OCCLUSAL SPLINT THERAPY

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DENT5310

Orofacial Pain and Dental Sleep Medicine Module

24th April 2026

DISCLOSURE

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Neither I nor my immediate family have any financial interests that would create a conflict of interest or restrict my independent judgment with regard to the content of this presentation.

AGENDA

- OCCLUSAL SPLINTS REVISITED
- OCCLUSAL SPLINTS DESIGN SECRETS
- MECHANISMS OF ACTION
- SCIENTIFIC EVIDENCE FOR OCCLUSAL SPLINTS
- TAKE HOME MESSAGE

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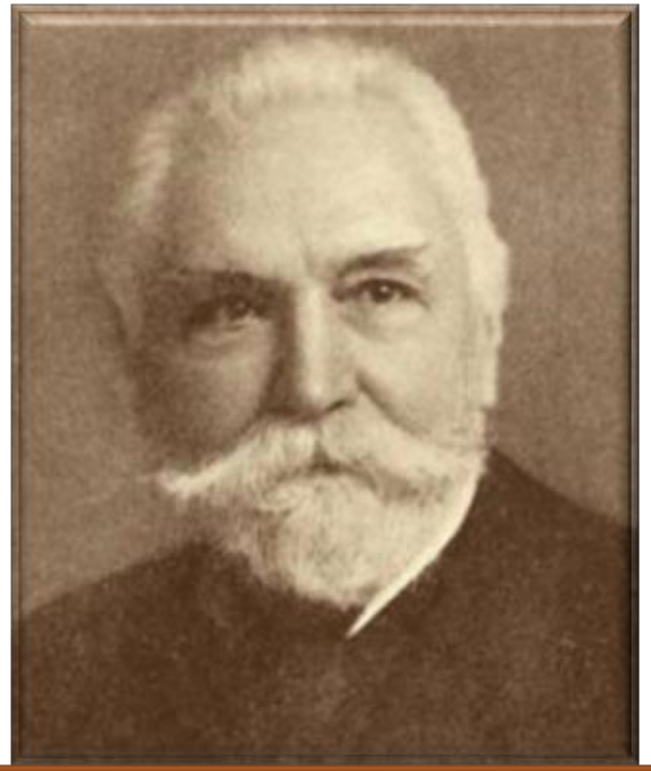
OCCLUSAL SPLINTS REVISITED



Dr Norman William Kingsley
(1829 –1913)
New York, USA

First to use “the occipital appliance” in 1866.

First to publish on intraoral appliances for the TMJ (Dental Cosmos in 1877).

The Glossary of Prosthodontic Terms: Ninth Edition. J Prosthet Dent. 2017 May;117(5S):e1-e105.

OCCLUSAL SPLINTS REVISITED

Early concepts: occlusal splint for temporomandibular disorders and bruxism

- Related occlusal disharmonies
- Related skeletal discrepancies

Treatment Goals:

- Occlusal disengagement
- Restoring vertical dimension
- TMJ repositioning
- TMJ unloading

Klasser GD, Greene CS. Oral Surg Oral Med Oral Pathol Oral Radiol Endod. 2009 Feb;107(2):212-23.

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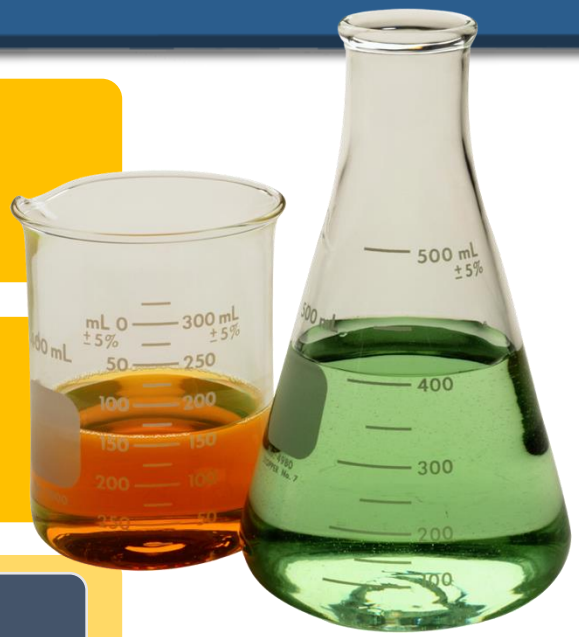
OCCLUSAL SPLINTS MATERIALS

Variations of Plastic

Occlusal Splints

Methodology

- CAD/CAM and 3D Printed
- Conventional



Hardness

- Hard
- Flexible
- Semi-Flexible
- Soft

Flexural Strengths

PMMA	Nylon	PEEK	Silicone-based
120-150mPa	50-70mPa	140-170mPA	5-15mPA

Courtesy of 3D Sleep Laboratory

Courtesy of Digident Laboratory

FLAT PLANE STABILISATION SPLINT

- Maxillary or mandibular arch - Uniformly occlude with opposing dentition. Turp et al. Clin Oral Investig 2004; 8:179-95.
- Canine vs No Canine Guidance Denardin et al. Oral Surg Oral Med Oral Pathol Oral Radiol. 2023 Jan;135(1):51-6. Conti et al JADA 2006; 137:1108-1114.

No Difference in TMD Symptom Reduction!

Purpose:

- Joint stabilisation
- Protect teeth
- Redistribute occlusal forces
- Relax elevator muscles
- Decrease bruxism

Courtesy of 3D Sleep Laboratory

Courtesy of Digident Laboratory

Klasser & Romero Reyes (2023) Orofacial Pain: Guidelines for Assessment, Diagnosis, and Management 7th Ed. Quintessence Publishing

HARD SPLINT VS SOFT SPLINT

Soft splints: No difference in TMD symptoms reduction.

Cheaper, short-term alternative.

Wright et al. J Orofac Pain. 1995 Spring;9(2):192-9.

Truelove J Am Dent Assoc 2006;137:1099-1107.

Increase EMG activity with soft splints.

Increase sleep bruxism in short-term.

Okeson JP. J Am Dent Assoc 1987;114:788-91.

Most studies support use of hard occlusal splints.

Stronger and easier to adjust.

TRADITIONAL ANTERIOR BITE PLANE SPLINT

Variations of orthodontic (Hawley, Sved, Shore) appliance.

- Palatal coverage horseshoe shape with occlusal platform covering 6-8 maxillary anterior teeth.

Advocates: prevents teeth clenching.

Critics: No posterior support - overeruption of posterior teeth and overloading the TMJs.

