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Appliance design and application

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Today's dental practice can increase patient satisfaction, as well as profitability, through the use of emerging technologies in the realm of dental appliances. Appliances can aid in an array of pathologies; however, many dentists struggle in their prescription of appliances due to a lack of scientific literature on the devices themselves. Blindly choosing an appliance can create a legal liability; therefore, undergirding selection with accurate information is critical for proper use and quality of care. The aim of this article is to serve as a quick reference for the practitioner in his selection of the appropriate dental device.

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After graduating from dental school, dentists typically have gaps in their knowledge of the extensive list of dental services a general practice can provide, especially in the area of appliances. At best, the four-year curriculum provides limited teaching regarding services that a caring, quality practice can provide. However, in the real world of dentistry, there is a need to provide an expanded number of services to establish a quality practice. In this regard, an inordinate amount of time and money are spent educating doctors on expanded services not covered in dental school.

Dental appliances have become a multimillion dollar industry, including such devices as: Nociceptive Trigeminal Inhibition (NTI) devices (Therapeutic Solutions International, Inc.), soft nightguards, soft/hard appliances, splints, deprogrammers, orthotic and suckdown appliances, retainer-type appliances, neuromuscular appliances, and store-bought mouth guards. These appliances are available for treating parafunction, muscle pain, partial disc displacements, complete disc displacements, and osteoarthritis. However, knowing which appliance to use in a given situation can be challenging (Fig.1). Many postgraduate dentists rely on the one appliance covered in dental school (the soft nightguard), due to a lack of time or money for further exploration of the options available. Or they rely on the one guru-driven appliance stumbled upon in early CE courses and tend to use it indiscriminately for all patients in all situations.

To provide the best service, a doctor must know both the patient and their pathology. As Dr. Mahan wrote in 1991, one must "never treat a stranger in pain by using irreversible therapies."[1] This statement applies not only to understanding the service, anatomy, physiology, and the latest research and science, but also understanding the patient. Until the purpose of each appliance and the science of the pathology being treated are understood, much of the appliance therapy should be referred to a specialist. Each appliance has a specific purpose and it is important to know them well.

Fig. 1. A wide variety of dental appliances.

Table 1. Appliances and their purposes.

Appliance	Design	Purpose
Orthotic	Passive, flat plane, full coverage, shallow anterior guidance	Reduce joint and muscle pain, reduce parafunction, decrease loading of the joint in osteoarthritis
Emergency	Retainers, suckdown, Aqualizer®	Reduce muscle recruitment, reduce parafunction, retain teeth
Acute trauma appliance	Directing appliance, full, hard, used less than one month	Trauma, joint effusion
Soft appliance	Soft, full coverage	Parafunction
Soft/hard	Hard out, soft in, full coverage	Parafunction, MPD
Deprogrammer (anterior segmental)	Segmental, anterior, quick, emergency appliance (NTI & Best Bite Discluder)	Muscle pain and partially displaced disc, help CR bite, emergency and episodic treatment
Posterior segmental appliance	Covers only posterior teeth	Parafunction, reduce power
ARS-LVI appliance	Anterior repositioning design, forward bite, bite set by TENS	Relieve retrodiscal pain, change bite
OTC nightguard	Soft guards, full, heat-adapted athletic guard	Reduce tooth damage from parafunction, athletics

Making an informed decision

Using scientific data as the background for appliance selection is critical to quality of care and practice safety. However, for many years there was a virtual vacuum in scientific knowledge concerning appliances. As recently as 1996, the National Institutes of Health (NIH) reported "little scientific literature exists on how appliances work."[2] This vacuum created a fertile ground for promoting and selling "magic plastics" that would cure everything as an all-in-one appliance. Thankfully, the 1996 NIH paper created a demand for an increased number of studies offering insight into how and why dental appliances work, a greater understanding of which appliances should be used for which pathologies of the chewing system, and the benefits and side effects of each appliance.

A 2003 retrospective study concluded that the problems cited in earlier studies still exist, such as clearly defining both chewing system and multifaceted pathologies, applying uniform descriptions of appliances, using clinical guidelines in measuring results, and lack of standardization of outcomes, which make the results difficult to interpret.[3] Studies also indicate the longer the duration of the pathology, the more difficult it becomes to define successful study results. This is due to outside factors associated with long-term chronic pain such as higher rates of depression, somatization, and health care use, which some patients were not able to cope with as well as patients in the study group.[4,5]

In a study by Wedel & Carlsson, results tend to emphasize the heterogeneity of patients who have differing factors underlying their particular functional disturbance of the masticatory system.[6] For example, articular disc disorder can result from multiple factors such as clenching, muscle tension, bite discrepancies, traumas, muscle splinting, dual bites, subluxation, and even cervical muscle hyperfunction. Three different appliances (the nightguard, orthotic, or deprogammer) may be effective in cases involving pure clenching or grinding at night (that is, with no pain or joint damage). It is important to understand—as recent scientific studies have made clear—appliances do have side effects. They are not benign tools and they have the potential to damage other parts of the chewing system. Both scientific and legal case literature show appliances can be and are being used inappropriately or indiscriminately. The practitioner must properly critique the current literature to make an informed choice. This article offers a review of the literature with the goal of indicating the correct usage for each appliance.

Reviewing choices

Dental appliances need to be evaluated from a scientific perspective. An appliance is deemed correct if it fulfills a chosen purpose without significant side effects. Not only should the right appliance be used for the right purpose, but the provider should never imply or hint that an appliance can deliver more than it was designed to do. This is particularly true when dealing with dysfunctional patients who often have unrealistic expectations of what an appliance can provide.

The choice of orthotics from a sampling of U.S. general dentists in 1995 included: 14% soft nightguards, 59.4% hard appliances, and 26.1% varied in selection of appliances.[7] A 2011 survey reported that 43.04% of dentists chose a stabilization splint for treating bruxism (not including jaw pain or restricted openings), while 8.63% utilized an unadjusted hard splint, 7.28% employed a soft splint, 5.22% utilized an anterior repositioning splint (ARS), and 1.2% used a reflex splint with anterior ramp.[8] Table 1 defines the various types of appliances and their purposes.

Fig. 2. An example of an orthotic appliance.

Orthotic appliances

The orthotic appliance is a passive, hard appliance with a flat plane in the posterior, evenly supported posterior contacts, and shallow anterior guidance (slope). The orthotic was developed as part of orthopedic therapy to treat significant pain and dysfunction of partial displaced disc cases, complete displaced disc cases, and osteoarthritis (Fig. 2). Orthotics can also be used for simpler chewing system damage cases (such as chewing muscle pain and nocturnal bruxers/clenchers), on destructive bruxers for protection, to protect temporary crowns and bridges, reduce pain in jaw joint damage, help achieve an accurate bite, and help with many chewing system pathologies.

An example of orthotic use is with patients who have dystonia of the jaw. *Dystonia* is a movement disorder that causes the muscles to contract and spasm involuntarily. In these cases, an orthotic can be used to protect the teeth. The orthotic is essential in osteoarthritis cases to decrease the muscular loading of the joint; however, the accuracy required in the placement of the appliance goes beyond the standard training and skills taught in most orthotic didactic courses or participation courses. An orofacial pain resident spends 2-3 years in training for the appliance use in osteoarthritis cases.

