INTRODUCTION OF STUDY OF PARTIALLY OR FULLY PROGRAMMABLE SIMULATORS

Gabriela Ifteni, Alina Apostu, Alina Jehac ,Cristina Cotea,

Nicoleta Ioanid,Oana Tanculescu

Department of Odontology-Periodontology, Fixed Prostheses
Faculty of Dental Medecine,"Grigore T.Popa" University of Medecine and Pharmacy
Iasi, Romania

*Corresponding author : Nicoleta Ioanid, Assistant Prof.
"Grigore T. Popa"University of Medecine and Pharmacy - Iași, România
e-mail: Nicole_ioanid@yahoo.com

ABSTRACT

Partially or fully programmable simulators are designed to reproduce – in part or in full – the anatomical peculiarities of anterior and posterior determinants. In what regards the normal joints and the accurate reproduction of the determinants of occlusion, simulators allow prosthetic restorations that require minimal intraoral adjustments and can be quickly integrated by the stomatognathic system. Next, we shall review the correlations established between the anterior and posterior determinants of mandibular dynamics and occlusal morphology, by referring also to articulator programming. On principle, the more the assessed teeth are closer to one of the determinants, the more the latter influences their morphology. Errors occurring in the shaping of the morphology of prosthetic restorations may range from inessential, by usage of entirely programmable simulators, to major ones, by using partial occluders (small, undersized hinge axis).

Assuming a patient's actual intercondylar distance is 90 mm and the used occluder has a 40 mm intercondylar distance, we observe that, on the new restoration, the grooves will be positioned towards the distal (for the maxillary) and towards the mesial (for the mandible).

Key words: edentulous, fully programmable simulators, mandibular dynamics

INTRODUCTION

Partially or fully programmable simulators are designed to reproduce – in part or in full – the anatomical peculiarities of anterior and posterior determinants. In what regards the normal joints and the accurate reproduction of the determinants of occlusion, simulators allow prosthetic restorations that require minimal intraoral adjustments and can be quickly integrated by the stomatognathic system[1,2]. Restorations' failure (of any kind: mobile or fixed dentures, fillings, orthodontic treatments etc.) to observe the limitations

imposed by the anatomical structure of the TMJ and the disregard of the relations between the mandibular and occlusal dynamics may lead to joint and muscle dysfunction(Fig.1,2,3,4).

Fig.1. Nonprogramable simulators

Fig. 2. Medium value simulators

Fig. 3. Semiprogramabile simulator

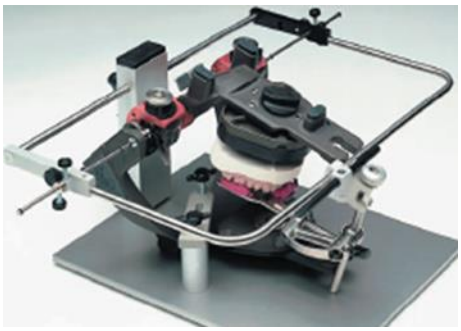

Fig. 4. Fully programable simulator

MATERIAL AND METHODS:

Next, we shall review the correlations established between the anterior and posterior determinants of mandibular dynamics and occlusal morphology, by referring also to articulator programming. On principle, the more the assessed teeth are closer to one of the determinants, the more the latter influences their morphology(Fig.5).

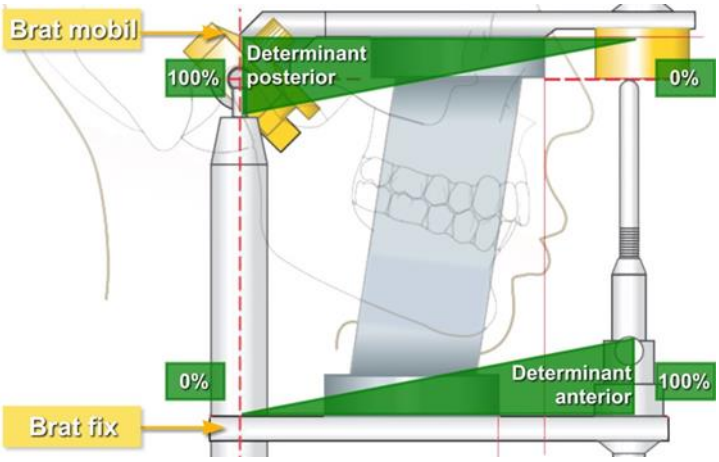

Fig. 5. Occlussal factors impact

RESULTS AND DISCUSSIONS:

Occlusal morphology is represented by cusps, ridges, fossettes and grooves.

