THESIS

The Problem of The Excessively Resorbed Alveolar Ridge
with
A Suggested Approach to Denture Restoration.
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PURPOSE OF THESIS.

To Throw Some Light on The Incidence of Excessive Alveolar Atrophy, and Emphasise The Need for Recognising a State of Malady Requiring Specialised Treatment.

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INTRODUCTION.

King Solomon\(^{(1)}\) said "there is no new thing under the Sun"; but we search in vain among the remains of those peoples, the Greeks, Egyptians and Babylonians, who at that time had already achieved a degree of culture and civilization, for any evidence of what we know today as prosthetic dentistry.

Not that these people were immune from dental ills, Sir Mark Armand Ruffer, as reported by Shaw,\(^{(2)}\) asked if there had ever been a time since man's advent upon the earth when he had not suffered from both tooth and gingival troubles; the occasion being the examination of skulls from recent excavations in Egypt.

The Babylonians\(^{(3)}\) of 4000 B.C. have given us the first written dental literature on their burnt tiles (British Museum) wherein they have described dental caries and pyorrhoea as we know them today.

The Ebers Papyrus, with its forty-eight prescriptions for 'toothache' and gingival ills, bears testimony that the Egyptians of 3000 B.C. were by no means dentally perfect; but - "there is no single instance of practical work having been carried out in the mouths of the thousands of mummies and skeletons examined in the last fifty years".\(^{(4)}\)

eventually to the making of casts and dies for swaged metal bases, definitely ending the wood, bone, and ivory era; and though there is no mention of any one individual having been responsible for the application of plaster of Paris to this purpose, Pfaff, dentist to Frederick the Great, is credited with being the first to actually describe the making of casts - (1756).

Gradually improvements were made; plaster, then modelling compound replaced beeswax for impression taking, the porcelain tooth came into being, and vulcanite bases brought dentures within reach of the many.

With the better understanding of the anatomy of the oral cavity and the study of the movements of the mandible, articulators came into the picture; and, though still the Cinderella of the profession, full denture construction advanced in a more or less leisurely way till given an impetus by the recognition of the importance of the mastication and ensalivation of food as a part of the digestive process.

Another era was, however, upon us. The Medical Profession began to regard the tooth system as actually part of the body, and not as something separate; the Roentgen Ray disclosed hitherto unsuspected 'foci of infection'; devitalised teeth were declared a menace to health, and an orgy of tooth removal began.

'Extraction' has become 'exodontia' or 'surgical removal', and full denture prosthesis takes pride of
place instead of being the last resort when crown and bridge replacements are no longer possible.

We have at the moment an amazing literature giving a multitude of techniques, and a nomenclature requiring the education of an anatomist, a physicist and an engineer to understand. The practising dentist trained in the older schools, but anxious to meet changed conditions, making a survey of the ever increasing literature - time will not permit more than a survey - is bewildered by the divergent views of writers; many of the groups are so emphatic in their claims to the excellence of their technique, instruments, and materials that one feels,

"So many gods, so many creeds,
So many paths that wind and wind".

and, if "all roads lead to Rome", which path, taken at the gait of an average operator, will lose itself in the outskirts, and which the one that will land him at the citadel?

Even the human, the patient, has changed! The same mouth certainly, but - an edentulous period of six months or so prior to being given something to fill the space between the jaws is no longer tolerated. The man in the street being better informed, and having been lectured and impressed with the importance of diet and mastication requests that his teeth be "extracted in the new way", and demands immediate denture service; incidentally expecting that same denture to last for the rest of his life without further attention, citing grandmother who "can bite an apple or chew anything" and who has worn
the same dentures for twenty-five years or more!

The materials for use in prosthesis have been added to and improved - plaster of Paris and modelling compound still hold pride of place as impression materials, but it is a 'plaster wash' and an improved modelling compound; artificial stones and denture base materials offer in wide array.

Whatever the materials chosen, and technique, or combination of techniques followed, the earnest worker striving to give the best possible service in this so important field of full denture prosthesis, might well absorb the spirit of Chardin, the French Painter who said: "We do not paint with colours, we use them, but we paint with understanding".
DIAGNOSIS AND CLASSIFICATION OF THE
EXCESSIVELY RESORBED ALVEOLAR RIDGE.

In the wide and much discussed field of full denture prosthesis the most difficult cases presenting are those edentulous jaws in which excessive alveolar resorption has taken place.