Popular literature promotes the misconception that the orthotic is the "magic plastic" appliance. Simply stated, the orthotic was one of the first appliances created to protect the joints and muscles from parafunctional damage at night. One of the problems in analyzing the effectiveness of orthotics is determining their main functions or benefits. Is the goal pain relief, reducing parafunction, or fixing the dysfunction? Does it stop clenching? Does it have a positive effect on occlusal relationships, tooth position (retention), tooth wear, jaw joint loading, and so forth?

Many scientific studies on dental appliances, especially the early ones, are unclear in terms of the definition or design of the appliance used, type of treatment utilized, sample size, or the study's definition of success. In a 1992 study of disc displacements without reduction, Lundh *et al* indicated that there was no significant benefit of patients treated with an orthotic (a flat occlusal splint) over control subjects with no orthotic treatment.[9] If perceived fatigue, pain, sleep dysfunction, and anxiety are primary targets for muscle-based pain, then management of these factors would be the primary interventions.[10] None of these factors are actually related to the performance of the appliance; this suggests the orthotic may not cure all the aspects of pain associated with articular disc disorders. However, in a 1978 study by Carraro & Caffesse, the use of only an orthotic (full-coverage occlusal splint) improved both pain and dysfunction symptomology.[11]

If a patient has jaw pain and is a significant grinder or clencher at night, the orthotic appliance will provide some pain reduction. A 2011 study by Badel *et al* found that orthotics reduced pain in 83% of the cases examined, which echoes the 1998 study by Ekberg *et al* that reported a reduction in pain due to orthotic use.[12,13]

In restricted opening cases, the orthotic has been purposed by some to recapture the disc.[14] In actuality, the orthotic may assist with relaxing the superior lateral pterygoid muscle, but as stand-alone therapy, it is not likely to provide enough muscle relaxation to recapture the disc. It would have to shorten the lateral ligament to the disc and repair the retro-discal elastin tissue to affect such an outcome, which is unlikely to work as a stand-alone appliance or therapy. In a 1991 study, Kirk observed the orthotic did reduce inflammation in the joint and joint loading, and did improve movement (disc condyle translation), but concluded that, "the concept of *disc capture* is a clinical term only, and does not indicate that an actual change in intra-articular anatomic relations has occurred."[14]

The challenge in determining the effectiveness of an orthotic appliance comes from the fact that articular disc disorders, myofascial pain dysfunction (MPD), bruxism, and osteoarthritis are different multi-factorial pathologies. For example, a 1984 literature review reported a 90% success rate when using orthotics and occlusal therapy to treat temporomandibular joint disorder (TMJ); however, a mixture of treatments were utilized and the specific role of the appliance in treatment was indistinct.[15] Even when the focus is on a single variable, the actual effectiveness may be hard to gauge, since some factors (such as clenching) vary from day-to-night, from night-to-night, and even from person-to-person. Clenching can occur both day and night. As a result, an appliance worn only at night may not address the complete problem.

Since the 1980s, science has tried to document the effectiveness of the orthotic for treating disc displacements, osteoarthritis, MPD (jaw pain), jaw dysfunction, dystonia, destructive bruxism, and even restorative cases with difficult bite.[16] A wide variety of pathologies can affect a specific joint. To achieve usable results, the definition of the pathology must be clear.

The widespread effectiveness of orthotics for relieving myofascial pain (that is, pain in the chewing muscles) is indicated in two separate reviews of literature by Clark and by Major & Nebbe.[17,18] These reviews show that many studies report the effectiveness of orthotics in relieving symptoms of pain and dysfunction.[17-37]

A 1998 study by Canay *et al* reported an orthotic produced no change in electromyography (EMG) from maximum biting but did reduce complaints of pain significantly. In this study, the defining success via "lower pain perception reports" was a problem in analyzing the effectiveness of orthotics.[38] In a 2010 meta-analysis, Fricton *et al* examined 44 random controlled trials (RCTs) and found that the orthotic improved jaw joint/muscle pain compared to no treatment at all or treatment using non-occluding appliances.[39] Conversely, Okeson reported that EMG activity decreased for most patients wearing orthotics.[40] Dahlstrom *et al* found that patients who either used an orthotic or underwent biofeedback demonstrated equal reductions in terms of EMG activity.[41]

The orthotic reduces the power of the bite by opening the vertical. Maximal clenching on an occlusal splint is significantly lower than the maximum bite in tooth contact position.[28] The maximum power occurs when teeth make maximum contact; opening the bite with a piece of plastic will reduce the power, which is why different appliance designs may provide some or slight benefits in muscle/joint related cases. The studies of occlusion, sleep, and EMG in appliances with proper anterior guidance of the orthotic produced the least muscle recruitment.[42] Other studies have reported that an orthotic reduces EMG activity in bruxing patients.[43-47] Elsewhere, it has been reported that an occlusal orthotic tends to reduce the level of EMG activity in masseter muscles during maximum clenching.[28,44,48,49] Different parameters, such as the length of time of a particular study, can affect a study's results. Kovaleski & De Boever reported that orthotics reduced muscle activity, but it took days or even weeks before the reduction in symptoms were apparent.[50] To properly evaluate the success of any one particular study, the pathology must be clearly defined. A 2003 study by Ekberg *et al* reported that an orthotic was more effective in myogenous cases than in disc displacement cases.[34] In a critical evaluation, Clark reported that orthotics offered 70%-90% effectiveness in treating joint muscle damage cases.[17] More recently, Kuttila *et al* reported a reduction in clinical signs when an occlusal splint was used by individuals with osteoarthritis (secondary otalgia was reduced as well).[51]

The non-directive, passive, reversible, flat-planed, and shallow anterior guidance orthotic is used to protect muscle and joints at night, but it can protect other structures of the stomatognathic system as well, particularly the teeth and tooth bone. One of the great benefits of the orthotic is that the units are reversible and conservative. The ADA presently recommends using reversible therapy for joint muscle pathologies. Many authors using reversible therapy place the effectiveness of the orthotic at higher than 70%.[34,52-54]

The orthotic is one of the few appliances that require anterior guidance, which can range from steep to shallow, rough to smooth, and short- to full-range motion, all of which can make assessing the success of treatment difficult. This pattern of equal posterior tooth contact and shallow anterior guidance on the canines and centrals causes a progressive shutdown of power as it goes further into lateral or protrusion distance (Fig. 3).[42,55] The overall largest percentage of patients (87%) had some degree of improvement in TMD symptoms (joint sounds or jaw pain) with an orthotic.[32]

Suvinen & Reade found that the stabilization of occlusal patterns was a good indicator of successful treatment in most patients with orthotics.[56] Beard & Clayton used a pantographic reproducible index and found that the muscle activity in chewing muscles decreased with orthotic use.[33] A study by Santander *et al* found the orthotic reduced EMG activity in cervical muscles.[57] A 2008 study by Nascimento *et al* reported that wearing an orthotic for 60 days significantly decreased TMD signs and symptoms among sleep-bruxing patients.[58] Other studies have reported that orthotic use reduced EMG activity in the right and left temporalis during maximum clenching, and in the anterior temporalis by inserting a well-adjusted splint.[33,59,60] The literature has indicated that the longer symptoms were present, the longer it took to achieve results with an orthotic.[33,35]

