials or self-release systems.[7,11] The range of neck movement some children possess (15 mm to 39 mm per side), incorrect fitting, and the headcap sliding off at night all contribute to the problem. Ideally, any facebow used with the self-releasing safety modular systems should be self-retentive,[8,11–13] because it is the presence of the oral microorganisms on the end of the inner bow, rather than the trauma, that radically alters the prognosis of the soft tissue injuries.[1,2,14] Some facebows have been designed with shielded or recurved ends to the inner bow in an attempt to reduce the severity of any soft tissue trauma. Although this design may reduce the severity of some soft tissue trauma, it will not prevent inoculation of oral microorganisms into the eye, as it is not self-retentive, and the ends of the inner bow are covered with oral microorganisms. Patients can also inadvertently roll onto any part of the dislodged inner bow while asleep and infect the eye.[12,13] In one study, nighttime disengagement of the facebow was found to be the largest cause of facebow injuries.[7] However, the use of a locking facebow used with self-releasing modular safety systems has been shown to significantly reduce nighttime disengagement of the facebow.[17,18]

CONCLUSION Return to TOC

Extraoral traction is still a very useful device to many orthodontists in helping to provide additional anchorage in a variety of situations.

Self-releasing safety modules with a minimum travel and a locking facebow have been introduced to counteract the problems of the simple elasticized traction and the standard facebow, improve safety standards, and increase the hours of wear.

These results suggest that when selecting a self-releasing safety modular system for cervical traction, the minimum travel required will be, on average, 25 mm. However, there may be a few patients who are able to extend up to 39 mm and might require a slightly longer travel if they experience repeated nuisance release of the modules.

ACKNOWLEDGMENTS

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REFERENCES Return to TOC

1. Holland GN, Wallace DA, Mordino BJ, Cole SH, Ryan SJ. Severe ocular injuries from orthodontic headgear. *Arch Ophthalmol.* 1985; 103:649–651.

2. Holland GN, Wallace DA, Mordino BJ, Cole SH, Ryan SJ. Severe ocular injuries from orthodontic headgear. *J Clin Orthod.* 1985; 19:819–825.

3. De Leo D, Bertele G. Lesione oculare penetrante da trazione extraorale ortodontica [in Italian]. *Minerva Medicolegale.* 1993; 112:1–6.

4. Chaushu G, Chaushu S, Weinberger T. Infraorbital abscess from orthodontic headgear. *Am J Orthod Dentofacial Orthop.* 1997; 112:364–366.

5. AAO Bulletin. Preliminary results of headgear survey. *Bulletin.* 1982; 1:2

6. Béry A. Les accidents dus aux forces extra-orales [in French]. *Rev Orthop Dentofacial.* 1992; 26:137–141.

7. Samuels RHA, Willner F, Knox J, Jones ML. A national survey of orthodontic facebow injuries in the UK and Eire. *Br J Orthod.* 1996; 23:11–20.

8. Samuels RHA. A review of orthodontic face-bow injuries and safety equipment. *Am J Orthod Dentofacial Orthop.* 1996; 110:269–272.

9. Postlethwaite K. The range and effectiveness of safety headgear products. *Eur J Orthod.* 1989; 11:228–234.

10. Stafford GD, Caputo AA, Turley PK. Characteristics of headgear release mechanisms: safety implications. *Angle Orthod.* 1998; 68:319–326.

11. Samuels RHA, Jones ML. Orthodontic facebow injuries and safety equipment. *Eur J Orthod.* 1994; 16:385–394.

12. Samuels RHA, Doll GM. Sicherheitsmabnahmen beim Tragen eines Headgears [in German]. *Kieferorthop.* 1998; 12:27–36.

13. Samuels RHA, Cacciafesta V. L'uso sicuro della trazione extraorale ortodontica [in Italian]. *Ortognatodonzia Italiana.* 1999; 8:313–322.

14. Booth-Mason S, Birnie D. Penetrating eye injury from orthodontic headgear—a case report. *Eur J Orthod.* 1988; 10:111–114.

15. AAO issues special bulletin on extraoral appliance care [editorial]. *Am J Orthod.* 1975; 68:457

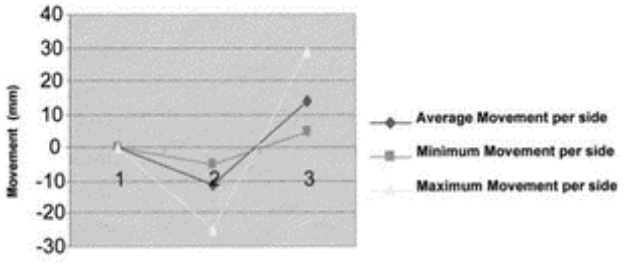
16. Hoeltschi IG. *An Ex-vivo Investigation to Compare the Release Behaviour of Five Representative Designs of Safety Release Cervical Extraoral Traction Device* [MSc thesis]. London, England: University of London; 1988.

17. Samuels RHA. A new locking facebow. *J Clin Orthod.* 1997; 31:24–27.

18. Samuels RHA, O'Neill J, Bhavra G. et al. A clinical evaluation of a locking orthodontic facebow. *Am J Orthod Dentofacial Orthop.* 2000; 117:344–350.

TABLES Return to TOC

TABLE 1. Average, Minimum, and Maximum Range of Change in Distance From the Back of the Neck to the Facebow[a]



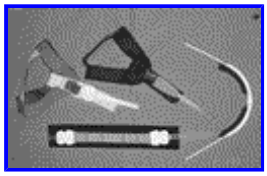
1 = Head in upright position (Fig 4).

2 = Head tilted downwards (Fig 5).

3 = Head extended forward (Fig 6).

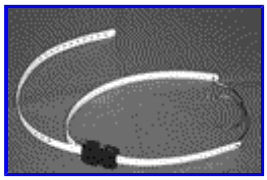
[a] Distance change with the patient moving the head form the upright position in the dental chair (1) to the head tilted downward (2) to the head extended forward (3).

FIGURES Return to TOC



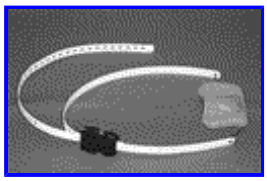
Click on thumbnail for full-sized image.

FIGURE 1. Some of the different designs of self-releasing modules available.



Click on thumbnail for full-sized image.

FIGURE 2. The far neckstrap is attached to the modified plastic module, which has had a slot cut at both ends and the internal spring removed to allow the near neckstrap to slide through the module. Both neckstraps are attached to the ends of the facebow



Click on thumbnail for full-sized image.

FIGURE 3. The facebow has now been covered with the dental wax beauty pink and molded to the upper teeth before being cooled to a hard consistency. The wax-encased facebow was placed over the patient's upper teeth to situate the facebow in the correct position

Click on thumbnail for full-sized image.

FIGURE 4. The patient in the upright position in the dental chair with the strap comfortably adjusted around the back of the neck. The first reference mark was placed on the strap in this position

Click on thumbnail for full-sized image.

FIGURE 5. The patient with her head tilted downward and the strap comfortably adjusted to this position. The second reference mark was placed on the strap in this position

Click on thumbnail for full-sized image.

FIGURE 6. The patient with her head extended forward and the strap comfortably adjusted to this new position. The third reference mark was placed on the strap in this position

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