

**CLINICAL
SECTION**

Orthodontic facebows: safety issues and current management

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Abstract

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Some patients treated with extra-oral traction provided by simple elasticated materials and a standard facebow have experienced problems with the standard facebow coming out of the buccal tubes at night and the catapult effect of the extra-oral traction. The disengagement of the facebow at night has affected the success of treatment and occasionally injured the patient. This paper draws on material from a variety of papers and lists the known causes and considers the associated safety issues. It also provides some clinical tips and makes several suggestions for the continued use of this very useful form of additional orthodontic anchorage.

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Introduction

Despite the interest in a variety of alternative devices the use of extra-oral traction applied via a facebow (Figure 1) still provides valuable additional anchorage in the treatment of a variety of malocclusions. It is both clinically and economically effective, and simple to use. Unfortunately, a few patients have been injured by the facebow during treatment. The injuries have been associated with the catapult effect of the simple elasticated extra-oral traction and with the standard facebow coming out at night. In certain circumstances, the standard facebow has been either knocked, pulled, or taken out of the buccal tubes, while still attached to the headgear or neckgear. The elastic traction has then acted like a catapult and caused the facebow to recoil, and hit the patient in the face, head, or neck. The other problem has been the tendency of the standard facebow to come out of the buccal tubes, while the patient is asleep, and occasionally it has caused a soft tissue injury to the head and neck region of the patient. This detachment of the facebow at night has also compromised the success of the treatment.

Before assessing any safety devices to prevent these injuries, it is important as part of any risk assessment process, to carefully examine how the injuries occurred, and any significant associated factors. The details of the injuries can be obtained from a number of case

reports^{1–9} and two questionnaire surveys,^{10,11} and are summarized in Table 1. These injuries have occurred with both removable and fixed appliances, and ranged in severity from minor lacerations to the loss of an eye. They all occurred in children aged between 9 and 14 years. One study found the most common cause of injury was the facebow coming out at night and suggested that night-time disengagement of the facebow was an important causative factor in facebow injuries.¹¹

Assessing the safety issues

In order to try and help prevent these injuries and improve safety standards, different manufacturers have introduced several safety devices. These include self-releasing extra-oral traction systems, plastic neckstraps, shielded facebows, and locking facebows.^{12–15} In 1975, the American Association of Orthodontists, after receiving details of a few injuries, recommended that patients should be instructed on the proper use of the appliance and, if feasible, headgear design needed to be changed. They also recommended that practitioners should take steps to eliminate accidental disengagement of the facebow from the buccal tubes.¹⁶ It has also been recommended that facebows should be designed so that the ends of neither the inner nor outer bow are capable of producing either penetrating injuries or lacerations.³

Dr Samuels has a financial interest in a product described in this article

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Fig. 1 The standard Kloehn type of facebow.

Table 1 Details of how injuries occurred.

Group 1	<p>The standard Kloehn type of facebow has either been dislodged or removed from the buccal tubes, and the simple elasticated traction has acted like a catapult, causing the facebow to recoil back and the ends of the inner bow have hit the patient causing an injury to the soft tissues of the head or neck.</p> <p>This has happened in three different ways:</p> <ol style="list-style-type: none"> 1. The patient was wearing their extra-oral traction while playing and accidentally their hand knocked the facebow out of the buccal tubes and the elastic traction caused it to recoil back causing a soft tissue injury. 2. The patient removed the facebow from their mouth without first disconnecting the elasticated traction and lifted the facebow up in front of their face to remove it. On one occasion the facebow slipped from their hand and the ends of the inner bow caused a facial injury. 3. The facebow was pulled out of the buccal tubes in the patient's mouth by another child and then released allowing the facebow to catapult back and cause a soft tissue injury.
Group 2	<p>The second cause has been due to the facebow coming 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.</p>

The aim or function of any of these safety devices must be to effectively reduce or preferably stop the catapult effect of the extra-oral traction, and prevent the facebow accidentally coming out of the buccal tubes.