It has been discovered that the orthotic can also reduce intra-articular pressures (IAPs). Nitzan *et al* found that clenching teeth creates an increase in pressure inside the jaw joint that stops the flow of nutrients into the jaw. The author measured IAP in 28 females and 7 males. The pressure inside the jaw joint ranges on open mouth were from -10 to +30 mm/Hg, while the pressure inside the joint on clenching teeth ranged from 20 to 200 mm/Hg (the highest readings were in females, which could help explain the considerably higher proportion of women with TMJ problems); while the maximum pressure inside the jaw joint when clenching on the orthotic ranged from 0 to 40 mm/Hg.[61,62] The center of the TMJ disc has no blood vessels and receives its nutrients from diffusion via an efficient lubrication system involving phospholipids.[63] A problem arises in dysfunctional TMJs after clenching is released, when a sudden rush of oxygen back into the joint space produces free radicals that cleave the lubricant molecules, which produces friction between the articular disc and the fossa.[63,64] This may be a major causative factor in articular disc displacement.[63]

In the past, the occlusal splint was thought to stop parafunction (for example, clenching and grinding). The orthotic has now been purposed to reduce clenching or grinding at night, as well as offering some protection against damage from bruxism, and in most cases this has been proven.[45,58,65-67] For example, a 1984 study found that of the subjects wearing orthotics, nocturnal muscle activity was reduced in 52%, increased in 20%, and 28% of the subjects reported no change.[66] In a 1993 study involving 31 patients, Holmgren *et al* reported that 61% still clenched or ground teeth at night after orthotic therapy, indicating the continued need for some sort of protection.[65] One must remember that the design and accuracy of the appliance does affect the outcome.

In a small percentage of cases, the orthotic can actually increase parafunction activity. Clarke *et al* reported that 20% of subjects reported an increase in neuromuscular activity.[66] This result of the increase in clenching can cause havoc in determining success when using an orthotic. The increase in clenching occurs in all appliances; some appliances may cause more of this effect than others.[67] This possible increase in clenching reinforces the need for multifaceted treatment of articular disc disorders from several different angles, including the use of an orthotic. These studies reveal that the orthotic is not the "magic plastic" appliance because parafunction activity (clenching is the most prevalent type) may occur during the day or night.[65-67] However, by placing an appliance that wears quicker than enamel, the orthotic offers protection of the teeth.[65-67] This is not the primary purpose of the orthotic, but is a positive side effect.

Fig. 3. An orthotic in protrusive guidance.

In cases where occlusal trauma is suspected as the reason for tooth pain, the orthotic can provide reversible evidence of the cause and effect (diagnosis and recommended treatment). One should avoid the temptation to use a bur to make occlusal or crown/bridge adjustments, as a prolonged open mouth procedure might have been the cause of increased pain or discomfort in teeth.

Some doctors find the reversibility of the orthotic offers some legal protection in cases of jaw pain where a dysfunctional (and possibly litigious) patient might otherwise

Table 2. Benefits of orthotic appliances.

Relieve muscle and joint pain
Reduce power
Reduce muscle recruitment
Reduce IAP
Stop lubricant destruction
Reduce clenching and grinding
Splint teeth together with reduced loading

receive equilibration, orthodontics, or reconstruction: If the orthotic cannot reduce the pain, the dental effort is unlikely to resolve it either. Making this discovery at an early stage stops the dentist from promising relief from alteration of tooth structure that may not be attainable. The orthotic reduces the damage resulting from the prolonged repetitive loads of parafunctional activity on teeth; such activity can lead to traumatic damage and pain.[65]

The overall interpretation of the scientific literature suggests that the orthotic is an appropriate appliance for reducing damage to the joint muscle complex due to nighttime parafunctional activity.[65-67] The orthotic, along with an NTI (deprogrammer), appear helpful in achieving centric relation (CR) (jaw joint bite) in a few rare cases where the jaw joint instability disallows proper centric occlusal (CO) position.

Most dentists who challenge CO (that is, tooth bite) by restoring many cases are familiar with measuring CR against CO in a small percentage of cases, yet the subject of CO is not covered in most dental schools. A great deal of literature on CR=/=CO is found in the post-dental school education of Spears, Pankey, and Dawson, especially the latest edition of Dawson's book, *Functional Occlusion*.[68] When the jaw joint is pulled downward/forward to fit the tooth-protected bite, the muscles have to splint the condyle on the slick incline. It is analogous to holding a bowling ball on a slanting board with oil on it. When the jaw muscles are recruited to hold any position for a period of time, the chewing muscles will eventually fatigue, lactic acid builds up, and pain results. The value of measuring CR against CO seems to be related to the size of the difference and the amount of clenching (parafunction) in CO (Fig. 1 and 2). A small difference (0.01 mm) is not significant enough to cause much muscle splinting, but a large CR=/=CO difference (3 mm) will produce a significant amount of muscle splinting. In other words, muscle activity increases as the difference between the ideal jaw joint position and the tooth protected bite (CR and CO) increases. An ARS or neuromuscular appliance would increase the CR and CO difference, thus making the problem worse; therefore, a moderate to large CR and CO difference is definitely a contraindication for a neuromuscular appliance or ARS.[16] The multifactorial nature of muscle and disc displacement cases means that a dentist must consider more than jaw joint position and the tooth protected position when determining what aggravates the chewing system. Again, one factor alone, such as the measurement of CR against CO, usually needs to be combined with other muscle recruiting activities in order to fully breach the adaptive capacity of the chewing system. If the patient experiences tension in chewing muscles, clenches, cervical hypercontraction, muscle splinting, or bite inefficiencies, measuring CR against CO may overstimulate the chewing muscles, overload the jaw joint, and result in pain. The teeth are hotwired to the brain to control the chewing muscles and therefore the brain can use its memory in engrams to control the tooth-protected bite. The orthotic binds the teeth together, intercedes between contacting teeth, and alters the ability of the teeth to control the muscles. The use of the orthotic improves the jaw joint's ability to direct the muscles to the bone-braced position (that is, CR), which anatomically refers to the most posterior superior position of the jaw joint. The anatomical description does not adequately define CR.

The CR position is where the least muscle activity occurs and the ideal position for the jaw joint to reduce muscle recruitment at night. The fifth nerve is much larger than the other cranial nerves because it contains the bundles of fibers from the plexus of nerves around all 28 teeth and combines with the other important head structures it innervates. The teeth have power over muscles to control the tooth-protected bite because the teeth are so important to survival. Therefore, a person's teeth being hotwired to the brain may be viewed as an evolutionary advantage. The orthotic can redirect or deprogram the muscles or dissipate muscle activity by allowing the jaw joint to go to the position where there is the least muscle activity and allows those muscles to be controlled more by the jaw joint.

The majority of patients have a difference between CR and CO that is small enough not to worry about, but in a few patients, the difference is large enough for the case to fail in terms of patient comfort. If a crown and bridge case succumbs to jaw pain, it must be managed appropriately with an orthotic and orthopedic therapy.

Fig. 4. An orthotic demonstrating equal posterior contacts and shallow anterior guidance.

Fig. 5. An example of a deprogrammer.

Orthotics can be used for other purposes, such as: allowing dentists to test patient comfort following an increased vertical dimension; removing occlusion from a cracked tooth (thus relieving pain); determining if parafunctional activity has injured a tooth (thus ruling out occlusal trauma and avoiding the need for root canal surgery); assessing the patient's psychological stability during the adjustment stage; protecting porcelain crowns, bridges, or implants from bruxism/clenching damage at night; resisting tooth movements or retaining teeth after braces (especially in cases where bruxism/clenching exists or in jaw damage cases); managing tension headaches; tracking condylar bone loss in osteoarthritis cases; and protecting teeth in dystonia. Table 2 summarizes the benefits provided by an orthotic.