Diagnosis is usually a simple matter, especially in the mandible; in the maxilla, in visual examination only, of the oral cavity, one may sometimes be misled by a simulated ridge till palpation of the ridge mucosa reveals a compressible mass unsupported by bony tissue.

Roentgenography is indispensable as an adjunct to visual and digital examination; while abnormalities of muscle attachment and arrangement may be detected by drawing the lips and cheeks, in the maxilla outward and downward, in the mandible outward and upward; by having the patient raise the tongue, also draw it backward; by observing conditions in the tuberosity regions with the mouth partly, and fully open.

What are popularly known as 'flabby upper' and 'flat lower' may occur singly or in combination; i.e.,

1. Excessively resorbed edentulous maxilla with complete, or almost complete dentate mandible.

2. Excessively resorbed edentulous maxilla with a few mandibular teeth retained, usually the anterior six.
3. Excessively resorbed mandible with maxillary teeth retained.

4. Edentulous maxilla having a firm, well rounded ridge opposed by a ridgeless mandible.

5. Both jaws edentulous and showing excessive resorption.

6. Excessively resorbed maxilla, the mandible still retaining a well defined ridge and normal muscle attachments; this is rare when the mandibular teeth have been out for some time.

These groups may be further subdivided:

The Maxilla.

(a) The area of excessive resorption may be confined to the space limited by the former site of the second bicuspids on each side, the molar regions and tuberosities being more or less rounded and firm; while the anterior gum is pendulous and compressible.

(b) Resorption may have progressed throughout the whole ridge including the tuberosities, which may be quite pale, movable, and cartilaginous; the palatal vault is usually flat; fibrous bands may be present unilaterally or bilaterally, passing upward and backward, or downward and outward, or both, from as far forward as the second molar area.

(c) The anterior ridge may be firm and well defined, the tuberosities diminished and movable.

(d) The maxillary suture may be anything from flat and almost indistinguishable to an actual taurus
palatinus.

The Mandible.

(e) The anterior ridge may be well defined, with firm covering mucosa, the molar-bicuspid regions quite flat or knife edged.

(f) The ridge may be flattened throughout, even involving the mental foramen on one or both sides.

(g) Actual depression of the ridge below the level of the movable soft tissues on either side, bands of fibrous tissue passing lingually, backward and inward from as far forward as the second molar region; buccally and labially quite a variety of irregular muscle attachment may be encountered.

The saliva may be anything from thin and watery to heavy, scant, and ropy.

The mucosa also may vary within wide limits. Atrophy may be, roughly, divided into two types.

(1) Uniform, both bone and tissue being involved, leaving flat, smooth surfaces with little or no resiliency in the mucosa, which is very sensitive to dental pressure over the ridge crest.

Roentgenographs taken with a light exposure show the thickness of the mucosa, but do not lend themselves to reproduction for illustration, the actual film being necessary for diagnostic purposes.

(2) Serrated alveolar atrophy, more frequently seen in the maxilla than the mandible, except for
a short time after the extraction of pyorrhoeic anterior teeth that have been too long retained. The mucosa in these cases is mainly a reflex of the type of denture being worn; pressure over the ridge crest or a crumpling of the soft tissue by the denture reacting on the surface appearance.

Roentgenography of these cases shows a ragged edged structure offering little resistance to the passage of X-Rays; the trabeculae are irregular, and there is an absence of a cortical layer; the bony margins are serrated irregularly, especially in the maxilla, Pendleton\(^5\) suggests occupancy of these indentations by blood vessels, while MacMillan\(^6\) ascribes the condition to an effort on the part of Nature to regenerate bone; McKevitt\(^7\) and Jackson\(^8\) however, think 'residual infection' is the explanation of the tattered appearance; probably all four are right to some extent.


Fig. 1 is the most pronounced case of atrophy of both alveolar bone and soft tissue the writer has encountered; the only vestige of alveolar ridge being a patch in the region of the third molar right, where there is either a residual root or a supernumerary tooth. The patient (Case History 2) stoutly refusing to allow investigation of an area that had been quiescent for twenty six years, the point was not pressed.

Fig. 2 is typical of the excessively resorbed maxilla, the whole ridge including the tuberosities
being serrated and offering little resistance to the passage of X-Rays; the mucosa, easily seen in the films, but not distinguishable in the reproductions, is of reasonable depth.