Significant factors

There are several very important factors associated with facebow injuries, which may not be appreciated when considering the safety issues. The presence of the oral micro-organisms on the ends of the inner bow radically alters the outcome of the soft tissue trauma, making the patient highly susceptible to infections.^{3,4,6,7} Surprisingly, facebow injuries to the eye can cause little pain at

the outset often delaying the child seeking treatment especially when it occurs at night.³ This delay allows the infection to proceed unchecked for a considerable period of time. The eyeball is also an excellent culture medium and when it becomes infected it is very difficult to control.³ When one eye is injured there is a risk to the other undamaged eye from a process called sympathetic ophthalmitis.³ Those patients who lose an eye often have a sunken appearance around the socket and are subjected to wearing a prosthesis, which requires constant maintenance. They may also have a reduced field of vision and may require surgery to the lower eyelid beneath the glass eye. It is also just as important to prevent intra-oral, as well as extra-oral soft tissue injuries.¹³

System failures

When assessing failures in safety systems it should be remembered that they can arise for two reasons: active failures and latent conditions. Active failures are the unsafe acts sometimes committed by people who are in direct contact with the patient. Latent conditions are the inevitable 'residual pathogens' within the system and arise from decisions made by designers, builders, etc. Unlike active failures, which can often be hard to foresee, latent conditions can be identified and remedied before an adverse event occurs. Understanding this leads to proactive, rather than reactive risk management.¹⁷ Incorporating effective extra-oral traction safety systems into a practice should be a pro-active, rather than a reactive change.

Self-releasing headgear and neckgear

The self-releasing mechanism in these devices has been designed to prevent or reduce the catapult effect encountered in the recoil injuries. The self-releasing modules are manufactured in a variety of designs (Figure 2).^{18,19} These modular systems can be used on either a headcap or a neckstrap. To reduce the catapult



Fig. 2 A selection of self releasing extra-oral traction devices.

effect to a minimum, the travel provided by these modules should enable a comfortable range of head movement by the patient without their unintentional release. Ideally, this distance should be less than that required to dislodge the facebow from the buccal tubes (usually about 4 mm long).²⁰ However, it will be governed by any change in the distance from the end of the facebow to the back of the head/neck during movements of the patients head, while putting it on or wearing it. As 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. This should allow the patient just enough extension to attach the strap to the outer hook of the facebow.

However, for cervical traction the requirements will be different. A study of 105 children aged between 9 and 14 years demonstrated that the distance between the back of the neck and the end of the facebow changes with head movements on average 25 mm per side.²¹ Therefore, the average strap extension for cervical traction (neckstrap) will need to be 25 mm per module.

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 non-axial distraction force, and the length of the outer bow.^{20,22} Until more data is available it is suggested the modules have an adequate retentive capability to enable them to provide the required therapeutic force without recurrent nuisance release, but can fairly easily be manually released when tested at the chair-side.

The self-releasing extra-oral traction systems can reduce the catapult effect to approximately 10 mm for the headcap and 25 mm for the neck strap, but cannot be relied upon to keep the facebow in place at night. This problem has to be addressed by some other mechanism.

Plastic neckstraps

These plastic neckstraps have been offered as a simple safety device presumably to retain the facebow within the buccal tubes (Figure 3). Because this strap is not flexible, it cannot accommodate the changing distance between the back of the neck and the facebow, and still provide a continuous resistance to the displacement of the facebow from the buccal tubes.^{12,13,14,15,21} When fitted tightly around the patients neck it is either very restrictive or too loose, depending on the position of the patient's head.²¹ Poor patient compliance with this strap has also been reported.¹⁰ Stapling the plastic strap to the

elasticated neckband or crimping the plastic strap to one end of the facebow does not ensure that it will be attached to both ends of the facebow by the patient. There is also a considerable amount of variation in the amount of tension placed on the strap when fitted by different orthodontists.¹⁰ Slack in the strap allows the possibility of distraction of the facebow from the tube housing. Once the facebow is clear of the tube housing it is free to rotate as well as recoil (Figure 4). If used with



Fig. 3 The white plastic safety neckstrap positioned cervically with an elasticated neckband.