Emergency appliances

Some appliances may serve as an emergency tool for acute jaw pain (that is, joint or muscle pathologies). Like medications, these emergency appliances have specific purposes (primarily to deprogram muscles and decrease muscle activity) along with side effects. Emergency appliances can be produced quickly and inexpensively for treating sudden onset muscle pains, simple partial disc displacements, or minor traumas. The primary purpose of emergency appliances is to decrease muscle activity or deprogram muscles.

Deprogrammers

The word *deprogrammer* refers to an appliance used to reduce the use or recruitment of muscles, leading to reduced muscle inflammation and pain. The insertion of an NTI in clenching patients leads to significant reduction in EMG activity of the jaw-closing muscles.[69] The deprogrammer is an anterior segmental appliance or piece of plastic placed in the front of the mouth to keep back teeth apart (Fig. 4). Deprogrammers have been used for years in orofacial therapy for emergency cases involving muscle pain. In orofacial pain therapy, the use of the deprogrammer in emergency pain cases is preferred to the orthotic for long-term care (Fig. 5). In a study by Van Eijden *et al,* clenching on the incisor teeth resulted in significant decline in EMG activity as compared to clenching in maximum contact of teeth.[70] Published research concerning deprogrammers primarily involves case reports such as the 2010 report concerning a 61-year-old whose short-term jaw pain was relieved by using the deprogrammer.[71]

In cases involving osteoarthritis or completely displaced discs, emergency appliances will increase joint loading on the condyle. This loading presses on the innervated retrodiscal tissue, thus increasing jaw pain.[72]

According to McKee, one can test a deprogrammer on a completely displaced disc by load testing the jaw joint to confirm that the condyles are not pressing on retrodiscal tissue.[72] One dilemma is that load testing a jaw joint is not part of the formal training in dental school. To avoid failure with a deprogrammer, practitioners should initially inform the patient it is a diagnostic device to differentiate the partial displaced disc from the complete displaced disc. A deprogrammer will fulfill its purpose if it increases the pain in the joint pain case, helping diagnose a completely displaced disc.

The deprogrammer can also help define the proper bite to manufacture and deliver the large bridge in moderate difficult bite cases. For instance, if the lateral pterygoid is not relaxed enough to give the proper bite for

Fig. 6. An example of an NTI splint.

manufacturing a second molar crown/bridge, a deprogrammer may be enough to relax the muscles.

When a deprogrammer is used 24 hours a day for extended periods, one side effect is the separated posterior teeth can supererupt. This happens when the patient fails to follow directions on the proper times to wear the device. A recently disclosed side effect of a specific deprogrammer, an NTI device, is its ability to relax the lateral pterygoid in cases where the jaw joint bite and tooth bite are different enough to measure setting up open bite by contact on second molars.[73] Relaxing the lateral pterygoid may create the illusion that the bite has changed: It really is just highlighting the difference between the jaw joint and the tooth bite (CR against CO), in which the majority of individuals do not have a measureable difference. The inexpensive nature of the appliance and its ease of learning are important considerations in its use.

The former deprogrammer was developed into a prefabricated deprogrammer called an *NTI* (Fig. 6). The prefabricated deprogrammer is realigned chairside to perfect the fit in relatively little time. Two other prefabricated deprogrammers, the Best Bite Discluder (Whip Mix, Contemporary Product Solutions) and the Kois Deprogrammer (Aztec Orthodontic Laboratory, Inc.), use plastic on the front teeth to disclude posterior teeth, which deprograms the chewing muscles while preventing clenching and grinding.[74] Both of these appliances allow full range of motion and any particular closure pattern as does their cousin, the NTI. According to a 2001 study by Shankland, the NTI and the orthotic were equally beneficial at reducing clenching, which in turn reduces headache symptoms.[75]

The NTI and the other deprogrammers can help deprogram the chewing muscles to reduce muscle pain. In a 2005 study by Jokstad *et al,* two splint designs were produced: an ordinary stabilization (Michigan type) and an NTI. The splint and the NTI were equally successful at reducing muscle, joint, and head pain.[76]

Muscle inflammation is created by over-use, over-recruitment, or over-stimulation of the chewing muscles. By reducing clenching, reducing power of muscles, and deprogramming muscles, the NTI has a great effect on muscle pain.

Deprogrammers are best for cases involving excessive muscle recruitment and simple partially displaced discs. According to Helkimo, the NTI is superior to other appliances when treating MPD, only because of its ease of fabrication.[3]

There are always psychosocial issues that can cause compliance issues or NTI failure. Several studies have reported that a deprogrammer such as an NTI significantly reduced muscle activity.[77-80] The NTI and other deprogrammers have been marketed for treating bruxism, TMD, tension headache, and even migraines. However, a 2004 study was unable to find evidence for all these claims.[81] A study of Best Bite Discluders by Goldstein & Gilbert reported that NTIs reduced the severity and frequency of migraine pain from a score of 6.6 to 3.3 on the Visual Analog Scale (VAS).[82] There are few studies concerning deprogrammers (especially in terms of testing specific deprogrammers) on reduction of headaches. By understanding the contribution of muscle inflammation in the pathophysiology of headaches, it makes sense that the deprogrammer could help in some of these cases. It is naive to think the deprogrammer would completely alleviate some headaches, especially as a standalone therapy, due to multifaceted sources of the inflammation and many different types of headaches.

Deprogrammers reduce muscle recruiting, especially in the lateral pterygoid, which allows the condyle to seat more in its fossa. In a small percentage of cases where CR does not equal CO, the jaw joint seats more superior and posterior in the fossa, which causes the second molars to pivot off second molars and sets up an anterior open bite (Fig. 6). For moderate to difficult bite cases, the deprogrammer helps determine the proper bite so that a large bridge can be manufactured and delivered accurately. The deprogramming of muscles by the deprogrammer makes the Dawson bimanual technique of load testing and getting CR bite easier to perform. It is well known that errors in recording the terminal transverse horizontal axis can lead to significant errors in occlusion.[83-85] Enough patients present with muscle tightness, tenderness, or overcontraction to warrant consideration of MPD/TMD as pathologies in the patients' population.[86,87]

If a disc is in proper position with the joint, and the joint can be loaded, the deprogrammer can help to relax chewing muscles by

Fig. 7. An example of a suckdown appliance.

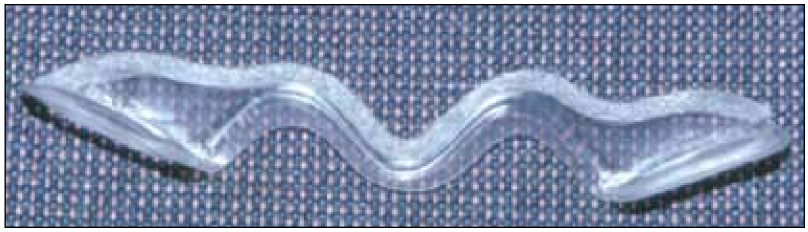

Fig. 8. An example of an Aqualizer®.

changing the terminal hinge position.[88] Even though cases in which CR and CO do not match are rare, they occur often enough to need deprogrammers to assist at bite determination in the evolving world of reconstruction (crowns and bridges). In reconstructive dentistry, a few patients are assumed to have a discrepancy between CR and CO that a deprogrammer may reveal during the course of managing TMD/MPD or large reconstruction cases.

