THE ANTERIOR HYPERFUNCTION SYNDROM - FEM SIMULATION

Cătălina Măgureanu Murariu, Elena Preoteasa
Removable Prosthodontic Department, Dental Medical School,
Discipline of Complete Denture, "Carol Davila" University of Medicine and Pharmacy
Bucharest, ROMANIA

Abstract: Objectiv: Establishing a corelation of biomechanic behaviour with clinical observations, of the support area of masticatory presions, through out specific changes which characterise the anterior hyperfunction syndrom. **Material and method**: Starting with some oclusal considerations there are presented clinical observations concerning the anterior hyperfunction syndrom with predisposant factors, manifestation and consequenses. There are evaluated, using finite element method FEM, the oclusal presions, analizing the support area and their efects on oral structures, for oclusal forces of 100N. **Results and conclusions**: The biomechanic results with FEM are confirming the role of residual ridge in lateral area as zone of primary support and the important resorbtion in frontal ridge leading to flaby ridge, that caracterise the anterior hyperfunction syndrom. The biomechanic results by FEM confirmes the lateral ridge as primary support, and also the accelerated resorbtion in frontal crest, that appears in anterior hyperfunction syndrom.

Key words: anterior hyperfunction syndrome, FEM simulation

GENERAL CONSIDERATIONS

The anterior hyperfunction syndrom is most of the time asociated with the combination syndrom (CS, described by Kelly). In 1972, Kelly presents the clinical case, most frequent, of the combination of complete maxilar edentulous with cls I Kenedy, termino -terminal mandibular edentulous, which he calls *the combination syndrome (known as Kelly`s syndrom)*. This combination of edentulous areas and removable dentures implies some specific changes, morphological and functional, beeing characterised by Kelly through five clinical simptoms:

- the important resorbtion of the frontal ridge, frequently apearing the flabby ridge with mobility in horizontal plane;
- papilary hyperplasia (on the palatal mucosa)
- inferior hypertrophy of maxillary tuberosities;
- extrusion and bucal migration of anterior mandible teeth (with periodontal affectation of them) and frequently disorder of occlusal plane.
- considerable resorbtion under denture`s base, especialy mandibular. He describes for the first time the loss of bone and changes in soft tissues of the maxilar and mandible, in this combination of edentulouism treated with removabal dentures.

Later, some authors (Saunders 1979, Budts 1981, Keating 1997, M. Martin, Cunha 2003) completed with their observations the clinical picture of combination syndrom, such as:

- anterior position of mandible, with mandibular disfunction;

- diminution of vertical dimension of inferior floor of face;
- changes of occlusal plane because of diving the mandibular denture and over-eruption of mandibular anterior teeth.
- epulis fissuratum, in the labial mucosa of the maxilar;
- periodontal afectation of the anterior mandibular teeth;
- difficulties in accomodation with dentures.

Cuhna in 2003 showes that 85% of pacients with this kind of edentulouism treated with removabal dentures are presenting the clinical signs described by Kelly, and some 5% are presenting only one sign. He showes that in over 7% of cases there are signs of mandibular disfunction, from wich 32% where moderate, 50% where reduced and 11% where none.

Shen and Gogloff (1989), by examing 150 patients with complete maxilary denture, they found:

- a frequency of 24% patients with complete maxilary denture oposing cls I Kennedy – bilateral edentulous areas located posterior to the remaining natural teeth, in mandible, with partial denture.
- in presence of a complete maxilary denture oposing a partial denture , with presence of molars, it was not described the simptomatology of the combination syndrom.

We can apreciate in this case, the importance of lateral teeth in preventing the combination syndrom.

The effects of oclusal pressions are depending of the size of muscular forces, of length of action, site and direction in wich it is working.

Lewin, Hartwel and Rahn divided the bearig area of support for the denture, in principal supporting areas, wich receives majority of oclusal pressions (the lateral ridge) and secundar supporting areas, wich receives more reduces pressions (the hard palat, tuberosities, frontal ridge).