Fig. 4 This patient has been fitted with the plastic neckstrap, but without the elasticated neckband. A light forward force dislodges the facebow, which can now rotate.

upper removable appliances, the plastic neckstrap will not retain a standard facebow in the tubes of the appliance should the appliance separate from the teeth.

The stiff nature of this simple device makes it unsuitable as a reliable method of retaining the facebow within the tube housing when fitted around the neck.

Shielded facebows

Some facebows have had shielding included on their inner ends in an attempt to reduce the severity or risk of soft tissue trauma. This design relies on the assumption that on recoiling the shielding will always contact the soft tissues first, which cannot always be relied upon. The shielding does not improve the facebows self-retentive capability and it can disengage at night in a similar fashion to the standard facebow. The ends of the inner bow including the shielding are also covered with oral micro-organisms and the shielding cannot prevent the ends of the inner bow being exposed to the soft tissues at certain angulations (Figure 5). Shielded facebows may reduce the severity of some trauma, but it is not self-retentive, which makes this an undesirable alternative to the standard facebow.

Locking orthodontic facebows

A standard orthodontic facebow relies on the headcap or neckstrap, and any incidental friction in the buccal tube housing to hold it in place. Both of these factors are

known to be unreliable.¹⁰⁻¹² To maintain the facebow reliably within the buccal tubes at night would require an alteration to the standard facebow or the buccal tubes to provide some active self-retentive capability. A variety of locking facebow designs were successfully used by a group of patients in a pilot study.²³ A subsequent study was then carried out by 12 orthodontists who assessed one type of self-retentive facebow in a variety of different orthodontic practises²⁴ ('Nitom Locking Facebow', Ortho Kinetics Corporation, 1611A South Melrose Drive, Suite 16, Vista, CA, 92083, USA). This study found that the facebow was successfully worn by 697 consecutively treated patients over a 2 year period.²⁴ The total number of nights the facebow was worn by all patients was approximately 166,550. All orthodontists and patients successfully learnt to use the facebow in their different practice conditions. The locking facebow design successfully reduced night time disengagement of the facebow to less than 1 per cent, which contrasts very favourably with the 65 per cent disengagement rate reported by practitioners using standard facebows in a previous study.¹¹ Of the 166,550 nights, problems were experienced on only 12, four of which the patients had some recollection of removing the facebow, four had rather a vague story, and on four there was no explanation. This reduced detachment rate also helped patients improve their hours of wear.

The Nitom facebow (Figure 6) was designed to be used with a self-releasing headcap or neckstrap with a short travel. It has bilateral locking catches designed to resist



Fig. 5 When detached, the inner ends of the shielded facebow will be exposed to the eye at certain angulations.



Fig. 6 The Nitom locking facebow with the nearest catch unlocked and the far catch locked.

light and medium displacing forces, and can be used with fixed (Figure 7), functional (Figure 8), and removable appliances (Figure 9). It has two omega bends so that it can be easily adjusted to fit different lengths of buccal tubes.²⁵

Proactive risk management—suggested changes

By combining the information available we would suggest the following.

The patient

Extra-oral traction should only be prescribed to those patients who are likely to comply with the orthodontists instructions. The use of the equipment should be clearly demonstrated to the patient and/or parent, consent obtained, and an entry made in the case notes. For some



Fig. 7 The Nitom locking facebow locked to the upper first molar with an occlusally positioned extra-oral traction tube.



Fig. 8 The Nitom facebow fitted to the Bass Functional Appliance.



Fig. 9 The Nitom facebow locked to two upper removable appliances.

of the younger, less dextrous, or poorly sighted patients, their parents can also be carefully instructed on how to fit the appliance, so they can supervise the fitting and removal of the appliance at home in the early phase of wear.

Written instructions should be issued to all patients and parents to take away with them.