Fig. 3 shows another type of degeneration;

Fig. 3.

the raggedness is not so pronounced, but on one side atrophy has taken place right down to the floor of the antrum; the depth of mucosa can be seen in some parts of this reproduction, but does not convey any idea of the spongy mass revealed on examination.

A great contrast to the three groups shown above is Fig. 4, of portion of the maxillary ridge

Fig. 4.

at the age of sixty-five, the teeth having been extracted at the age of twenty-two.
The excessively resorbed mandible has little to show as a rule, it often being difficult to distinguish between the upper and lower borders of the bone except in the anterior, and no means of deciding which is the left and which the right side; the writer frequently uses two different makes of film for the two sides, thereby making certain of correctly placing an unsuspected residual root which may have no surface mucosal indication of its presence; Fig. 5 is a typical example, there is some remnant of alveolar bone in the incisal region from which several pyorrhoeic teeth had been extracted about a year before. Posteriorly there is some indication of the knife edge mucosa that rendered the making of a comfortable lower denture a complicated matter.

Fig. 6, from which the eight anterior teeth, pyorrhoeic apparently, were extracted eight months previously, offers all the disadvantages of the excessively resorbed case and is a fit complement to its maxillary opponent Fig. 2, the extreme resorption.
of the posterior regions with no indication whatsoever
of residual alveolar ridge giving a typical flat

Fig. 6.

lower; the bulk of the anterior alveolar bone
apparently having disappeared before the extraction
of the teeth.

Fig. 7, the mandible opposing Fig. 3, is
another example far removed from the ideal; the
bicuspid region on the left shows a thickening of

Fig. 7.

the bone where two bicuspids were retained for the
purpose of "keeping in" the lower denture; the dark
line on the right indicating a dense, well established
cortical layer not favourable to denture pressure.
AETIOLOGY OF EXCESSIVE ATROPHY.

Causative factors in excessive alveolar ridge atrophy may be said to be (a) predisposing, (b) exciting.

(a) Among the possible predisposing causes that may be grouped as more or less inter-related are all those abnormal conditions preceding the edentulous state: caries, mal-occlusion, root-end infection, pyorrhea, Vincent's infection, inadequate, or neglect of, partial denture service.

Frequently when the operator reluctantly advises the removal of remaining teeth in preparation of the field for full dentures, the mouth is already a hopeless wreck; pyorrhea pockets, extensive root-end infection, mal-occluded teeth and unused edentulous spaces may have already taken such toll of the alveolar bone that a state of excessive resorption already exists; while the amount of covering bony material that must, in many cases, be removed in the recovery of exostosed roots and impacted teeth assures a depleted ridge height in that particular area; each adverse item lessening the fulfilment of the patient's expectation of permanent dental restoration. As Gillis(9) complains, the mandibular ridge may actually be below the general level of the surrounding adjacent tissues before the approach to full dentures is begun.

Traumatic occlusion as a potent factor in pyorrhea and alveolar ridge destruction was for

many years, the burden of the late Morse Withycombe's song; but his was as a voice crying in the wilderness.

Maddern demonstrated, by numerous specimens, the pathologic results of traumatic occlusion, and the work of Box, Mallory, and others as reported in the Canadian Research Foundation's Bulletin No. 1, emphasises the devastating effects of traumatic occlusion of the natural teeth as shown by the extensive tissue destruction in pyorrhoea.

Many other writers including Stillman and Hoffer, view traumatic occlusion of the natural teeth as a most serious matter; while Farmer who is indeed retrospective, asserts that tissue tolerance enters into the situation from the placement of the simplest occlusal filling!

The need for preserving the ridges by attention to the details of partial denture construction in anticipation of the time when full dentures are to be worn is emphasised by Cummer, Roach, Kennedy and many other writers; Schuyler says: "We have all seen too many tissue borne partial restorations destroy the ridges and render impossible the making of a satisfactory full denture restoration". The writer would go farther, and say that many teeth used for 'occlusal rests' in being asked to carry a much greater burden than their formation and


position in the dental arch warrants, are not only doomed with the placement of the partial restoration, but resorption of the alveolar bone into which they are relentlessly driven by the force of mastication is assured.

The possibility of refraining from partial denture service producing a condition of dis-use atrophy depends upon the width of edentulous space, and whether there is sufficient friction from food during mastication to afford the necessary stimulation to prevent such happening; the more usual experience

Fig. 8.

is that degeneration of the alveolar bone occurs to a greater or less extent in these spaces, Fig. 8 being an example; in this case the second bicuspid and first and second molars had, to the writer's knowledge been missing for fifteen years, the patient refusing to wear a partial denture.