Errors occurring in the shaping of the morphology of prosthetic restorations may range from inessential, by usage of entirely programmable simulators, to major ones, by using partial occluders (small, undersized hinge axis). Errors characterizing deviations from physiologic morphology can be positive and negative:

- A positive error occurs when the articulator compensates insufficiently or inefficiently the mandibular trajectory. This is expressed by a diminution of the trajectory impact on occlusal morphology. Ultimately, the result is an interference either by the oversizing of a morphological detail (height of a cusp/ridge or of the transverse dimension) or by their positioning in areas which, normally should allow the disengagement of antagonist cusps in the dynamic movement.
- A negative error occurs when the articulator compensates in excess the mandibular movement. The result is a loss of occlusal relief, consisting either in morphology attenuation, by widening of various fossettes or grooves or, by the dimensional reduction of the mesial-sagittal cusps and/or ridges which become narrower. Thus, the disocclusion of

the posterior teeth is easier to make.

The laterality movement is achieved by rotation around the pivoting active condyle. The movement of this condyle is a rotation movement around its vertical axis, to which a rotation around the sagittal axis and a lateral displacement (side-shift) or displacement towards the posterior may be added, depending on the morphology of the glenoid cavity[3,4]. The condyle on the inactive side performs an orbiting movement around the pivoting condyle. The latter's excursion is towards anterior, median and lower.

As during laterality movements, the cusps pass between the antagonistic cuspal ridges, through vestibular-oral occlusal grooves, these factors determine the placement of cusps [Okeson, 2005].

Each cusp generates laterotrusion and mediotrusion trajectories in laterality, on antagonist teeth surfaces:

All these trajectories represent arcs of circle made by the cusps around the pivoting condyle.

Trajectories are described at both maxillary and mandibular arch level. In order to view them easier, the following imagination exercise could help: each supporting cusp has at its top a marker leaving traces on the antagonist arch during laterality movements, in both directions[5,6].

In assessing these trajectories, we learn that on the active site, the supporting mandibular cusps move lightly through vestibular occlusal grooves and occlusal embrasures, without any interference. The trajectories are relatively transverse, their orientation depending on the factors we are to pass in review. Interferences in laterotrusion may occur in case of isolated or group position anomalies and in the cases of Angle classes II or III(Fig.6,7,8,9).

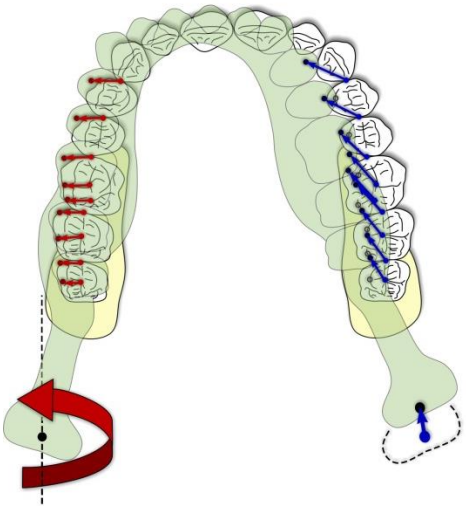

Fig. 6. Support cusp trajectories

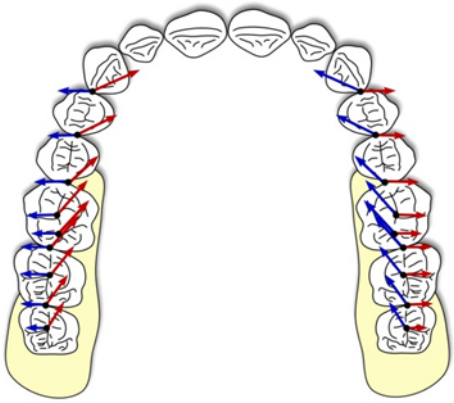

Fig. 7. Combined support cusp trajectories (right =blue, left = red)