Courtesy of A/Prof Sanjivan Kandasamy

MINI-ANTERIOR APPLIANCES

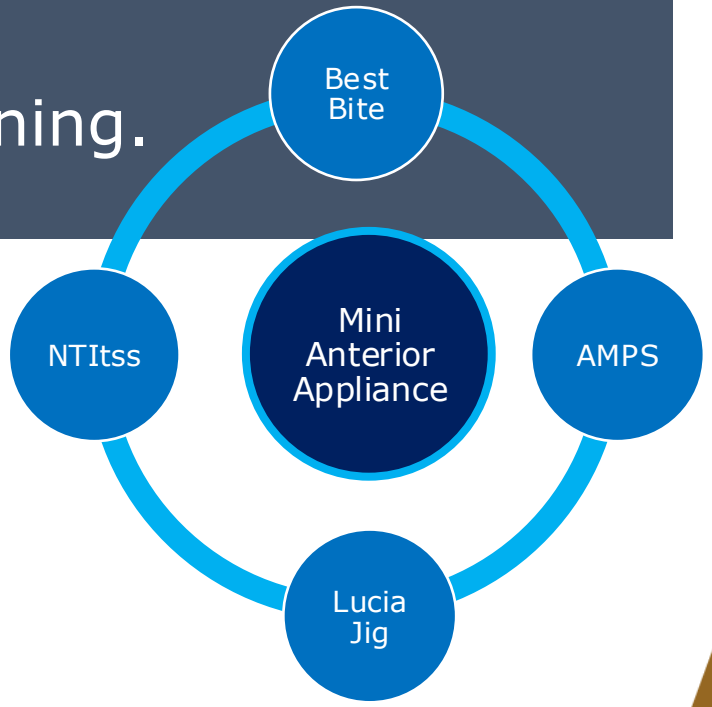
Variations of a theme that engages 2-4 incisors.
Turp et al. Clin Oral Investig 2004; 8:179-95.

Advocates:

- Disengages the posterior teeth.
- Utilised for TMDs, sleep bruxism, and headaches.

Systematic review: NTItss may be useful for bruxism and TMD.

- Reduction of jaw closing muscle activity.
- Applications in acute pain and limited opening.
  Magnusson et al. Swed Dent J 2004;28:11-20.



MINI-ANTERIOR APPLIANCES

Adverse Effects:

- Posterior teeth overeruption and anterior openbite development.
- Mandibular anterior teeth mobility and maxillary anterior teeth displacement.
- Risk of swallowing or aspiration.

MINI-ANTERIOR APPLIANCES

Scientific Evidence

No difference between NTItss and stabilisation appliance in TMD symptoms or headache.[1]
NTItss less effective than a flat plane stabilisation appliance for TMD.[2]

No differences between AMPS device and stabilisation appliance for myogenous pain.[3]

Thickness and elasticity of masseter muscle significantly decreased after NTItss among bruxers.[5]

NTItss more effective than "full coverage appliance" for headache.[4]

- Flawed study: bleaching tray controls and statistics unclear

[1]Jokstad A. et al. Acta Odontal Scand 2005;63:218-26.
[2]Magnusson T. et al. Swed Dent J 2004;28:11-20.
[3]Al-Quran FAM, Kamal MS. Oral Surg Oral Med Oral Pathol Oral Radiol Endod. 2006;101:741-7.
[4]Shankland WE. Cranio 2001;19:269-78.
[5]Yalcin ED, Aslan Ozturk EM. Cranio 2025;43(1):135-143.

ANTERIOR REPOSITIONING SPLINT

Positions the mandible anteriorly with anterior guiding ramp.

Advocates:

- "Recapture" the disc from clicking, catching or locking and pain.
- Followed by comprehensive dental and surgical procedures.

Farrar J Prosthet Dent 1972;28:629-36. Tesco et al. Cranio 2004;22:209-219.

- Disk displacement with reduction
- positions disk temporarily taking pressure off

ANTERIOR REPOSITIONING SPLINT

3 indications for internal derangement:

i) Acute TMJ pain

ii) Sleep bruxers who awaken with TMJ pain

iii) Nocturnal TMJ locking

Klasser GD, Greene CS. Oral Surg Oral Med Oral Pathol Oral Radiol Endod. 2009 Feb;107(2):212-23.

ANTERIOR REPOSITIONING SPLINT

Critics:

Occlusal and skeletal changes with long-term use.

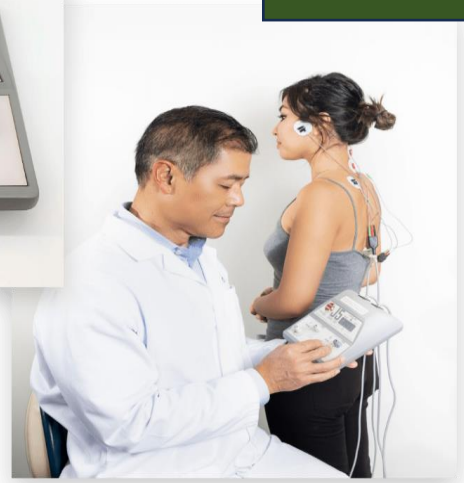
Tesco et al. Cranio 2004;22:209-219.

NEUROMUSCULAR SPLINT

Jaw muscle stimulators with surface EMG and jaw-tracking machines for the ideal vertical and horizontal position of the mandible: **"myocentric position"**.[1]

- Dental reconstruction at the new jaw position.
- Neuromuscular mouthguards do not enhance competitive athletes.[2]

[1]Cooper BC. Oral Surg Oral Med Oral Pathol Oral Radiol Endod. 1997 Jan;83(1):91-100.
[2]Cotter JA et al. J Strength Cond Res. 2017 Jun;31(6):1627-1635.



K7x Evaluation System

NEUROMUSCULAR SPLINT

OccluSense by Bausch

myotronics.com

Noromed MES 9000

NEUROMUSCULAR SPLINT

myotronics.com

NEUROMUSCULAR SPLINT

NEUROMUSCULAR SPLINT

Systematic review: variables influencing digitally analysis of jaw movement

Digital Devices
electromyography
optoelectronic and ultrasonic
oral or extra-oral tracking
electronic axiography
photogrammetry
sirognathography
digital pressure sensors

Confounding Variables influence Jaw Trajectories
mandibular and condylar growth
kinematic dysfunction
shortened dental arches
previous orthodontics
habitual head posture
temporomandibular disorders
fricative phonetics
parafunctional habits
unbalanced occlusal contact

Variations in device accuracy: between 50 and 330 µm across digital systems

Farook et al. Clin Oral Investig. 2023 Feb;27(2):489-504.

NEUROMUSCULAR SPLINT

Scientific Evidence for Neuromuscular Splint Therapy

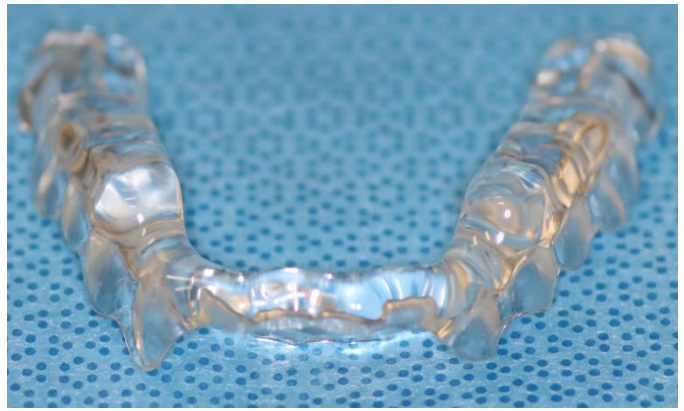
- Digital devices can't accurately recreate variations in jaw motion and muscle contractions.[1]
- Neuromuscular mouthguards do not enhance competitive athletes.[2]
- Evidence for the "Neuromuscular Dentistry" philosophy is lacking. [3, 4]

[1] Farook et al. Clin Oral Investig. 2023 Feb;27(2):489-504.
[2] Cotter et al. J Strength Cond Res. 2017 Jun;31(6):1627-1635.
[3] Gonzalev et al. Oral Maxillofacial Surg Clin N Am 2008;20:211-220.
[4] Klasser GD, Okeson JP. J Am Dent Assoc. 2006 Jun;137(6):763-71.