Types of degeneration as shown in Figs. 9 and 10 could not be expected to yield ridges favourable to denture construction following extraction of the teeth; especially in the case of elderly people whose regenerative powers are on the wane, and where long continuance of the condition precludes
the possibility of bone trabeculae remaining beyond the already rarified cancellous bone.

The possibility of systemic disorders, vitamin and mineral deficiency being responsible for progressive resorption of alveolar bone has until fairly recently been considered but little. In 1934 Broderick (13) complained of his lonely position in his claims to the recognition of the fact that dental lesions reflected deviation from the normal of the physiological processes of the body. Other writers had, however, already attacked

the subject. Reynolds (14) says: "After making due allowance for the possibility of local factors such as mal-occlusion and microbial retention, or exogenous factors such as diet and infectious disease, there appears to be some predisposing constitutional factor not yet understood."

Klein (15) reporting on the result of his research in feeding rats on a diet low in the element magnesium found severe hyperplasia of the gingivae, loosening of the teeth, and excessive deposition of calculus, particularly in the molar regions.

Other writers, Becks, Citron, Gottlieb, Boenheim, have suggested that metabolic disturbances may possibly be contributing factors in excessive resorption.

Such systemic disorders as are known to be associated with calcium-phosphorus deficiency, diabetes, tuberculosis, gastric ulcer, the allergic group, ovarian dysfunction, goitre, to mention a few, are frequently associated with excessively resorbed cases, though patients are sometimes reluctant to mention the fact unless questioned, and the reason for questioning explained.

Conditions resulting from acute mental distress, or long continued illness during which impaired nutrition and lowered general resistance


are apparent in other directions must also be taken into account as possible contributing factors in excessive alveolar atrophy.

Melvin Page,\(^{16}\) referring to the amount of literature dealing with the subject from the point of view of trauma says: "We know that alveolar process is similar to bone, and like bone responds to the lack of nourishment, we do note this difference; the process may be lost under systemic conditions which appear to affect the other bodily tissues but slightly."

(b) Exciting Causes.

That the human race has for many centuries suffered more or less from systemic disorders there can be no shadow of doubt; and the important status of the "medicine man" in primitive communities of the present day precludes any assumption that they are immune to systemic disease while only civilized peoples fall victim; it is reasonable then to assume that there are extraneous causes for the increase in the incidence of excessive ridge atrophy among the edentulous. That we have always had a certain proportion of such cases is granted; but that the ratio has increased may be gathered from the many articles that have appeared in the current dental literature of the last few years dealing with such subjects as 'Tissue changes under dentures', "Stabilising dentures' and 'Methods of relining dentures'.

From the weight of expressed opinion the

underlying causative factor in excessive alveolar atrophy may be said to be 'trauma', with a lesser number of writers favouring a too excessive surgery, though the effects of either, or both, may be greatly accentuated by an accompanying systemic disorder.

The term 'trauma' is comprehensive; and includes the result of faulty impression technique, disregard of the biologic aspect in failing to avoid compression of the blood and nerve trunks upon which the tissues rely for their maintenance and tone, and failure to secure a maxillo-mandibular relationship that will permit a balanced contact of full upper and lower dentures, allowing free gliding of the occlusal surfaces of the teeth during speech and mastication.

Some years ago the writer came to the conclusion that with the means at our command, the human mandible being articulated as it is, and subject to the action of some of the most powerful muscles of the human anatomy, to obtain balanced occlusion, and a free gliding of posterior occlusal surfaces during function was an utter impossibility; the anatomic posterior tooth with its interdigitating cusps and broad bucco-lingual surface will be discussed in detail at a later stage as the arch offender in traumatism.

Under the heading of trauma, or traumatic occlusion may be grouped those cases amounting to deformity that result from the too long retained lower anterior teeth occluding with a full upper denture and absence of posterior balance; also,
R. Gillis\(^{(9)}\) thirteen causative factors in extensive ridge atrophy, including over-post-damming and over-extended denture borders; in short, any denture condition or combination of occlusal forces that will cause a rocking occlusion or tilting of dentures, or that will necessitate a denture wearer to seek some abnormal closure of the jaws as a position of least discomfort.

Schlosser\(^{(17)}\) maintains that malocclusion is one of the most prevalent causes of failure of artificial dentures, and results in irritation and atrophy of the mucosa and underlying bony structures.