For cases of emergency muscle pain, emergency appliances such as suckdown (Fig. 7), Aqualizer® (Fig. 8), and other prefabricated emergency appliances may be acceptable. The suckdown appliance is made on a model of the patient with all the cusp and fossa relationships and interferences reproduced in the appliance. The primary purpose for the suckdown is tooth protection in parafunctional situations, but many orthodontists use these for retainers. The side effect, due to reproducing interferences (walls of fossa), is increased muscle activity in clenching. If the bite inefficiencies are a small factor for excessive muscle use, the suckdown will not be effective in reducing muscle activity.

One benefit of the suckdown is the ease of making the appliance and the ease of insertion to the patient. Another benefit is the lower cost. Patients also readily accept it due to its thin nature and its similar contours to teeth.

Suckdown appliances are good as tooth protectors and retainers. By molding an appliance to the position where the teeth should be positioned, the suckdown device will help to keep the teeth in place. The reduction in power due to opening bite is minimal since the appliance is very thin. The suckdown appliance can be converted into an orthotic by adapting acrylic precisely to the appliance, but the cost of conversion is not cost effective. The suckdown appliance may be ineffective as partial disc displacement therapy due to its duplicaton of lateral guidance interference, its duplication of poor anterior guidance patterns, and its continuation of clenching; thus, the muscle recruitment deprogramming has not been accomplished.[56]

Aqualizer®

Aqualizer® is a self-contained, disposable splint filled with fluid that can shunt from one side to the other for equalization. It is a ready-to-use, prepackaged appliance for treating MPD/TMD pathologies and for emergency situations involving mostly muscular jaw pain (Fig. 8). A layer of fluid is used to separate the posterior teeth, cushion the bite, and reposition the jaw to produce a more adaptive bite. The appliance was designed to achieve even pressure on both sides of the arch. For muscle cases, this helps to reduce uneven muscle activity due to even posterior contacts; the even pressure from side-to-side and tooth-to-tooth helps to reduce the irregular muscle activity. Like the soft splint, the Aqualizer® still has posterior lateral interference that increases chewing muscle activity. Like a soft appliance, it increases joint loading and produces some increase in muscle activity.

Practitioners and patients should be aware that the Aqualizer® will increase pain in complete disc displacement. In addition, it can rupture in cases of destructive bruxism. Its use is limited due to its ability to help only in muscle cases and also due to the difficulty of patient retention, particularly in cases where the patient has an anxious or nervous tongue.

Athletic guards

Some medical doctors and young dental graduates with a limited knowledge of jaw problems may recommend that a patient purchase a soft over-the-counter (OTC) athletic guard for joint muscle pathologies; however, they were created primarily for tooth protection. The athletic guard is also bulky, which can irritate gums, the tongue, and

Fig. 9. En example of an OTC sports guard.

Fig. 10. An example of an anterior repositioning splint.

cheeks. Besides the production errors found in any OTC product, an athletic guard may be difficult to keep in place or may not fit the patient's bite properly. One of the primary benefits of an OTC athletic guard is its low cost. One of its potential negative side effects is relying on patient-directed care, using a tool that may not target the real problem due to incomplete diagnosis. The soft and compressible athletic guards introduce interferences that increase muscle activity and loading of joints (Fig. 9). Whether due to mass production manufacturing errors, the increase in clenching, or the patient acting as doctor with self-directed treatment, the soft athletic guard has a high failure rate as a jaw joint pain appliance. The waste of money and the frustration for the patient is definitely one of the athletic guard's most negative attributes. Occasionally in an acute muscle pain case, the soft athletic guard interferes with the trauma to teeth enough for the patient to perceive a reduction in discomfort.

The favorite reasons for using emergency appliances are in helping reduce urgent care pain, ensuring less dependence on pain medicines, and the convenience of a fast approach. Emergency appliances are quick (used on the same day), effective (on muscle-based pain), acute (usually used for only brief periods of time), and cheap (as compared to full coverage appliances).

Acute trauma appliance

The emergency appliance used for significant acute trauma to the jaw joint is a short-term anterior repositioning appliance. Its primary purpose is to manage pain associated with pressure on retrodiscal tissue in part due to swelling (significant inflammation) in the temporomandibular joint, similar to the treatment of a swollen ankle. The purpose of an acute trauma appliance is to reduce pain without using opioids (Fig. 10). This anterior repositioning appliance pulls the condyle down and away from inflamed retrodiscal tissues. When incorporating steroids, muscle relaxants, and physical therapy, the emergency anterior repositioning device can effectively reduce acute trauma pain in the jaw. The biggest side effect of the anterior repositioning device occurs when the appliance is not stepped back fast enough or is left in the anterior position too long, causing overgrowth of retrodiscal tissue (permanent posterior open bite) making it impossible to return to CR.

Many patients with acute pain in their jaw joints will go to an emergency room for relief of the pain. However, most ER doctors do not fully understand acute trauma to jaw joints and may fail to refer the patient to a specialist in a timely manner, setting the stage for limited use of emergency appliances. A trauma to the jaw causes acute fluid retention in retrodiscal tissue that pushes the disc and condyle downward and forward, so an indication of jaw trauma requires the need for not only timely referrals but also the use of an acute trauma appliance.

Soft appliances

Another group of appliances are soft full-coverage appliances (Fig. 11). The majority of dentists use the word *nightguard* to refer to these professionally made appliances; however, the term has been overused to refer to OTC or Internet-ordered soft appliances. True nightguards are full-coverage appliances made with soft material that can be fabricated by a dental office or laboratory. The grinding of teeth at night is a highly destructive behavior and there is a great need for recommending tooth protection or preventive dental services to this group of patients.[89] Studies have estimated that 15%-90% of the population suffers from destructive forms of parafunction (such as clenching, grinding, tooth brace, and so forth).[90-92] Bite forces are much greater during nocturnal activity compared to daytime mastication.[93] The initial benefit of the soft appliance is its ability to interfere with the power of the grinding of teeth at night. The second benefit of the soft nightguard is to protect the teeth from the destructive wear caused by parafunctional habits.[94] In 2000, Halachmi *et al* reported that soft splints were more efficient than hard splints in protecting teeth against damage, despite an increase in compressive force.[95]

As with comparable dental appliances, the soft nightguard can interrupt muscle activity by interfering with occlusal contacts.[96] In most cases, the soft nightguard increases lateral interferences due to its compressibility, which in turn increases muscle activity in lateral movement. In addition, a 1987 study reported that a soft nightguard did increase EMG activity in the majority of the patients.[40] The soft nightguard was more effective for palliative treatment of muscle pain.[97] In a 1998 study, Pettengill *et al* found that both soft and hard appliances were effective at reducing muscle pain.[98] According to Quayle *et al,* a soft nightguard can even help to reduce tension headaches. When the soft nightguard reduces parafunction power, it could in turn reduce most of the inflammation in the temple muscle, reducing the pain from tension headaches while increasing EMG activity.[99]

Fig. 11. An example of a soft nightguard.

In a study of soft appliances versus medications, the soft appliances reduced tenderness of muscles and improved mouth opening more than medications.[100] The soft nightguard may have a periodontal benefit as well, by reducing the lateral forces that could lead to cervical erosion, recession, mobility, or cracking of teeth.[100]

The biggest complaint about professional soft nightguard appliances is that they are hard to wear due to their bulky nature. The biggest side effect is their inability to disclude the posterior surfaces in lateral and protrusive movements, which increases muscle recruitment.[55] Soft appliances can be problematic as severe grinders or bruxers can chew through the soft full coverage appliance in a short period of time. On the plus side, soft nightguards are easy to insert and were one of the first appliances used in dentistry. This is the best appliance for parafunction teeth protection due to low cost, ease of production, and ease of delivery.