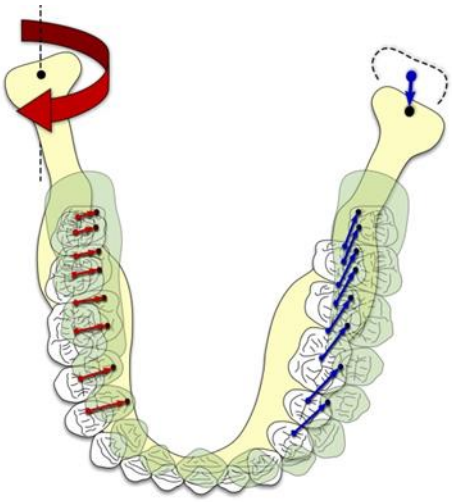

Fig. 8. Support cusp trajectories in right lateral movement

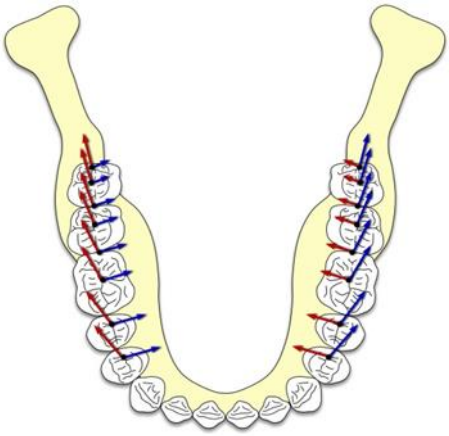

Fig. 9 Combined support cusp trajectories in right lateral movement

On the inactive side, the disocclusion may represent an issue. Trajectories are oblique, thus the vestibular mandibular cusps can interfere with the cuspidal slopes of the maxillary palatal cusps. Disto-palatal maxillary cusps usually do not interfere with the antagonists, as they are dimensionally smaller. On the other hand, the mandibular cusps' output of the maxillary central

fossettes can be prevented by the cuspidal edges of the mesial-palatinate cusps, thus occurring mediotrusion interferences. Moreover, by definition, the contacts within the mediotrusion are interferences[7,8].

The status of the premolars is more favorable, especially of the first superior premolar, where the disocclusion is distally performed by the tip of the palatal cusp, firstly, due to the position closer to the median line and secondly, because this tooth's morphology, with its lingual cusp is positioned slightly towards the mesial[9,10].

Supporting maxillary cusps' trajectories on the mandibular arch pursue the same pattern as that of the mandibular supporting cusps, mirroring them and being distally oriented.

In the laterotrusion, all supporting cusps of the supperior molars easily leave the maximum intercuspal position through the occlusal grooves and lingual embrasures, the trajectories being rather transverse. The presence, on the first premolar, of a slight slope toward the lingual and of a dimensionally reduced lingual cusp favors the disocclusion. In what concerns the second premolar, the morphology most favorable to disocclusion is the one with 3 cusps – a vestibular one and two lingual. In this case, the trajectory will pass between the two lingual cusps[11,12].

In the mediotrusion, the trajectories are oblique and distally oriented, the mandibular vestibular-distal grooves contributing to the disengagement of the maxillary mesial-lingual cusps.

According to specific anatomical structures, we shall observe that the angles between these trajectories in mediotrusion and laterotrusion vary, imposing the disposition of the occlusal relief.

The factors influencing the direction of the ridges and occlusal grooves are of geometric nature (distance to the condyles, the intercondylar distance, the position of the teeth on the arch, in relation to the medial sagittal plane) or of anatomical nature (the morphology of the glenoid cavity, arches' appearance)[13,14].

As it can be seen in the figures herein, the angles between the trajectories taken by the supporting cusps on the antagonistic arch vary mesiodistally. For both arches, the angle between the laterotrusion and mediotrusion trajectories made by the supporting cusps, on the mesial antagonistic arch, increases proportionally to the distance from the pivoting condyle. The difference consists in the fact that the obtained gothic

angles are open towards the distal and oral for the mandible and towards the mesial and vestibular for the maxillary(Fig.10,11).