French\(^{(18)}\) suggests that any form or arrangement of the teeth that will produce excessive pressure at certain points with a corresponding pull in opposite points leads to atrophy.

McNeely\(^{(19)}\) says extreme interference in occlusion would cause pathological conditions that result in rapid resorption of the alveolar bone.

Wright\(^{(20)}\) asks, "are we certain that the dentures are not contributing to resorption? ...... when atrophy occurs under newly constructed dentures the occlusion is first disturbed; unbalanced occlusion

17 R. O. Schlosser \ Journal of the American Dental Association 1923, P.803

18 F. French \ Ibid 1924, P.929

19 C. McNeely \ Ibid 1931, P.938

20 W. A. Wright \ Journal of the American Dental Association 1929, P.1027
results, causing atrophy". Many of us, if we
cared to admit it, must have asked ourselves the
same question, and been satisfied in blaming the
method or instrument by which we had obtained
occlusion rather than face the fact that by using
anatomic posterior teeth we were contributing to
our own undoing and causing irreparable damage in
the mouths of our patients; or else we have
failed to grasp the fundamental fact that full
denture prosthesis is a matter of applied mechanics,
wherein mechanical laws must be observed if we are
to achieve the success merited by all earnest
endeavour, or to be overtaken by disaster should
those laws be disregarded. De Van (21) deals with
this subject, but till recently little attention
has been paid to the pure mechanics of 'force'
as may be demonstrated in the mouth.

Provided dentures have been constructed on
casts made from properly developed impressions,
attention having been paid to relief areas to
insure freedom from over-compression of blood and
nerve trunks, and absence of strain on hard areas,
and provided also that the occlusal surfaces of the
posterior teeth are in balanced contact, vertical
force, that is, the direct thrust delivered by the
occlusal surfaces of the mandibular posterior teeth
against the occlusal surfaces of the maxillary
posterior teeth, is countered by the bony tissues
underlying the mucosa on which the dentures rest;
the semi-fluid mucosa absorbs some of the shock,
recoils when the pressure is released and resumes

21 M. M. De Van The Dental Cosmos. 1933, P. 394
a state of rest, having received physiological stimulation in the process; its normal position on the bone not having been disturbed. On the other hand, a horizontal force, such as is produced when the mandible, sliding into lateral or protrusive positions during function, meets some obstruction to the free passage of the occlusal surfaces one over the other, there being no counter forthcoming from lips, cheeks, or tongue, all motile tissues, such force or thrust must, of necessity, be taken by the mucosa upon which the dentures rest, and delivered as shear, or torsion to the underlying bony base from which it is being dislodged in proportion to the magnitude of the obstruction, i.e., height of cusp, and the tension of the muscles of mastication; alveolar bone being cancellous, and therefore not designed to withstand strain of torsion as is dense, cortical covered, medullated bone, reacts by a decrease of cancellations and formation of marrow spaces, as demonstrated by E. C. Pendleton. Many writers contribute to the general belief that trauma, either from the shape of the occlusal surfaces of the posterior teeth, their general arrangement in artificial dentures, (or both), is the most potent exciting cause of degeneration of the alveolar ridges in the edentulous case.

Still another factor possibly contributing to the loss of cancellous bone may be the too radical removal of alveolar bone when surgical extraction is performed, or when the ridges are prepared for the immediate insertion of dentures.
De Van (22) considers the alveolectomies he has advised as the greatest blunders of his life, realising that cancellous bone does not grow from the periosteal flap.

Cocker (23) is averse to radical surgery, advising the making of a flap, removing the teeth, leaving the lingual and labial walls.

Tench (24) says: "ridges do not grow; every vestige that is healthy should be left intact, .... not more than the gingival third should be removed and the spiculae smoothed off."

The writer has had some extreme examples of ill-advised alveolectomy upon which to construct dentures, but thinks that with the better understanding of the requirements for full dentures, especially where immediate restoration is practised, and when the operation is performed by the dentally trained, rather than by the medically trained surgeon, we may face the future with confidence; dismissing surgical extraction and alveolectomy as even possible causative factors in tissue atrophy, realising that failure on the part of the patient to have primary dentures serviced is the more potent factor leading to progressive alveolar atrophy through the irritation arising from rocking dentures, the lower especially,


23 J. Cocker The British Dental Journal 1932, P.394.

where the disadvantages are great compared to the upper with its hard palate to prevent the burying of the buccal flange in the soft tissues.
EFFECTS.