POSTERIOR BITE PLANE SPLINT

MORA

Modified MORA



Posterior Plane Splint

Variations: mandibular orthopaedic repositioning appliances, modified MORA

Acrylic resin platforms over posterior mandibular teeth with lingual wire

Hence disoclusion of anterior teeth and changes the vertical and horizontal maxillomandibular relationship

Bodenham RS. Br Dent J. 1970 Jul 21;129(2):85-6.
Smith SD. N Y State Dent J. 1978 Aug-Sep;44(7):278-85.

POSTERIOR BITE PLANE SPLINT

Advocates: Increase physical strength

No difference in power with seated press with MORA vs placebo splint

Moore et al. Phys Sportsmed. 1986 Dec;14(12):137-45.

MORA has no effect on muscular strength compared to no splint or placebo splint

Yates et al. J Am Dent Assoc. 1984 Mar;108(3):331-3.

POSTERIOR BITE PLANE SPLINT

Adverse Effect: posterior openbite

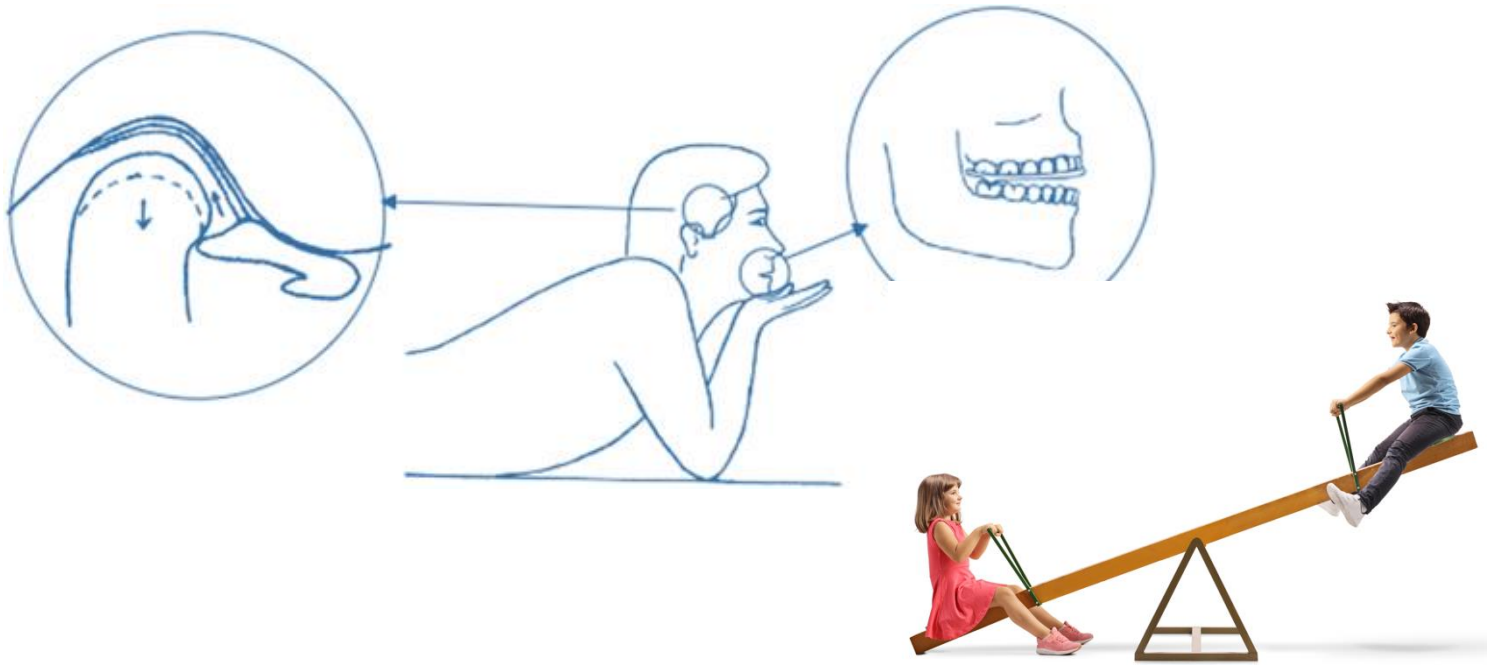
PIVOT SPLINT

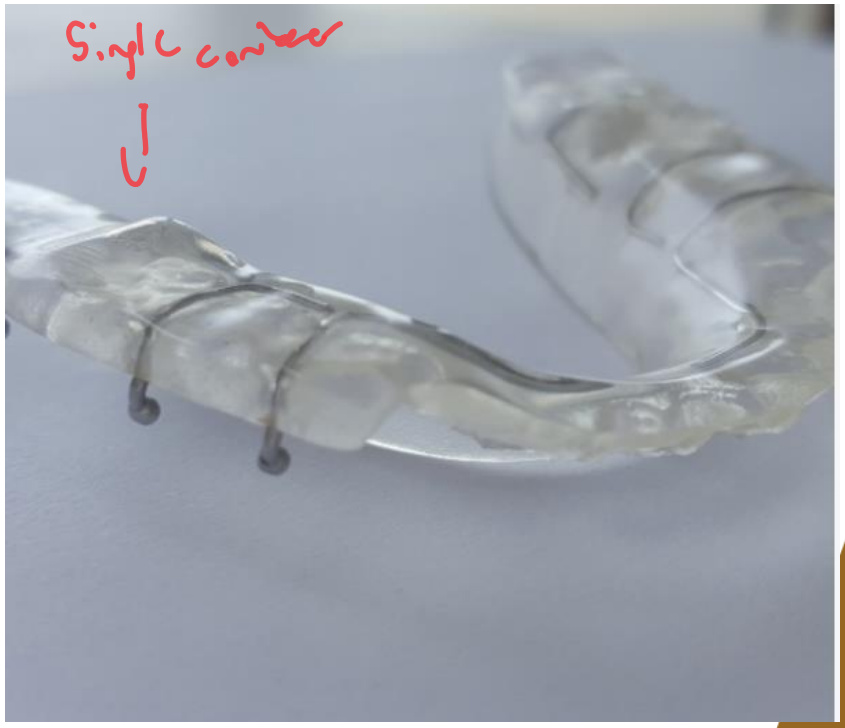
Variations: fulcrum type splint

Hard acrylic with single posterior contact in each of the quadrants

Advocates: mandible fulcrums around the pivot hence unloading the articular surface.[1]

- Treatment for osteoarthritis and internal derangements.[2]





Muhtarogullari M, Avci M, Yuzugullu B. Head Face Med. 2014 Oct 9;10:42.