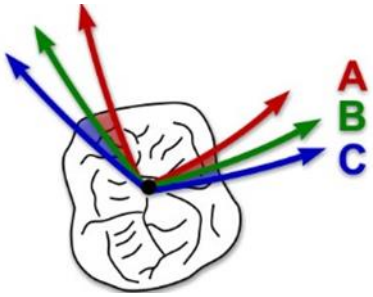

Fig. 10. Projecting on mandibulary arch the maxilary trajectories

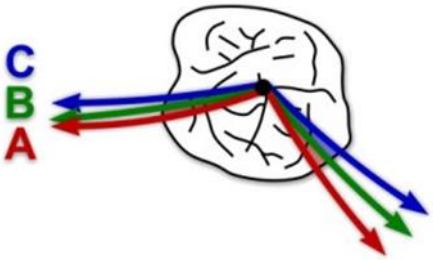

Fig. 11. Projecting on maxilary arch the mandibulary trajectories

From a practical standpoint, in order to record, transfer and reproduce the distance between dento-periodontal units and the intercodylar axis, systems composed of facial arc and simulator are required. The use of simple articulators that do not allow the recording and reproducing of an accurate distance to the intercodylar line generates the occurrence of various interferences, in the areas marked in the above figures.

There is a short distance from the intercodylar axis, when using occluders and average value articulators, the distance being even more reduced if imprints that do not record the entire lateral area (for example, sectorial imprints required for restorations performed in the premolar area) are used(Fig,12,13).

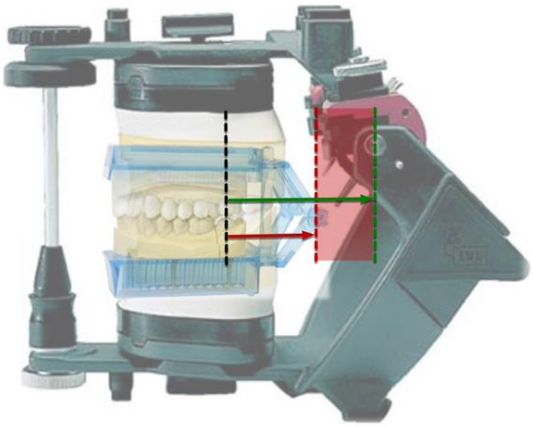

Fig. 12. Difference between the restaured tooth and intercondylian line on two different simulators (green = normal, red = smaller)

Generally, it is considered that an error of 5mm in locating the real intercondylar axis (hinge axis) results in an error of about 0.2 mm in the anterioposterior positioning of the inferior model in the articulator.

The distance towards the pivoting condyle and implicitly, towards the hinge axis, also impacts the opening/closing trajectories: the lesser the distance, the more the trajectory will be mesially oriented.

The positioning of the cuspidal slopes, according to a hinge axis positioned much closer to restoration than in reality, leads to the occurrence of various interferences between mesial slopes of the upper teeth and distal slopes of the lower teeth (positive errors).

Thus, the intraoral check of the retrusion and of the closure trajectory, in centric relation, in order to identify and eliminate the interferences becomes necessary.

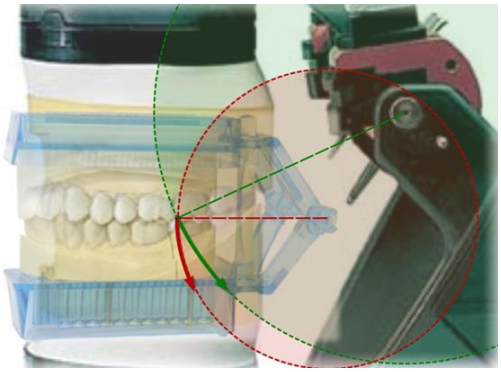

Fig.13. Opening trajectories

According to the intercondylar distance, the angle between the trajectories described by supporting cusps on antagonists varies inversely proportional with it. Regarding the maxillary, the trajectories are directed towards the anterior while for the mandible, the trajectories are oriented towards the posterior(Fig.14,15).