Teeth, not being organs in themselves but only part of the digestive system generally, their primary function is to so deal with food that it may be finely triturated; the bolus, in the process, being aerated and ensalivated in preparation for exposure of the greatest possible surface to the digestive juices of the stomach; the unhappy individual with excessively resorbed ridges bearing unstable dentures, unable to masticate food properly, bolts the greater part of the solids ingested without their having had a chance of being either triturated or ensalivated. The human stomach, unable to deal with such solids, rebels, and passes on a mass of undigested material with a twofold result; 'indigestion' with all its sequela, and physical reaction to the loss of the nutrient elements contained in the food.

The writer prefers the term 'triturate', ("to grind with the molar teeth, to masticate thoroughly")\(^{25}\) to 'commute', ("reduce to small fragments")\(^{26}\); the former implies lateral movement of the mandible; the latter could be accomplished by an up and down movement only; the bicuspids may be said to 'commute', while the molars 'triturate'.

Carbohydrates suffer the same precipitate passage from lips to gullet; predigestion by the ptyalin in the saliva being negligible; whatever


26. Ibid.
ptyalin may be swallowed with the food acts only until stopped by the acid peptic fluids, hence the frequency of a 'starch dyspepsia' associated with these cases, as the pancreatic enzyme cannot be expected to do more than its allotted task of completing the work that should have been begun by the ptyalin in the mouth.

Painful and debilitating as these physical reactions may be, the writer thinks the mental effect is the more health and peace-of-mind destroying.

The excessively resorbed ridge case wearing unstable dentures can usually be recognised at a glance; the lips and cheeks are in-drawn in a sustained effort to keep the dentures in place, giving a grim, tight-lipped, non-smiling appearance that may be greatly at variance with the true character of the individual. The tongue, pressed in behind the lower incisors, cannot be spared for use in phonation, the individual creating a habit of speech with the least possible opening of the jaws, the edges only of the lips being used, till it becomes almost, if not quite a matter of 'speaking through the teeth'; a serious handicap to those whose calling in life requires distinct enunciation and freedom of expression.

The tale of woe that usually begins before the dental chair is reached is invariably of an upper denture that falls down, or out, when laughing, coughing, putting a spoon in the mouth, etc.; a lower that floats about, making speech difficult and mastication impossible; the discomfort, or even pain,
of juggling the lower denture back into position; bruised feeling of the gums, particularly in the upper anterior region, recurrent sore spots. Probably one or more dentures, or sets, are tendered as evidence of a long and expensive search for denture comfort.

The mental condition of these cases calls for much tact and sympathy, as well as understanding, on the part of the operator.

The self-consciousness engendered by the dread of 'making an exhibition in public' is not the least of their troubles. Their inability to indulge in a hearty laugh, sneeze with satisfaction, yawn with freedom, or perform any of those physiological exercises that cause spasmodic contraction of those muscles that have lost their normal bony insertions, or are being deflected by denture borders, tempers the joy of living to an extent that can only be fully appreciated by one of this group.

Unfortunately few of us reach that so desirable physiologic state of being readily able to "argue from without", that it is difficult for the prosthetist with a dentate mouth to fully appreciate the situation.

The writer may be permitted to state that she speaks from the position of having extreme examples of both 'flabby upper' and 'flat lower' so is able to view the matter from both subjective and objective angles. Up to about eight years ago every full denture technique (or so it seemed), that had been advanced in the previous fifteen years
had been tried, in all sincerity, by one or another professional friend. A clue to one possible cause of discomfort came from the chance remark of an old lady who had worn the same dentures for over twenty years, ordinary vulcanite bases, with flat, narrow, shapeless posteriors; and for whom the writer had constructed new dentures with anatomic posteriors, the inter-digitating cusps articulated on an anatomic articulator, face-bow and other details of procedure having been faithfully carried out. The old lady, after wearing the dentures for a few days asked plaintively "couldn't she have the back teeth picked off her old plates and put on the new ones instead of the big, broad, bumpy things that wouldn't let her chew, and left no room for her tongue".

The writer then began investigating possible causes of this malady, and having such excellent examples always on hand with which to experiment, has gradually evolved a technique for treatment that has met with great success in her own and similar cases. Failures there have been, of course, but the percentage is small and only serves to spur one on to still greater effort to find a means of giving the greatest possible comfort to established cases, and minimise the incidence of excessive atrophy in those not yet so afflicted.
PREVENTION.