The size of pressions applied to muco-bony structures is different, bbeing implied different factors(age, sex, muscular tonicity, the tipe of mastication, thopografic zones, frontal or lateral), by Gateau, Chokroun, 1998.

A study of Bakke (1986) developed on 63 women and 59 men, of different ages, showes that mastication force depends on age. It is average of 356,9N at 5-10 years old, then it groes at 610,8N ,at 40-50 years old then it reduces at 373,8 N at 60-70 years old.

Depending on sex, Waltimo and Konen (1993) by mesuring the average loading in molar region, they found values of 847N for men and 597N for women. By decreasing the muscular tonicity of mandibular elevation muscles, wich come with time and by reducing the contribution of proteins, the mastication forces are limited.

The pain in maxilar bones and mucosa, in muscles or temporo-mandibular joint, limits the masticatory effort.

Erhardson (1993), showes in EMG study, that maximum oclusal forces are obtaind only in MI (maximum intercuspidation). In case of unilateral mastication this forces are reduced with 25%. He affirmed that second molar supports maximum contractions and this one diminishes by incisal zone (with 20%). On premolars the loading is about 400N (Kovarik).

The time of loading the support structures can be prolonged in case of heavy abrasion of teeth, in bruxism, dentures lack of stability or increasing of oclusal vertical dimension. By prolonging the action time on support structures, after Jores rules, it produces ridge resorbtion and replacing the bony tissue with fibrous tissue, leading to fibrous ridge.

The vertical and intermitent pressions are generaly well supported by the muco-bony structures. By alteration of occlusal relations or by heavy wearing of teeth asociated with tendency of mandibular propulsion, can appear horizontaly pressions, usually with anterior direction. This kind of pressions are producing oclusal instability and denture`s lack of stability with difficulties in wearing accomodation and distructive effects on the support structures.

The determinating factors of structural and functional changes in this syndrom are constitued by the presence of anterior mandibular teeth, or anterior prosthetic reconstructions (bridges) with antagonist, a complete maxilary denture. The artificial teeth from the denture are producing oversolicitation of the frontal ridge in maxila, by developing high pressions and denture instability.

The asociated modifications in combination syndrom are explained by the moving of the denture on the support areas and diving of the mandibular denture, with changes in the occlusal field (missing of contacts in lateral zone and mooving the occlusal field in frontal region) and instability of the maxilar denture. By loosing the occlusal contacts in lateral zone there are using in mastication the frontal teeth. Because of that the combination syndrom is calling the anterior hyperfunction syndrom.

BYOMECHANICAL STUDY

The aim of this syudy is to corelate the clinical issues with biomechanic isues. The byomechanic study consisted in numerical analisys of the effort in bone surface at complete edentulous, which appear under the occlusal pression, throught digital investigation.

MATERIAL AND METHOD

For evaluation of deformation and tensions in bone structure of maxillar we used the FEM.

With a FORTRAN program we acomplished a geometrical model formed by volumes, throught which was represented the complete denture (base and artificial teeth), and the bony support of the denture (fig. 1).

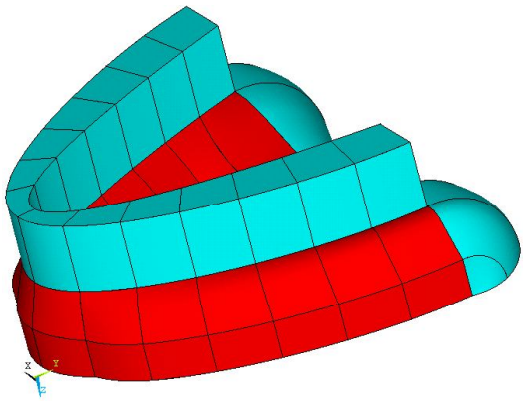

Fig. 1. Global geometrical model: artificial teeth, denture's base and area of support.