PIVOT SPLINT

Study: Postulated that clenching on pivot = anterior downward condylar movement

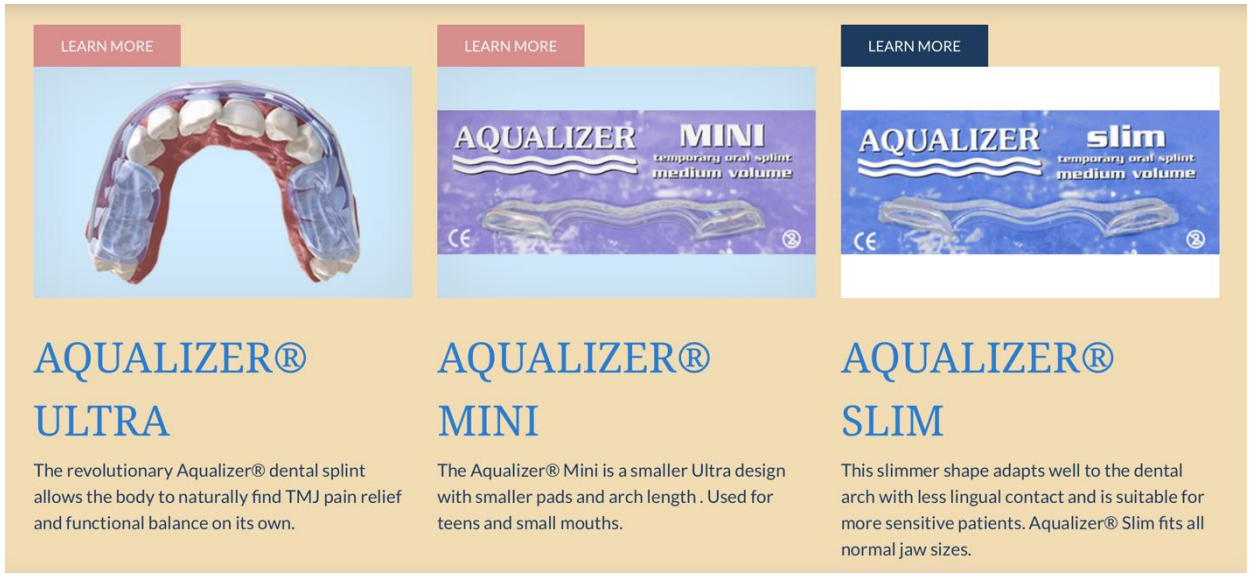
- Pivot prevents protrusion = upward condylar movement (0.3mm)
- No distraction rather TMJ compression.[3]
- Adverse effect: posterior openbite

[1] Moncayo S. J Orofac Pain. 1994 Spring;8(2):190-6.
[2] ito et al. J Prosthet Dent 1986;56:478-84.
[3] Seedorf et al. J Oral Rehabil 2007;34:34-40.

HYDROSTATIC SPLINT

Bilateral water filled plastic chamber on a maxillary appliance (Short-term)

Advocates: mandible would automatically find the ideal position because it is not directed



Lerman MD. J Am Dent Assoc. 1974 Dec;89(6):1343-50.
https://aqualizer.com

HYDROSTATIC SPLINT

Scientific Evidence: Effectiveness of Aqualizer system in establishing the maxillomandibular relationship no better than chin point guidance.

Gin

Water

Huth et al. Sci Rep. 2023 Dec 18;13(1):22535.

BIOFEEDBACK SPLINT

Design: incorporation of a pressure sensor and microcontroller with intrabuccal vibratory stimulus

- Sensor triggered: 10-20kg

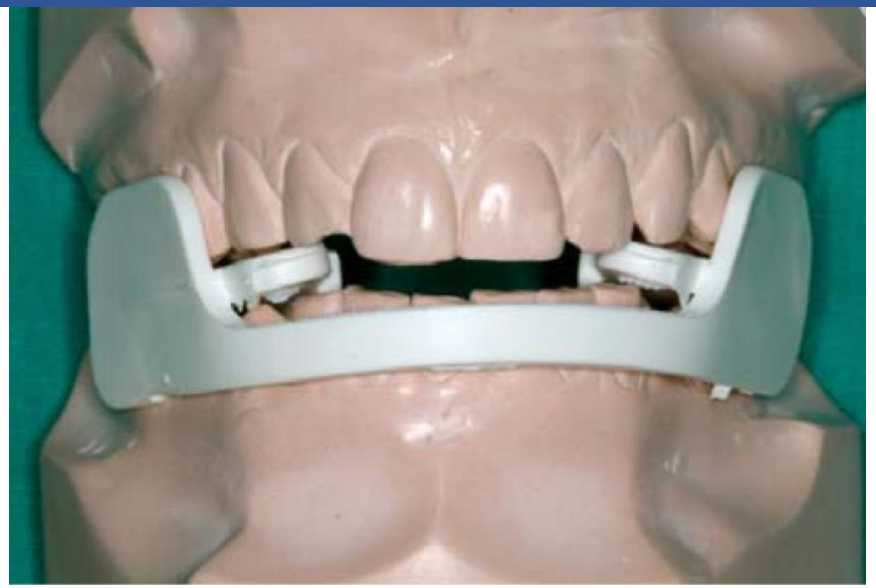
Study: BFS significantly reduces frequency and duration of burst

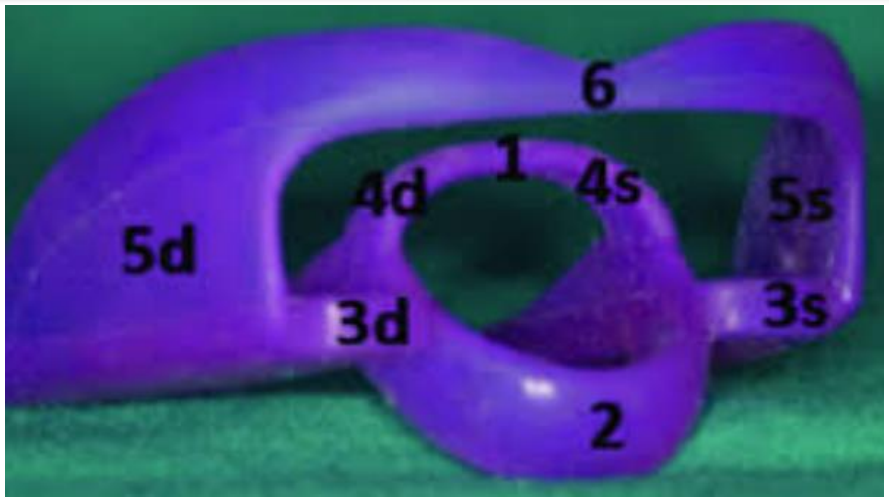
- Reduces pathological load on masticatory system

Bergmann et al. Clin Oral Investig. 2020 Nov;24(11):4005-4018.

EXTRATERRESTRIAL SPLINTS

Universal Neuromuscular Immediate Relaxing Appliance (UNIRA)





Lingual Ring Ri.P.A.Ra device

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HOW DO SPLINTS WORK?

8 Explanations For Treatment Success:

- Alteration of the occlusal condition
- Alteration of the condylar position
- Increase in the vertical dimension of occlusion
- Cognitive awareness
- Increase peripheral input to CNS hence decreasing motor activity
- Regression to the mean i.e. the natural fluctuation of symptoms
- Placebo effect

*Only theories, nothing confirmed

HOW DO SPLINTS WORK?