These instructions should include the following details:

- 1 Patients should be advised *never* to wear their headgear during playful activity.
- 2 Should another individual grab their facebow, the patient should also take hold of it until the other person has released their hold. They should then dismantle the headcap and/or neckstrap, and facebow to check that nothing has been dislodged or broken.
- 3 *Always* fit the locking facebow first. This should always be fitted the way the orthodontist has demonstrated to avoid problems. When the locking facebow has been fitted, patients should check in a mirror to make sure it is seated correctly and then confirm the 'lock' with a gentle forward pull. Once the facebow is in position *then* the self-releasing headcap/neckstrap may be fitted, whilst holding on to the facebow, to the prescribed tension as shown by the orthodontist.
- 4 If the headcap/neckstrap/facebow ever comes off at night or there are any other problems, the patient should stop wearing the appliance, and return to see the clinician as soon as possible.
- 5 If the patient experiences a problem unlocking or removing the facebow, excessive force should *not* be used to remove it. The facebow should be left in place and the patient should attend the orthodontic practice as soon as possible to allow the orthodontist to rectify the problem.
- 6 Before removing the facebow the patient must *first* remove the headcap/neckstrap.
- 7 If the patient wakes up and removes the headcap/neckstrap and facebow in the middle of the night they should place it outside the bed before going back to sleep.
- 8 The patient and parent should also be advised that, 'if in the rare and unlikely event, they suspect that part of the headcap/neckstrap/facebow might have caused an injury to the eye, then the eye should be examined without delay by a suitably trained medical Practitioner.'

A warning should be given that failure to comply with the instructions may result in injury.

The equipment

Use a self-retentive or locking facebow. Contour the outer bow of the facebow to fit the patient's face (approximately 1 cm space between cheek and outer bow). If possible place a slight inward turn on the hook of the outer bow to prevent it catching²⁶. Fit a self-releasing headcap and/or neckstrap with a suitable force and a short travel.

The equipment should be carefully checked at each review appointment and the patient asked if it has ever come off or caused a problem. If the patient removes the extra-oral traction and facebow in their sleep leaving the facebow in the bed, and cannot remember doing it on more than two occasions, careful consideration should be given to discontinuing the extra-oral traction.

If facebows are used with removable appliances, construct them as an integral part of the appliance. If, for a good clinical reason, they need to be a separate unit, then use a locking facebow with the appliance. Always ensure extra retention is built into any removable appliance used with extra-oral traction.

Clinical tips

These are some additional suggestions provided by practitioners using the Nitom Locking facebow that may be helpful. Before fitting the facebow on the patient demonstrate and describe its function on a model of an upper arch with molar bands, which gives the patient a clear idea of what is required.

When fitting the correct size of facebow on the patient place both ends of the inner bow in the mouth with the catches unlocked. Insert the first end into the buccal tube. Some operators then like to engage the first catch at this stage as they feel this tends to stabilize the facebow. Apply no expansion to the inner bow at the first fitting, as it makes it much easier for the patient to insert the second side into the buccal tube.

Some practitioners prefer to teach the patients to remove the facebow, rather than fit the facebow as the first task. They feel their patients learn to use the facebow quicker.

Other practitioners prefer to demonstrate and fit only the locking facebow at the first visit and withhold the extra-oral traction. The patient can then practice fitting and removing the locking facebow at home with their parent's help if required. On the subsequent visit to the orthodontist, the patient can demonstrate fitting the facebow, and then the headcap or neckstrap is issued to the patient.

A few patients like to play with the catches. Advise them against doing this because eventually the wire will harden and break.

During space closing sliding mechanics in the upper arch, when the archwire tends to appear behind the upper first molars, the facebow can be turned over (180 degrees), so that the ends of the catches don't get trapped on or under the archwire ends. This can make it difficult for the patient to disengage the catch.

Conclusions

The patients instructions are designed to reduce the risks of injuries as a result of horseplay or incorrect fitting. The locking facebow is designed to counter the mild/moderate forces of accidental disengagement of the facebow at night, and will provide moderate resistance to intentional disengagement. It should also improve the hours of wear achieved by some patients. The self-releasing headcap or neckstrap should prevent the recoil traction if a large anterior displacing force from another child (bully or aggressive violence) overrides the locks on the facebow. These pro-active suggestions should help to improve patient safety, while increasing the hours of wear and supporting the continued use of a very useful piece of orthodontic equipment.

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