Soft/hard appliances

The recently introduced soft/hard appliance has a hard top and a soft thermoplastic inside surface. Due to ease of delivery to the patient, such appliances reduce delivery time and hassles for the doctor. The occlusal surface of the appliance is hard plastic that allows for adding acrylic to the surface to perfect the contact of the teeth in order to achieve muscle recruitment reduction and decrease loading of jaw joint. The inner surface (adjacent to teeth) is firm thermoplastic material that allows for ease of delivery due to its heat-adaptive quality. This appliance is designed to combine the best of both worlds of soft and hard appliances.

The downfalls of soft/hard appliances include the following:

- A thin, hard outer surface that does not have much room for reducing plastic in cases of adapting to opposing tooth contacts that are not even or equal. The only way to get somewhat ideal contacts in the posterior is to add acrylic. Therefore, this limitation reduces versatility in perfecting the occlusion on the appliance.
- The perfection of the occlusion is more difficult due to the slight compressibility of the soft inside of the appliance.
- Another problem with a soft/hard appliance is if the first insertion of the appliance reveals an instability (pivoting or rocking), it must

Fig. 12. An example of a segmental appliance.

Fig. 13. Long-term wear of ARS produces posterior open bite that must have the occlusion corrected post-ARS. In this case, they have used a partial to restore the occlusion that was changed with ARS. *Left:* A patient with a posterior open bite wearing an ARS. *Right:* The same patient without the appliance.

be remade because it cannot be relined. Skilled impressions and proficient lab work reduce the chances of this happening, but at times it does occur.

- A fourth problem that occurs is when the patient bites in maximum intercuspation when the goal is to deliver the appliance in centric relations (jaw joint bite). If the opposite arch occlusion is too far off, the thin hard surface and the need for major additions are too difficult to overcome. In this case, the appliance has to be remade. The management of fit and occlusion on a completely hard splint is an accomplished skill that requires major training in order for the appliance to achieve all its purposes, but on an appliance with some compressibility it can be nearly impossible. It is believed the degree of accuracy needed on the appliance goes up as the instability in the jaw joint goes up. This might indicate that the soft/hard appliance is not well-suited for the complete displaced disc or osteoarthritis. No studies are available to confirm this proposition.

The beauty of the soft/hard appliance is that in patients with irregular wear of the appliance, the adaptable inner surface allows for the micro-movements of the teeth and the appliance still fits. The hard material on the outside means a longer life for the appliance due to its resistance to the grinding forces of the chewing system. In addition, this appliance is less compressible than a soft nightguard, increasing its ability to be more accurate on the occlusion, which could help in some muscle cases. Another benefit of soft/hard appliances over soft appliances is their improved adaptability for changes to the anterior guidance, which occur in a small percentage of cases that have CO and CR discrepancies large enough to increase chewing muscle activity. In these cases, there is a need to add acrylic to the front aspect of the appliance.

The main drawback to soft/hard appliances is that, like soft appliances, they aid in some muscle cases but are not very effective in joint damage cases. The posterior disclusion on movement would not be adequate enough in all cases for significant jaw joint instabilities such as osteoarthritis or complete disc displacements. Unless the exact status of the disc position is known, the concern for the soft/hard appliance would be using it on a joint muscle case that is more complex than it appears at first. However, the soft/hard appliances can be used for parafunctional cases, muscle-based cases, and even some simple early partial displaced discs.

Segmental appliances

Segmental appliances only cover a partial aspect of the occlusal table (Fig. 12). The segmental appliance can be divided into anterior and posterior segmental devices. The anterior segmental devices are also known as *deprogrammers*.

The posterior segmental appliances cover both sides of the arch, but only posterior teeth. The posterior segmental creates the bite-reducing power with an increase in vertical from the acrylic. These appliances allow for posterior interferences due to the lack of anterior guidance while increasing muscle recruitment in lateral and protrusive movements. The combination of reducing power and increasing muscle activity may equal small improvement in patients with muscle pathologies. The posterior segmental appliance increases joint loading, making it inappropriate for compromised joint tissue pathologies (that is, completely displaced discs or osteoarthritis). They could be used as posterior retainers, provided the anterior teeth are stable and the posterior teeth are not involved periodontally. A posterior segmental appliance worn constantly (that is, 24 hours a day, seven days a week) can change a patient's bite by anterior tooth eruption or posterior tooth intrusion. The bite changes occur most often when the patient falls out of care and "forgets" instructions to wear it only at night or for short periods of time. This is especially true in psychologically challenged patients who are not able to listen to or follow instructions, and as a result may be surprised and angry when their bite changes. The posterior segmental can serve as an acceptable parafunctional appliance (Fig. 13). However, clinical observation indicates the posterior segmental is usually less effective at reducing muscle pain than an anterior segmental appliance.

Anterior repositioning appliance

The ARS (anterior repositioning splint) reduces pain by repositioning the condyle downward and forward past the maximum intercuspation.[101] In a 1985 study by Lundh *et al,* the ARS was compared with a flat occlusal splint and the control group found that the ARS removed the "click" (that is, the sound made when the posterior band of the disc moves rapidly over the condyle), decreased joint pain, and reduced muscle tenderness while the flat occlusal splint reduced joint discomfort.[102] The problem with that study was that the variability of the appliance design did not provide anterior guidance, nor was the clicking reduction an appropriate symptom guide.

In the past, the literature has suggested that the purpose of TMD treatment was to reposition the condyle back under the center of the lateral pole of the disc, thus stopping the click.[88,103,104] In a 1985 study by Tallents *et al*, 18% of cases treated with an ARS had a click and disc recapture failure.[105] As Joondeph pointed out in his study on the long-term stability of ARS, there is high potential for relapse in relieving the click.[106] A 1988 study reported that 65% of patients who had originally lost the click relapsed.[107] Moloney & Howard examined 241 patients who wore ARS appliances constantly for four months and found 70% of patients had no click one year after the conclusion of treatment, with 53% success at two years, and 36% success at three years, which suggests that the success was temporary and fails over time.[108] A 1984 study treated 25 patients with ARS appliances; however, in only one case was the click removed.[109] That same year, Manzione *et al* found that only 26 of 56 discs responded positively to ARS therapy.[110]

The ARS appliance can reduce pressure on retrodiscal tissue. A 1990 study reported significant reductions in patients' jaw pain, temporal headaches, and ear pain in disc displacements with reduction; however, 40% of patients experienced joint symptoms after ARS treatment.[111] In addition, while ARS devices can be used to treat partial disc displacements, these constitute only a percentage of MPD/TMD cases. In a study by Hoffman & Cubillos, they found 67% were disc displacement with reduction, 22% were disc displacement without reduction, and 10% were osteoarthritis.[112]

Using an arthrogram study, Tallents *et al* found that 15% of cases continued to experience displaced discs even after ARS treatment.[105] One must consider that the failure of ARS may be due to inadequate understanding of disc status due to the lack of a clinician's examination before treatment, inadequate management of the two most prominent causalgia of articular disc disorder (parafunction and tension in muscles), or the anterior displacement of disc tissue loses its biconcave shape over time. The Gelb appliance, one of the original ARS appliances, was marketed and dispensed before the NIH paper of 1996.[2] The Gelb appliance survived for a number of years by clinical marketing pressure and the fact that appliances do not have to be studied before entering the market (that is, they do not go through double-blinded, randomized, scientific experiments). The Gelb appliances had a negative effect on posterior open bite and redundant retrodiscial tissue. Extended wear of the ARS over time resulted in permanent bite changes (positioning condyle downward and forward), new condylar position, increased posterior superior joint space, and redundant retrodiscal tissue.[113,114] The reasoning behind the use of the Gelb appliances was that recapturing the disc was a higher priority than the other symptoms, especially long-term pain.