Ideology

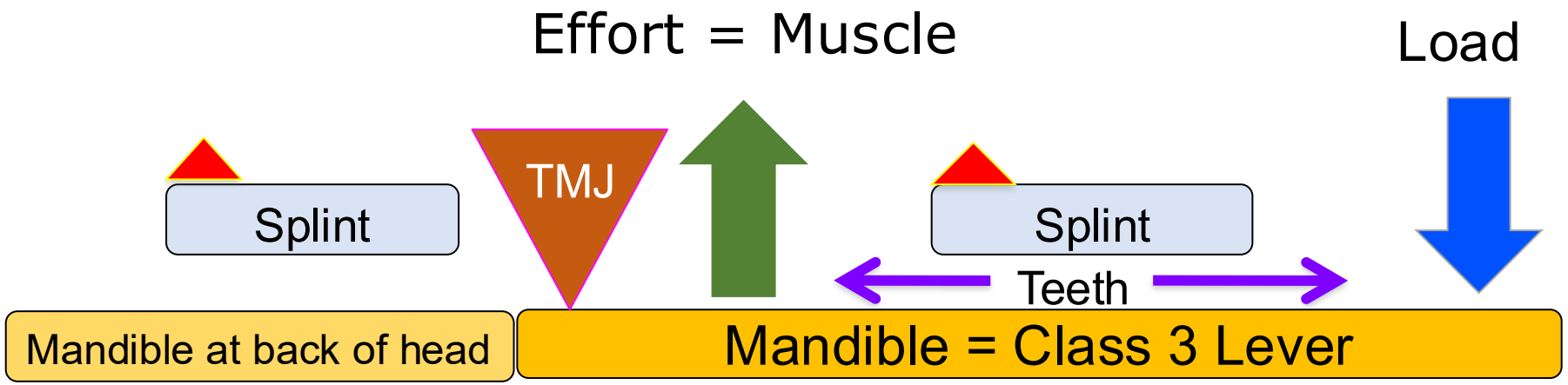
Confirmational Bias

OCCLUSAL SPLINTS: FACTS VS FICTION

FICTION: TMJ UNLOADING

Occlusal splint cannot ”unload the TMJ”!

- Mandible is class III lever: cannot fulcrum at any point anterior to the masticatory muscles
- **Fact:** can reduce or redirect the condylar loading

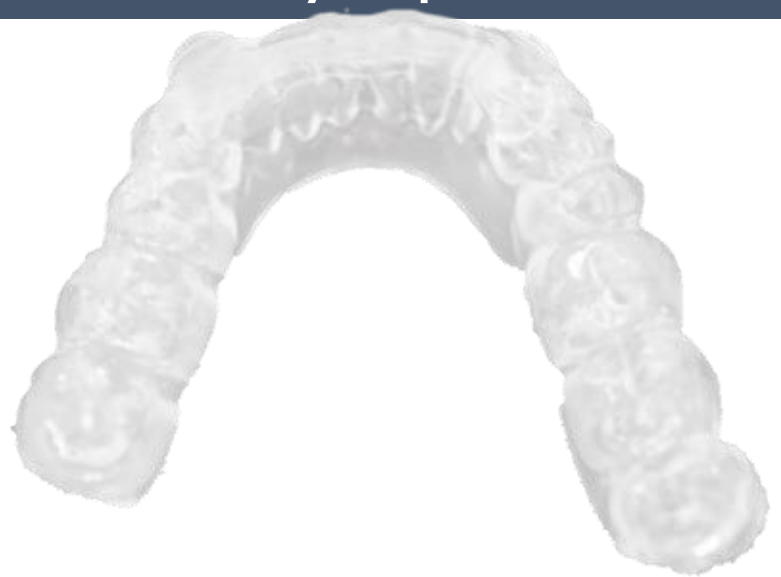


Hylander WL. Am J Phys Anthropol. 1975 Sep;43(2):227-42.

FACT: DECREASES MUSCLE ACTIVITY

Occlusal splint can decrease nocturnal muscle activity.[1,3]

- Reflective response to "foreign objects" between teeth.
- Nocturnal muscle activity returns to baseline after discontinuing splint use.[3]
  - Even while using splint.
- Muscle activity can increase in asymptomatic bruxers.[4]



[1] Dube et al. Dent Res 2004; 83(5): 398-403.
[2] Clark et al. J Am Dent Assoc. 1979 Oct;99(4):607-11.
[3] Sheikholeslam et al. J Oral Rehabil 1986;13(2):137-145.
[4] Krioth et al. J Prosthet Dent 1998;80:209-213.

FACT: TREATMENT FOR HEADACHE

"Headache attributed to temporomandibular disorders"

- >70% of TMD patients report headache

Sleep bruxism generated myalgia may trigger tension-type headache and migraine.[1]

[1] Jensen R. Cephalalgia 1999;19(6): 602-21.

FACT: TREATMENT FOR HEADACHE

Randomised controlled trial: 60 patients with TMJ arthralgia patients and tension-type headache

- Stabilisation splint effective in headache improvement at 6 and 12 months compared to controls.

- Ekberg et al. Swed Dent J 2002; 26: 115-24.

Prospective controlled study: 60 patients with myogenous TMD and tension-type headache.

- Stabilisation splint effective in headache improvement compared to control appliance at 10 weeks, 6 and 12 months.

- Ekberg EC, Nilner M. J Oral Rehabil. 2006 Oct;33(10):713-21.

FACT: TREATMENT FOR HEADACHE

Double-blind, randomized, placebo-controlled study to assess the separate or joint effects treatment of comorbid migraine and TMD.

4 treatment groups: propranolol & stabilisation splint (22); placebo pill & stabilisation splint (23); propranolol & non-occluding splint (23); placebo pill & non-occluding splint (21).

Migraine in women with TMD and migraine only improved when both conditions treated.

Goncalves et al. J Orofac Pain. 2013 Fall;27(4):325-35.

Systematic review and meta-analysis: stabilisation splint decreases both headache frequency and intensity in TMD patients. Manrriquez et al. J Dent Anesth Pain Med. 2021 Jun;21(3):183-205.

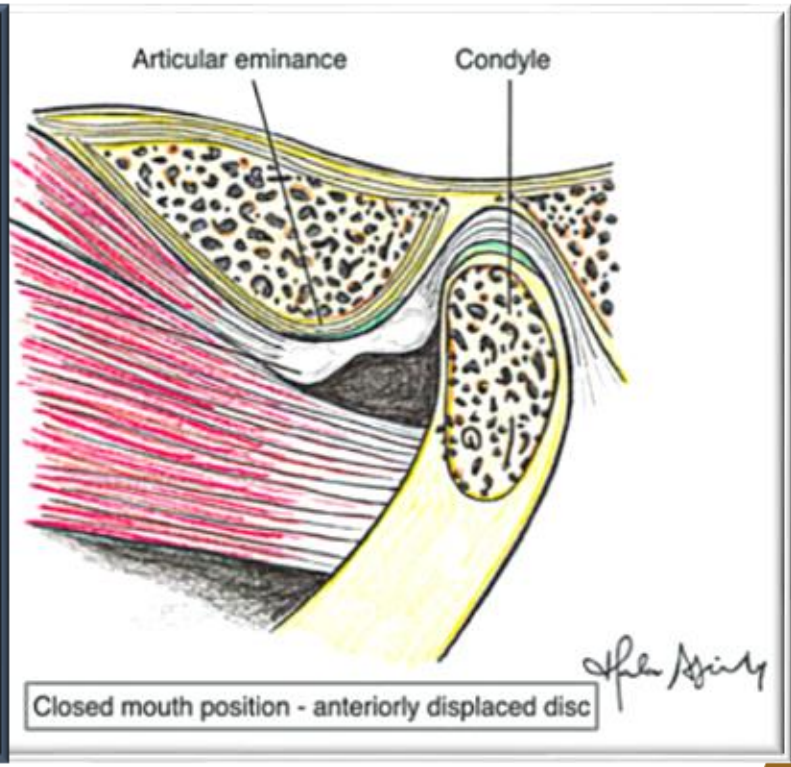
FICTION: TREATMENT OF TMJ INTERNAL DERANGEMENTS

Misconceptions about the need to treat TMJ disc displacements.