In suggesting measures to combat the predisposing causes of alveolar ridge atrophy, the field is so wide that it can only be touched upon.

Ante natal care, preservation of the deciduous dentition by diet and prophylaxis, the maintenance of the permanent dentition, each is a subject in itself upon which extensive research by such workers as May Mellanby, Weston Price and McCollum, is being carried out all over the civilized world. Scott (27) says: "preventive dentistry, a virgin field --- means the insurance of oral health and the postponement of the edentulous state."

As practising dentists we may all do our share by instructing our patients in matters of oral hygiene and diet as far as our present information will permit; and here the writer cannot resist the opportunity of emphasising the need for teaching the average individual how to wash out the mouth!

'Washing out the mouth' sounds so very simple that at first glance the matter might be dismissed with a shrug of the shoulders. From observation, however, the writer has come to the conclusion that very few people know how to perform this simple operation; probably the drinking of hot or iced liquids has so firmly established the habit of drawing the buccal and labial muscles against the teeth, that association of ideas subconsciously leads to the same procedure when water, intended

27 E. J. Scott Dental Items of Interest 1935. P.125.
to cleanse, is taken into the mouth; any value that tooth brushing may have is negatived by failure to expel all the dislodged finely-ground food remnants together with stagnant saliva with its content of globulin precipitated from the mucous, much of which remains to be forced into occlusal and gingival crevices by the next meal.

It is our duty to point out the need for orthodontic treatment; nor should we lack the courage to advise extraction in gross overcrowding of one or both arches, of third molars for which it is patent there will never be sufficient room, nor of overfilled and overtreated teeth of which the retention so often results in a condition necessitating extensive bone removal before the tooth can be dislodged.

We have it in our own hands to restore tooth surfaces consistent with the age of the patient when inserting fillings, and we are in a position of being able to stress and explain the need for partial denture service, not only for the restoration of lost functional occlusal surfaces, but that standing teeth may remain in function where otherwise they might drift, converting harmonious into disharmonious occlusal relation. Also, when the loss of posterior teeth throws the burden of mastication on the anteriors, adequate partial denture restoration will avert that condition of gross malocclusion leading to pyorrhoea and irreparable loss of supporting alveolar bone; with, perhaps, ill-health from toxic absorption and undermasticated foods. Still another safe-guard in partial denture service
is the prevention of dis-use atrophy so frequently seen in edentulous spaces.

There is great diversity of opinion on the value of calcium therapy, but rather than decide against its usefulness, the writer, as a general practice, and in conjunction with the medical adviser, suggests diet, and calcium medication on the extraction of any number of teeth; giving the patient the chance of any advantage to be gained therefrom. If, as many writers suggest, teeth are lost through disturbance of mineral metabolism, the logical deduction is that the ridges will also disappear to a greater or less extent if this condition persists without some effort being made to improve the systemic condition.

The writer thinks that when blood, endocrine, and allergic tests become less costly, such tests will be secured as a matter of routine in all cases of threatened progressive degeneration of tooth and alveolar tissue not directly traceable to traumatic causes; then we may be able to avert not only the incidence of excessive atrophy, but maintain the natural teeth in a greater number of cases.

A. Y. Russell (28) advises proper diet and exercise as a help to denture stress-bearing areas, and Page (29) thinks systemic treatment is advisable in nearly all denture cases.


29 M. E. Page Ibid. 1935, P.52.
F. H. McKevitt suggests several possible ways of fortifying against atrophic change, viz., proper surgical procedure, good prosthetic dentistry, vitamin and glandular therapy.

C. Lane thinks we can prevent most of the bone degenerative cases by balancing the diet and supplying the missing vitamins.

R. McCausland says "the part dentistry plays in maintaining normal healthy bodies becomes a very important one, and no dentist should look upon the oral cavity today as an inanimate piece of mechanism that requires simply mechanical restoration of its parts .... Good health depends on good digestion, of which a well balanced masticating mechanism is a prerequisite."


31 C. Lane Ibid. 1931, P.312.

TREATMENT.