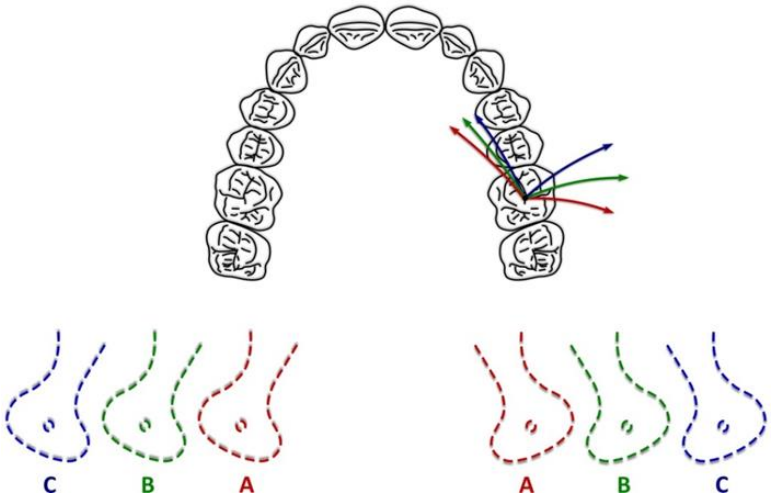

Fig.14 Trajectories in lateral movement and forward movement

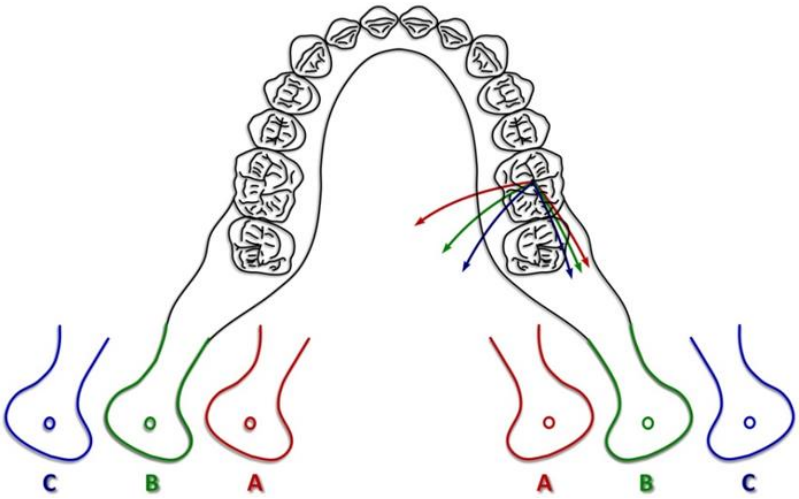

Fig. 15. Trajectories in lateral movement and forward movement – support mandibulary cusps

The effects of an incorrect intercondylar distance are reflected, on the active side, in the incorrect positioning of the intercuspal occlusal vestibular grooves, for the maxillary, or of the oral ones, for the mandible, as well as of the marginal ridge, and on the inactive side, in the positioning of the vestibular mandibular cusps and palatal maxillary cusps.

Assuming a patient's actual intercondylar distance is 90 mm and the used occluder has a 40 mm intercondylar

distance, we observe that, on the new restoration, the grooves will be positioned towards the distal (for the maxillary) and towards the mesial (for the mandible). If the articulator to be used has an articular distance greater than the actual one, the grooves will be positioned towards the mesial (for the maxillary) and towards distal (for the mandible)(Fig.16).

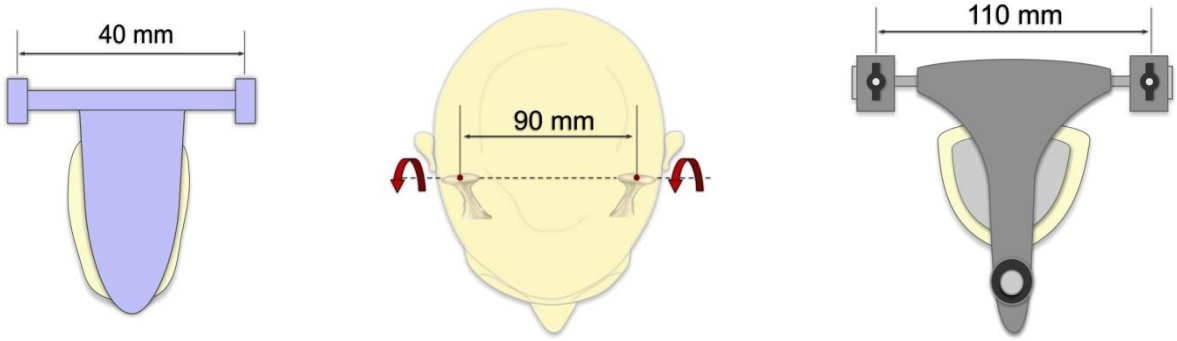

Fig.16 A. Segmentary occlusor - B. Real dimension C. Simulator

The influence of the internal wall of the glenoid cavity is emphasized in the frontal plane, as vertical determinant, this component influencing also the height of the cusps and the depth of the fossettes.