- Treatment of disc displacement with catching and locking is recommended.
  Williamson EH, Rosenzweig BJ. Cranio. 1998 Oct;16(4):222-5.

Advocates:

- Avoid progression from TMJ clicking to locking

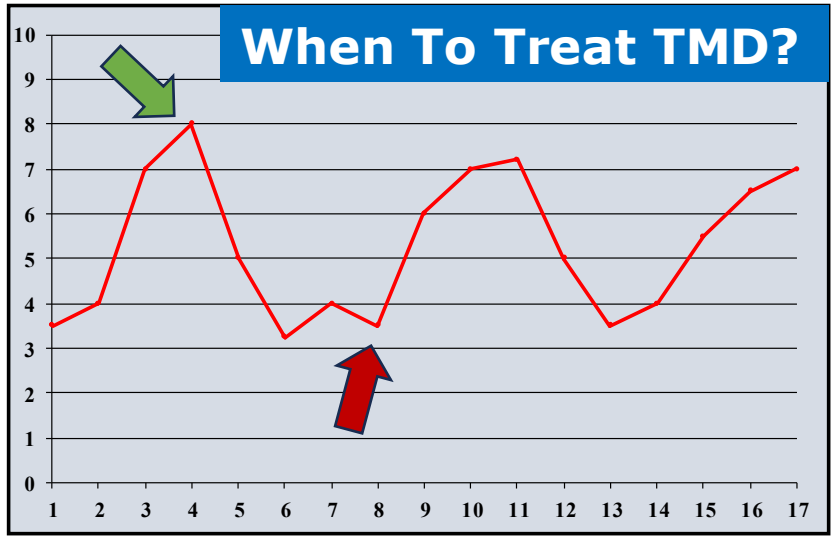


FICTION: TREATMENT OF TMJ INTERNAL DERANGEMENTS

Treatment versus no treatment did not change the outcome of patient adaptation. de Bont LG, Dijkgraaf LC, Stegenga B. Oral Surg Oral Med Oral Pathol Oral Radiol Endod. 1997 Jan;83(1):72-6.

Facts:

- Symptomatic relief



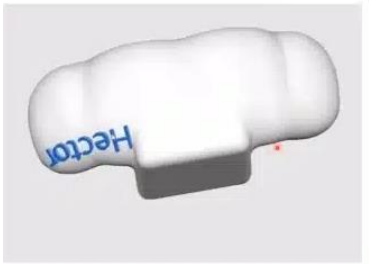
FICTION: DEPROGRAM THE MUSCLES

Advocates: Deprogram TMJ musculature and produce "ideal" jaw relationships

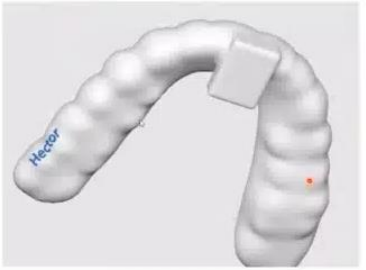
- Study: Deprogramming splint and occlusal equilibration alleviated TMD and "minor changes in condylar position".[1]
  - Flawed study

Facts: Muscle engram is learned pattern determined by the morphology of moving structures.

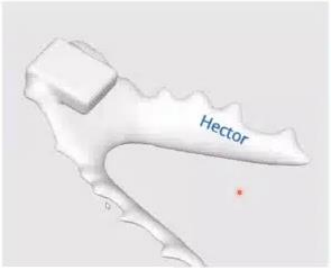
•Changing the occlusal scheme (morphology) can change the engram……But is this "THE" centric relation?[2,3]



Anterior Bite Splint



B Splint



Kois Deprogrammer

[1]Ramachandran et al. Cranio. 2021 Jul;39(4):294-302.
[2]Rinchuse DJ, Kandasamy S. J Am Dent Assoc. 2006 Apr;137(4):494-501.
[3]Rinchuse DJ, Kandasamy S. Am J Orthod Dentofacial Orthop. 2006 Feb;129(2):299-308

FICTION: DEPROGRAM THE MUSCLES

No evidence that ideal occlusal and skeletal treatment positions for dental patients based on “deprogramming” should be adapted for TMD patients

Rinchuse DJ, Kandasamy S. J Am Dent Assoc. 2006 Apr;137(4):494-501.
Rinchuse DJ, Kandasamy S. Am J Orthod Dentofacial Orthop. 2006 Feb;129(2):299-308.

FICTION: IDEAL VERTICAL DIMENSION

Advocates: occlusal splints reduce abnormal muscle activity and pain by restoring VDO "lost" to tooth wear and lost posterior support

- Success attributed to increase VDO

Facts:

i. VDO is highly variable
ii. Most individuals with decrease VDO do not have TMD

Block LS. J Am Dent Assoc. 1947 Feb 15;34(4):253-60.
Rugh JD, Drago CJ. J Prosthet Dent. 1981 Jun;45(6):670-5.
Lassmann Ł, Calamita MA, Manfredini D. J Esthet Restor Dent. 2025 Jan;37(1):94-105.

FICTION: IDEAL VERTICAL DIMENSION

Scoping Review: Concept of Vertical Dimension of Occlusion

- No evidence for trial phase of new VDO to assess patient adaptation
- Stability of VDO changes – does not cause or cure TMD

Almost everything we were taught about VDO is a myth!

Block LS. J Am Dent Assoc. 1947 Feb 15;34(4):253-60.
Rugh JD, Drago CJ. J Prosthet Dent. 1981 Jun;45(6):670-5.
Lassmann Ł, Calamita MA, Manfredini D. J Esthet Restor Dent. 2025 Jan;37(1):94-105.