The ability to recapture a partially displaced disc depends on the extent of joint damage, how much of the lateral ligament is torn, or how soon the click occurs on opening. A 2002 study reported that the ARS was effective 83% of the time at recapturing a lateral pole displaced disc, compared to 50% success in recapturing a middle displaced disc and no success in recapturing a completely displaced disc.[115] In fact, in the Kai *et al* study of 15 ARS cases, of the 10 patients reviewed post-treatment with arthroscopic evaluation, only 4 actually completely recaptured.[114] Interestingly, the theory to recapture as a success criteria was incorrect and the ability of the ARS to recapture disc was wrong. In 1988, Lundh *et al* chose 63 patients with an anthrographic diagnosis of disc replacement with reduction to carry out their ARS study; they found that not all discs were recaptured.[116]

Fig. 14. Upper ARS device inserted into mouth. Note the ramp used to reposition the mandible forward.

Fig. 15. ARS end-to-end bite.

ARS devices were designed to remove the click in cases with lateral pole partially displaced discs. If the disc was only partially displaced in the anterior and medial direction, the ARS might recapture the lateral pole portion of disc; using the ARS alone will not eliminate the problem unless the factors that caused the lateral ligament tear in disc displacement are eliminated also. The use of this appliance alone seems doomed to failure. However, in an ARS appliance study by Williamson & Sheffield, the patients in that study self-reported improvement of 90% success in three years.[117]

In the complete displaced disc, the longer the disc is displaced, the more likely it will lose its biconcave shape (in other words, it turns into a *blob*). This change makes it difficult to recapture the disc, as the three convex surfaces do not fit together or have stability. The ARS is not realistic for treating complete displaced discs or osteoarthritis, but the science in Gelb's day did not allow for differentiation of partial versus complete displaced disc cases. We presently have enhanced MRIs and are able to see the disc, position and shape, which if used appropriately might help decrease the indiscriminate use of the ARS on all types of disc displacements and osteoarthritis. The biggest mistake in the use of the Gelb or ARS appliance is the one-size-fits-all treatment without the ability to determine the severity of displacement. The amount or degree of displacement and the amount of time the displacement was present are critical factors in how Gelb or ARS therapy could be considered a success (which most studies define as removal of clicking).

A second problem exists regarding the severity of displacement. If the degree of disc displacement is all the way to the medial pole (disc is completely displaced), the distance to move the condyle forward to recapture the disc by the ARS is too great. In other words, if it is necessary to move the mandible forward so much that the lower incisors are near or past end-to-end, all anterior guidance (overjet and overbite) will be removed, which helps reduce muscle recruitment. If you move the condyle downward and forward, so that the condyle is at or past the eminence, you remove all the translational ability of the chewing system, which is approximately half of the opening distance. If, in fact, the displaced part of the disc at the lateral portion or even middle disc area has turned into a *blob* shape, the disc cannot be recaptured because the three convex surfaces do not fit together (Fig. 14 and 15). Using MRI, Eberhard *et al* reported that the ARS appliance could not recapture a non-reducing disc or a severely degenerated disc.[115]

Neuromuscular appliance

Despite its side effects, lack of research (science), and potential for lawsuits, the ARS appliance is still being used today as the neuromuscular appliance of choice. The neuromuscular dentist uses a transcutaneous electrical neural stimulation (TENS)-induced outside chewing muscle-fatigued bite.[52] The TENS-induced bite moves the condyle downward and forward so that the neuromuscular bite is forward to the patient's tooth bite (maximum intercuspation). In this way, the neuromuscular appliance becomes an anterior repositioning appliance. The high cost of neuromuscular therapy is due to the need to crown or orthodontically reposition posterior teeth to the new bite. Not even considering the significant cost of ARS therapy, the side effect of the posterior open bite makes ARS a less likely consideration due to the ADA's position of more reversible and conservative approaches.

As with the ARS or Gelb appliance, the neuromuscular appliance relieves pain initially in joint-related cases by pulling the condyle away from inflamed tissues, thus decreasing blood flow.[31] A study by Lundh *et al* reported better results with neuromuscular appliances than flat plane splints using arthroscopically chosen disc displacement with reduction cases.[116] However, the ARS group was given counseling.[116] Choosing the ARS appliance only for cases of partial disc displacement with reduction and specifically not for all joint-related cases is a subject selection bias. In addition, there is the bias of using counseling on only one group of subjects.[116,117] Another study by Mazzetto *et al* in 2009 found that ARS appliances better reduced joint vibrations in internal derangements (disc displacements with and without reduction) than did stabilization appliances.[118] It makes sense that recapturing of the disc by the lateral pole in partial disc displacements would have a reduction in joint sounds. Most of every study cohort is comprised of partial disc displacement cases due to its high prevalence in pain groups.

The theory of TENS-induced bite is that by fatiguing the outer chewing muscles, a proper bite will be determined. This TENS-induced bite is downward and forward to maximum intercuspation. Multiple studies indicating the use of surface electrodes to accurately evaluate muscles and bite position are flawed.[119] A 2006 review by Klasser & Okeson provided more information on the use of surface EMG to diagnosis and treat jaw joint problems.[120] A 2008 study by Tecco *et al* reported that ARS reduced the EMG activity in masseter and temporalis muscles over a 10-week period; however, clenching increased EMG activity.[121] In a study by Cooper & Kleinberg, the success criteria (using self-reported improvements in jaw related pain) resulted in flawed data.[101] A 2008 case study involving left internal derangement (partial disc displacements) with a significant discrepancy between CR and CO reported that the ARS was not effective.[16] The irreversible side effect of pulling the condyle forward is the production of posterior open bite, creating a need for more work on the patient.

The creation of a TENS-induced bite makes no economical sense, even when considering the initial pain reduction, when other conservative, reversible, and scientifically proven methods exist to manage the pain. Moving the condylar muscle downward and forward on a slick incline ignores the good anatomy and physiology of the chewing system.

There is little doubt that the short-term benefit of using an ARS (neuromuscular) device to reduce pain of a partially displaced disc (lateral pole disc displacement) gives it some appeal. The fact that most chewing system pathologies are partial disc displacements increases a neuromuscular device's initial success rate in reducing pain. However, the appliance is indiscriminately used on complete disc displacements and osteoarthritis, which have shown poor success rates with ARS appliances. In many clinical cases, the neuromuscular dentist does not examine the chewing structures to reveal differentiation of the different damage levels before implementation of the TENS or ARS; they often tend to be used in all cases. Review of scientific literature is where most doctors are able to see past the "smoke and mirrors" of this indiscriminate treatment concept.