The volumes where discretisated in finite elements; the bony support, which is the study object, was shaped in volum and discretisated in tetraedric tridimensional elements. (fig. 2 a and b).

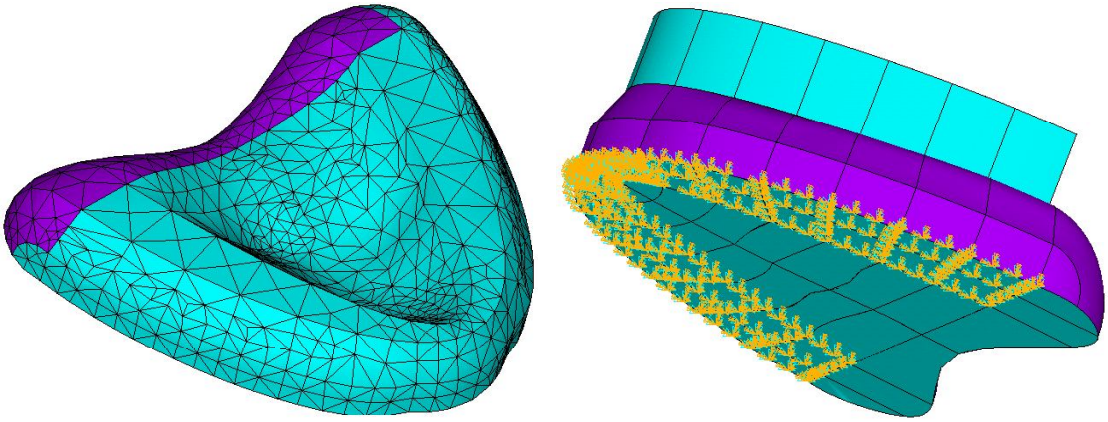

Fig. 2 a, b. The bony support of the denture discretisated in volume elements.

For loading of the model we considered a force F of 100N, applied as vertical occlusal pression on the occlusal surface in the lateral area (a phisiological aspect because lateral area is the one used in mastication) and frontal area (a modified functional situation as it happened in anterior hyperfunction syndrom).

The results are presented like equivalent von Misses tensions, in numbers and grafic in MPa.

THE BYOMECHANIC STUDY concerns:

1. Observations aiming aplication of pressions in lateral zone.

Was verified the solicitation throught occlusal surface by unilateral application. The loading of the model was on the lateral right side on the geometrical model, with a pression coresponding at F of 100 N, in vertical direction, in premolar-molar region, without incisal participation (fig.3).

The results are showing the deformation and tenssions field limitated on a half of the rest area, between the passiv mobile mucosa and the middle line of hard palate, 1/3 from incisal zone and 1/3 to distal area, the Ah zone.

The tenssions values are decreasing from middle to perifery. The maximum is 0,85 MPa on the ridge area, in intern crest between molar and premolar. The values are decreasing in vestibular retrozygomatic area- 0,47 MPa untill 0,19 MPa.

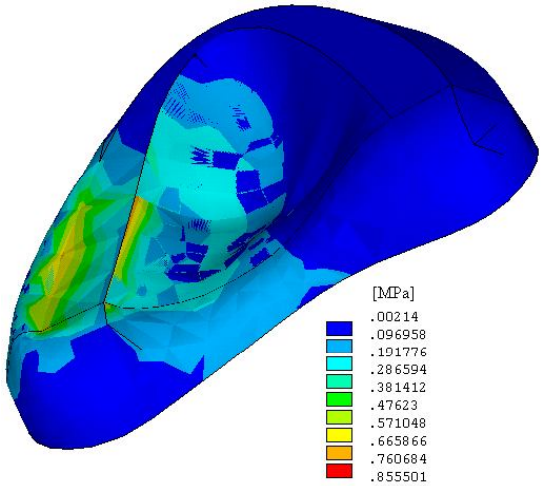

Fig. 3. The tention field in lateral crest on bearing area

On palatinal zone it is observed a decreasing of tensions arriving on middle line at 0,009 MPa.