THE SIMPLE FACTS OF OCCLUSAL SPLINTS

Fact	Fiction
Decrease / alter loading on TMJ	Unload the TMJ
Reduce muscle activity by foreign object	Retrain the muscle to be less active
Reduce headache intensity or frequency if triggered by sleep bruxism	Relieve primary neurovascular or vascular headache
Improve TMJ locking upon awakening related to sleep bruxism.	Recapture displaced disc and prevent progression

THE SIMPLE FACTS OF OCCLUSAL SPLINTS

Fact	Fiction
Disrupt neuromuscular engram that determine TMJ-fossa relationship	Produce ideal neuromuscular and occlusal relationship.
Protect teeth and dental restorations from sleep bruxism	Permanently reduce or eliminate sleep bruxism
Change the vertical dimension of occlusion	Establish “ideal” vertical dimension of occlusion

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OCCLUSAL SPLINTS FOR TEMPOROMANDIBULAR DISORDERS

Meta-analysis of RCTs (2025)

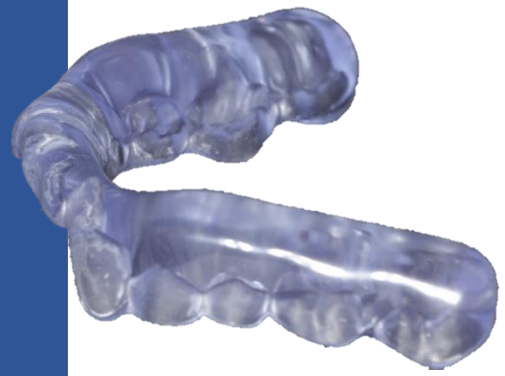
Efficacy of occlusal splint compared to other conservative treatments for TMDs

18 articles: occlusal splints compared to other conservative treatments

- Not superior in pain management
- Not superior in improvement mouth opening

Conclusion: occlusal splints

- More effective than counseling in pain management
- Reduced the incidence of TMJ clicking
- More effective than placebo splints for pain and mouth opening



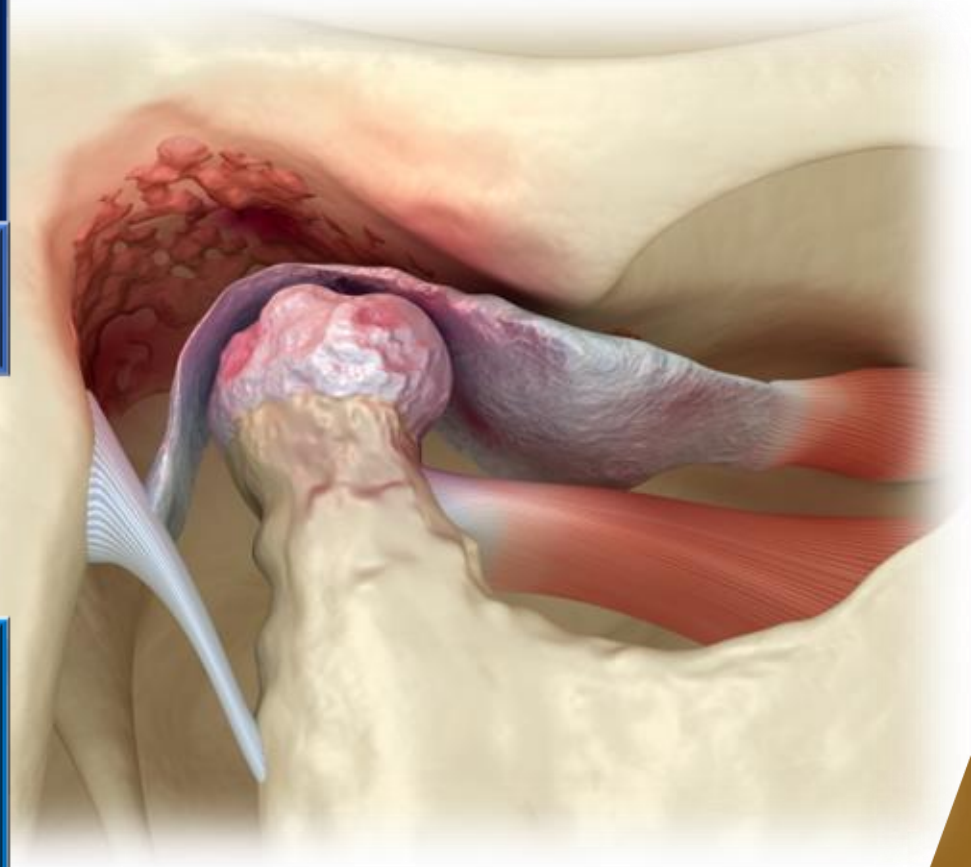
Zhang et al. Oral Surg Oral Med Oral Pathol Oral Radiol. 2025 May;139(5):509-520.

OCCLUSAL SPLINTS FOR TMJ PAIN

Systematic Review & Meta-Analysis:
Efficacy of Conservative Treatments for
Intracapsular TMJ Pain

13 RCTs (844 Participants)

Occlusal Splints effective for TMJ pain relief



Ferrillo et al. Cranio. 2025 Mar;43(2):258-274.

OCCLUSAL SPLINTS FOR MASTICATORY MUSCLE PAIN

Systematic Review
(2024)

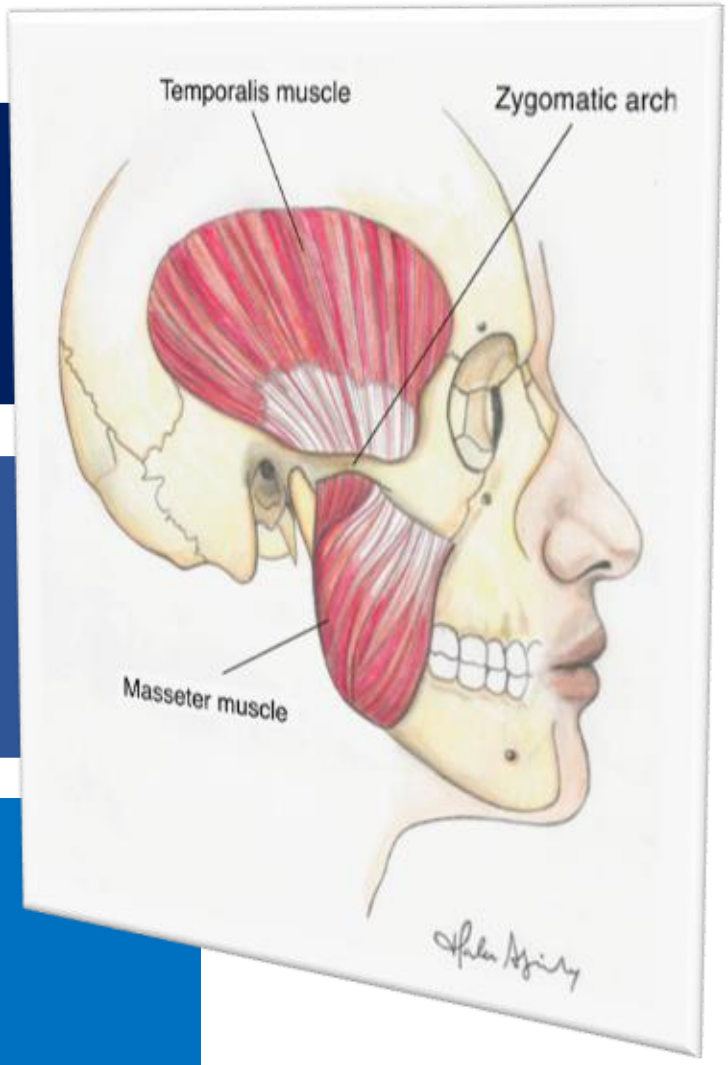
Stabilisation splint for muscle pain

10 Articles

Pressure pain threshold
Pain during chewing
Mouth opening
Spontaneous pain
Palpation pain