Summary

In a 2003 study, nearly 27.2% of the Sardinian population were grinding their teeth and destroying their chewing structures.[122] In studies using a broader definition of destructive habits, the percentage of the population that has parafunctional habits would be much greater. Many of the current studies have focused specifically on grinding or clenching. However, there are more destructive oral habits, such as muscle or tooth bracing. Similarly, there are factors besides bruxism, such as tension in muscles (stress-induced contraction of muscles) that can damage the jaw joint and lead to muscular inflammation. If one wants to be successful in managing pain from the chewing system, one cannot get too focused on just one aspect of care, such as "magic plastic."

In 1990, it was reported that 48% of women and 38% of men suffered from tension headaches.[123] As the majority of tension headache patients were also found to suffer from parafunctional habits, parafunctional protection can help reduce pain for these patients.[123] Kemper & Okeson found that occlusal splint therapy reduced headaches by 30.3% and reduced tension headaches by 63.6%.[124]

The type of appliance used will depend on the structure that is being damaged and the amount of damage involved. For instance, to protect teeth, a nightguard is a good choice, but not an OTC-type sports guard due to its 90% failure rate as related to pain. The orthotic is best for those patients trying to protect the jaw joints. Based on

Table 3. Appliance types and their effects.

Appliance	Tooth load	Parafunction	Joint load	Periodontal	Muscle	Bite change
Orthotic	Decrease	Decrease	Decrease	Decrease	Decrease	No
Deprogrammer	Decrease posterior	Decrease	Increase	Decrease posterior	Decrease	Yes
NTI	Decrease posterior	Decrease	Increase	Decrease posterior	Decrease	Yes
Suckdown	Decrease	Increase	Increase	Decrease	Increase	No
Aqualizer®	Decrease	Increase	Increase	Neither	Increase	No
Soft appliance	Decrease	Increase	Increase	Neither	Increase	No
Soft/hard	Decrease	Increase	Increase	Neither	Increase	No
Posterior segmental	Decrease	Slight increase	Neither	Decrease anterior	Slight increase	Yes
LVI	Anterior teeth	Decrease	Increase	Anterior teeth	Decrease	Yes
Gelb/ARS	Anterior teeth	Decrease	Increase	Anterior teeth	Decrease	Yes

the literature, the NTI is appropriate for cases involving short-term pain, small amounts of damage, partially displaced discs, and much muscle inflammation. Table 3 summarizes the various appliances and their uses.

In 2010, The National Institute of Dental and Craniofacial Research stated that "reversible treatments such as stabilization appliances are useful in relief of pain."[125]

There are various appliances for treating acute traumatic jaw pain, tooth protection, occlusal trauma, jaw joint damage, muscle inflammation, osteoarthritis, complete displaced discs, and partially displaced discs. The most important aspect of appliance selection is diagnosing the problem and tailoring the treatment to specifically control the major factor that causes that problem. General dentists with limited diagnostic ability might agree with Greene & Laskin in their study's conclusion that the conservative and reversible approach yields some of the best results.[53,126] Dentists should diagnose and treat patients with the instruments that fulfill the treatment objective based on their knowledge of science, common sense, and empathy. Prepare for the world of clinical dentistry with the shield of knowledge and science. Love your work and care for the patient with all your skills and heart.

Disclaimer

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Manufacturers

Aztec Orthodontic Laboratory, Inc., Tucson, AZ
888.744.1588, www.aztecortholab.com

Therapeutic Solutions International Inc., Oceanside, CA
877.468.4877, www.therapeuticsolutionsint.com

Whip-Mix, Contemporary Product Solutions, Virginia Beach, VA
888.259.9754 , http://cpsmagazine.com/our-partners-member/whipmix

Exercise No. 320

Appliance Therapy

Subject Code 185

The 15 questions for this exercise are based on the article *Appliance design and application* on pages e359-e377. This exercise was developed by Thomas C. Johnson, DMD, MAGD, FICOI, in association with the *General Dentistry* Self-Instruction committee.

Reading the article and successfully completing the exercise will enable you to understand:

- the need for advanced, evidence-based training in appliance selection and use;
- the benefits to patients of the various appliances;
- the side effects of different appliances; and
- the importance of realistic patient expectations related to appliance therapy.

1. Which of the following factors makes interpretation of the results of appliance studies difficult?
    A. A homogenous pool of patients
    B. Standardization of treatment outcomes
    C. Clear definitions of pathologies
    D. Multifaceted pathologies

2. Some appliances may be used for bruxism but not for pain cases. Appliances may have side effects, damaging parts of the masticatory system.
    A. Both statements are true.
    B. The first statement is true; the second is false.
    C. The first statement is false; the second is true.
    D. Both statements are false.

3. Which condition will require an orthotic with a design and accuracy that requires advanced training?
    A. Periodontal protection
    B. Trauma with joint effusion
    C. Clenching and grinding with no pain or joint damage
    D. Osteoarthritis

4. Which is the most prevalent form of parafunction?
    A. Clenching
    B. Bruxism
    C. Dystonia
    D. Tongue thrust

5. The orthotic appliance is versatile and may be used with all of the following conditions except one. Which is the exception?
    A. Osteoarthritis
    B. Completely displaced disc
    C. Nocturnal bruxism
    D. Joint trauma with effusion

6. All of the following design components are characteristic of the orthotic appliance except one. Which is the exception?
    A. Evenly supported posterior contacts
    B. Posterior directing ramp
    C. Flat plane posterior
    D. Shallow anterior guidance

7. A small percentage of patients will have increased parafunctional activity with appliance use. This reflects the multifactorial nature of articular disc disorders.
    A. Both statements are true.
    B. The first statement is true; the second is false.
    C. The first statement is false; the second is true.
    D. Both statements are false.

8. Which appliance is contraindicated with a moderate to large discrepancy between centric relation and maximum intercuspation?
    A. Soft/hard
    B. Segmental
    C. Neuromuscular
    D. Aqualizer®

9. Which appliance may be used to decrease muscle activity and deprogram muscles?
    A. Aqualizer®
    B. NTI
    C. Soft/hard
    D. Suckdown

10. Load testing the jaw joint can help diagnose a completely displaced disc and osteoarthritis. The NTI appliance decreases joint load and will relieve pain with these cases.
    A. Both statements are true.
    B. The first statement is true; the second is false.
    C. The first statement is false; the second is true.
    D. Both statements are false.

11. Which is a common side effect of soft material appliances?
    A. Posterior interferences in mandibular excursions
    B. Supereruption of posterior teeth
    C. Posterior open bite
    D. Growth of redundant retrodiscal tissues

12. All of the following should be goals of therapy for MPD/TMD except one. Which is the exception?
    A. Improve the function
    B. Stop the clicking
    C. Stop the progression of the disease
    D. Reduce the pain

13. All of the following are side effects of long-term use of an anterior repositioning splint except one. Which is the exception?
    A. Permanent posterior open bite
    B. Redundant retrodiscal tissue
    C. An increase in posterior superior joint space
    D. Posterior interferences in mandibular excursions

14. Which of the following is synonymous with the neuromuscular device?
    A. Orthotic appliance
    B. NTI appliance
    C. Gelb/ARS
    D. Posterior segmental

15. An anterior repositioning splint (ARS) can be used as an acute trauma appliance by pulling the condyle away from inflamed retrodiscal tissue. How soon should the patient be transitioned out of the ARS to avoid permanent joint changes?
    A. 1 week
    B. 1 month
    C. 90 days
    D. 6 months

Answer form is on page 552.
Answers for this exercise must be received by October 31, 2013.

To enroll in Self-Instruction, click here.