The more the positioning and orientation of the internal wall of the glenoid cavity forces the condyle to a larger lateral displacement, the more difficult the disocclusion in the lateral area will be. This requires the development of cusps of reduced height and of superficial fossettes, in order to avoid interferences or prematurities(Fig.17,18).

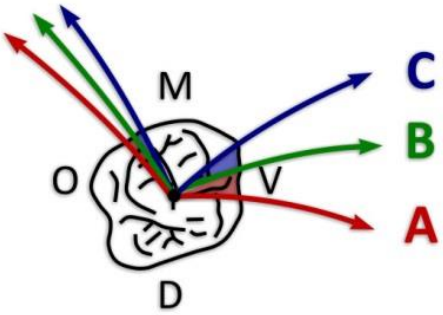

Fig. 17. Interference zone maxillary arch

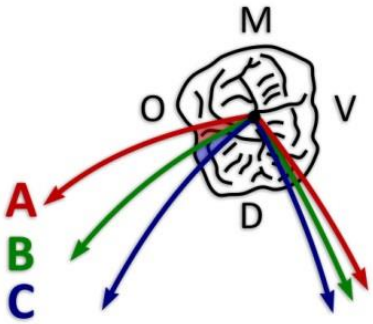

Fig. 18. Interferance zone mandibulary arch

The more reduced or even absent the side-shift is, the more favorable the status of the lateral teeth, a prominent cuspidation being then possible.

Widening of the occlusal grooves in order to facilitate the disengagement of the cusps in flawed occlusions is more physiological than the height reducing of the cusps involved in supporting the maximal intercuspation. The reducing of the cusps leads to passive eruptions accompanied by teeth mobility and possible further interferences in laterality movements, mediotrusion or premature contacts.

CONCLUSIONS:

Choosing an articulator with an intercondylar dimension different from the patient's, generates a restoration morphology created according to laterotrusion and mediotrusion trajectories different than the real ones.

The intercondylar distances of the occluders are below average values. Most medium and semi-programmable articulators have a fixed intercondylar distance of approximately 10 mm. The fully programmable articulators allow the setting of the aforementioned distance, according to the recordings performed for the patient, with facial arcs or pantographs.

References:

1. Abjean J., Korbendau J.M. - L'occlusion - aspects cliniques, directives therapeutiques, Julien Prelat, Paris, 1977.
2. Angle E.H. - Classification of Malocclusion of the Teeth, 7`h eds., Philadelphia, SS White Mfg Co, 1967.
3. College national d'oclusodontologie. Commission de terminologie: Lexique d'occlusodontologie, Paris, 2001
4. Dawson P.E. - Les problemes de l 'occlusion, Prelat, Paris, 1993.
5. Dawson P.E. - Position optimale du condyle de l'ATM en pratique clinigue, Rev. Int. Parodont. Dent. Rest., 3:11-31, 1985.
6. Holban C., Agop D., Forna N.,Preparations pro-implant versus pro-prosthetic, Romanian Journal of Oral Rehabilitation, Vol.8, No.3,2016, 72-79
7. Rassouli NM, Christensen LV- Experimental occlusal interferences III. Mandibular ortation induced by a rigid interference, J Oral Rehab, 1995,
8. Rinchusea Donald J. and Sanjivan Kandasamyb - Orthodontic dental casts: The case against routine articulator mounting, Am J Orthod Dentofacial Orthop 2012;141:8-16
9. Thompson J.R. - Anatomic and Physiologic Considerations for the Positions of the Mandible, Aust. Dent. j., 57:22-5, 1953.
10. Valentiv C, Morin F- L'intercuspidation maximale: examen clinique. Caracteres de l'intercuspidation maximum, Cah prothese, 1982.

11. Zarb G.A., Carlsson G.E. - Temporomandibular Joint ¬Function and Dysfunction, Munksgaard, 1979.
12. http://www.leeds.ac.uk/dental/Oroface/TEETH/tstart2.html
13. http://www.step.es/~jlarena/fotos8ing.htm
14. http://www.dent.ucla.edu/ - Andrew Pullinger DDS, MSc - Clinical Occlusion, Division of Oral Biology & Medicine, Section of Oral Medicine and Orofacial Pain, Handout, cours