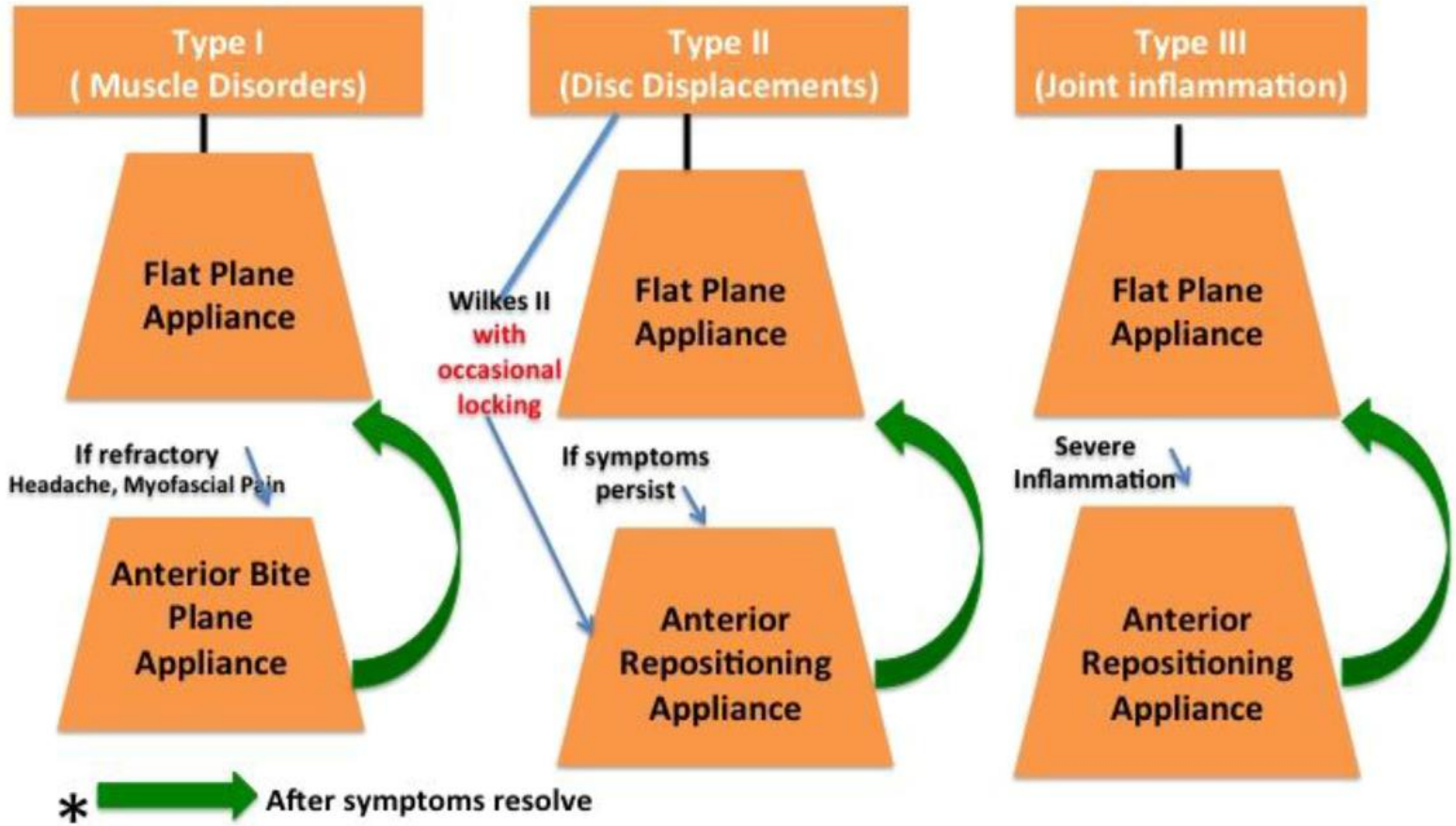
Results

Stabilisation splint (n=160) as effective as other treatment (n=209)



Honnef et al. Cranio. 2024 Nov;42(6):718-729.

OCCLUSAL SPLINTS FOR TMD BASED ON DIAGNOSIS



Greene CS, Menchel HF. Oral Maxillofac Surg Clin North Am. 2018;30(3):265-277.

EFFECTS OF OCCLUSAL SPLINTS FOR SLEEP BRUXISM

Systematic Review & Meta-analysis of RCTs (2024)

12 studies: 3 RCTs
(certainty of evidence: low/very low)

Does occlusal splint influence masticatory muscle function in sleep bruxers?

- Soft or hard splints did not affect muscle activity and bite force
- Splints did not affect masticatory performance and muscle volume
- Splints reduce tongue force

Ferreira et al. Eur J Oral Sci. 2024 Apr;132(2):e12979.

OCCLUSION MATTERS?

Randomised controlled trial of 80 TMD subjects treated with occlusal splint vs palatal splint:

At 6 & 12 months, 30% pain improvement:

- 50%: occlusal splint
- 42%: palatal (non-occluding) splint

Both groups had improvement in function

Nilsson H, Vallon D, Ekberg EC. J Oral Rehabil. 2011 Oct;38(10):713-21.

OCCLUSION MATTERS?

Non-occluding splints may be effective in TMDs (weak evidence).[1,2]

Efficacy theories for non-occluding splint:

- Placebo
- Cognitive awareness

When selecting a splint for TMD, "cover the occlusion" as occluding splints more effective for pain reduction.[3, 4]

[1]Dao TTT. et al. Pain. 1994 Jan;56(1):85-94.
[2]Nilsson H, Vallon D, Ekberg EC. J Oral Rehabil. 2011 Oct;38(10):713-21.
[3]Ekberg E, Vallon D, Nilner M. J Orofac Pain. 2003 Spring;17(2):133-9.
[4]Alkhutari AS. et al. The Journal of prosthetic dentistry, 2012 126(1), 24-32.

AGENDA

- OCCLUSAL SPLINTS REVISITED
- OCCLUSAL SPLINTS DESIGN SECRETS
- MECHANISMS OF ACTION
- SCIENTIFIC EVIDENCE FOR OCCLUSAL SPLINTS
- TAKE HOME MESSAGE

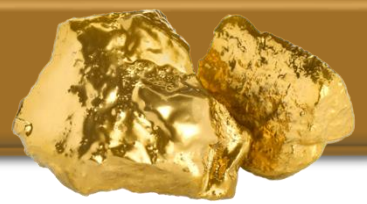
WHY DOES ONE PATIENT NEED ALL OF THESE SPLINTS?

HOW DO SPLINTS WORK?

8 Explanations For Treatment Success:

- ~~Alteration of the occlusal condition~~
- ~~Alteration of the condylar position~~
- ~~Increase in the vertical dimension of occlusion~~
- Cognitive awareness
- Increase peripheral input to CNS hence decreasing motor activity
- Regression to the mean i.e. the natural fluctuation of symptoms
- Placebo effect

TAKE HOME MESSAGE



- Occlusal splints are “oromandibular crutches” no different to orthotics
- Avoid full-time wear and designs that may lead to change in occlusion
- Mechanism of action of occlusal splints remains unknown
- Occlusal splints protect teeth from bruxism but do not stop bruxism
- Occlusal splints may be effective for TMD and headache triggered by sleep bruxism

OCCLUSAL SPLINT THERAPY

Ramesh Balasubramaniam OAM

THANK YOU!!!