In the other regions of the rest field of the denture, the values of tenssions are insignificant on a surface of 52%, this phenomen could affecting the denture stability.

2. Observations aiming application of pressions in frontal zone.

The frontal application of pressions can appear in anterior guiding or in food

incision, but as we know, most of the authors are forbiden remaking the anterior guiding at dentures, as same as incisal function.

We applied a force of 100N, in incisiv zone. It showes o increasing of bone tenssions in frontal ridge, with values of 1,735MPa (fig.4), which are reducing in lateral way, in canine zone is 0,77MPa. In other areas the values of tenssions are insignificant.

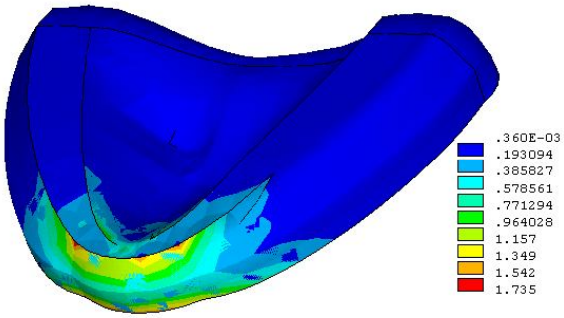

Fig. 4. The frontal tenssions

CONCLUSIONS

We can say that:

- the oclusal presions are beginning on oclusal level throught tooth to tooth contacts or tooth- food-tooth contact;
- these oclusal presions are transmited throught denture's base on the support structures;
- in normal, phisiological raport (with mastication in lateral region), the pressions are supported first by lateral ridge, capabal to sustain vertical pressions, in some valoric limits;
- the pressions transmited in frontal region are not functional, especialy when they became horizontal, they are distructive on the support structures, explaining the great resorbtion on frontal ridge with aspect of fibrous ridge, from anterior hyperfunction syndrom;
- the byomecanical simulations confirmes the clinical observations concerning, the capacity of support structures and modifications at this level in unphysiological situations, of excesiv pressions, in the anterior hyperfunction syndrom.

REFERENCES:

1. Budts-Jorgensen E. - Prosthodontics for the Elderly, Quintessence Publiching, Co., Inc. 1999.
2. Gateau Ph, H Choukroun - Le point sur les reconstitutions corono-radiculaires. AOS , 1998, nr 204.
3. Kelly E. - Changes caused by a mandibular removable partial denture apposing a maxilary complete denture. J. Prosthet. Dent., 1972, 27, 140.
4. Langer Y, Laufer BZ, Cardash HS: Modalities of treatment for the combination syndrome. J Pros Dent. 1995,4:76-81.
5. Levin B – Impressions for complete dentures, Quintessence, 1984
6. Magureanu-Murariu C, M Păuna, M, Glăvan – Edentaţia totală. Aspecte de analiză biomecanică, Bucureşti, Ed Cerma, 2002
7. Ottenhoff, A. van der Bilt, H.W. van der Glas, F. Bosman and J.H. Abbink - The relationship between jaw elevator muscle surface electromyogram and simulated food resistance during dynamic condition in humans. Journal of Oral Rehabilitation, 1996, **23**: 270-279.
8. Pauna M, Preoteasa E – Aspecte practice în protezarea edentaţiei totale, Ed Cerma, Bucureşti, 2002
9. Preoteasa E - Sindromul combinaţiei, Medicina stomatologică, 2004, 5, 15
10. Saunders TR, Gillis RE, Desjardins RP: The maxillary complete denture opposing the mandibular bilateral distal extension partial denture: Treatment considerations. J. Prosthet Dent 1979, 41:124-128.
11. Shen K, Goggloff RK: Prevalence of the combination syndrome among denture patients. J Prosthet Dent 1989;62:642-644.