When the pendulous ridge case is complicated by the presence of hypertrophied tissue due to the wearing of an ill-fitting denture, an excessive amount may require surgical excision; when, however the amount is moderate to small, rest from the offending denture or reduction of an overextended flange with the frequent and vigorous use of a mouth wash for a few days will usually clear the field sufficiently to allow an impression to be taken. As a mouth wash, the writer finds a solution of Magnesium Sulphate superior to the many preparations tried over a period of years; it is inexpensive, and the patient readily understands the instructions, "one teaspoonful of Epsom Salts dissolved in one cupful of boiling water", the solution to be made freshly each day, as Epsom Salts does not make a stable watery solution. A demonstration of how to blow out lips and cheeks should be given; the increased flexibility of the buccal and labial muscles as well as reduction of morbid tissue amply rewarding the operator for the time spent on demonstrating. Objection voiced by the patient to the taste of Epsom Salts can be countered by explaining that unless the solution be gargled or swallowed, any taste will hardly be noticed, as the taste buds appreciating this and similar solutions are situated at the dorsum of the tongue.

It is interesting to quote here that B. B. Badanes\(^{(33)}\) says: "Black found the sticky

\(33\) B. B. Badanes The Dental Cosmos. 1935, P.307.
material which forms an insoluble film on artificial dentures as well as on the natural teeth, to be composed of globulin (from the mucous secretions)". This material which also constitutes the organic basis of salivary calculus, and cannot be washed away under running water, Black called "agglutination of calculus". The only harmless substance that may be used often in the mouth which will help to dissolve it ...... is a solution of magnesium sulphate or magnesium chloride in a concentration of not over one per cent."

The wisdom of surgical removal of the pendulous ridge and freeing of muscle attachments is a moot point; impression taking would certainly be simplified, but there are other factors to be considered. In proportion to the amount of tissue removed so would the weight of a denture be increased; also, there would be so much less 'buffer' tissue between the denture and the already degenerated bony ridge more often than not sharply serrated, as may be seen in so many Roentgenograms; also, we should lose the tough keratinised epithelium described by Rowe(34) which is peculiar to the ridge mucosa, and so much better fitted to withstand whatever denture pressure is allowed to fall upon it, than is scar tissue which may be dense, inelastic, and troublesome, as pointed out by R. Tench.(35)

In any case the secondary stress-bearing

areas would still have to bear the brunt of the greater part of the denture burden.

Pendleton (36) considers any surgical interference for the removal of soft tissue or correction of low muscle attachments "an unwarranted practice"; this writer's research on the minute anatomy of the tissues likely to be affected by the wearing of dentures reveals a padding of the buccal and labial muscle insertions, also a layer under the oral ridge mucosa, composed of connective and adipose tissue which confers a considerable degree of elasticity upon the soft tissues favourable to denture retention and comfort.

Wright, who says he operates sometimes.

Fig. 11.

but does not press the point, has recently published (37) micro-photographs of the human oral mucosa that are of special interest to the


37  W. H. Wright  The Dental Cosmos. 1936, P.903.
prosthetaist, (Figs. 11, 12, 13). In the reproductions of Dr. Wright's illustrations Fig. 11 contrasts the mucosa of a lad with that of an adult, showing the relatively greater depth of epithelium in the adult, though the general characteristics are the same; the loose connective tissue, the element giving elasticity to the mucosa is shown in abundance.

Fig. 12 also shows the underlying connective tissue, though as pointed out in the text, the presence of round cells denotes some inflammation, and there is absence of the cornification of the epithelium (keratinised layer) shown in Fig. 13; but with a properly developed impression it is reasonable to expect greater comfort from, and tolerance of, a denture than would be the case were the underlying elastic cushion removed.

Although Beube and Silvers have actually succeeded in securing regeneration of alveolar bone in dogs' jaws, by implanting a bone meal, with our present knowledge we cannot hope to do

F. E. Beube → Journal of Dental Research
more for the human with excessively resorbed alveolar ridges than so construct our mechanical replacements that they will be in harmony with the physiological and biological requirements of human tissues, and that they satisfy the aesthetics; but, by a better understanding of the causes of this atrophy, we may lessen its incidence in our patients who may ultimately become edentulous, and prevent its further progress in those who have already reached that unhappy state.
A. FULL DENTURE CONSTRUCTION.

That full denture construction, given the most favourable conditions, is considered a difficult and complex problem by workers in the prosthetic field may be gathered from a few expressed opinions taken at random.

Sims (39) "the time will never come when dentures can be made without effort .... nothing will ever render it an automatic proceeding."

Frahm (40) "the present day study of denture construction for the edentulous patient is a complicated one with little prospect for simplification of principles and methods of procedure."

Wilson (41) "there is no legerdemain associated with prosthesis, the profession being only an expression of cause and effect; therefore it behoves us to cultivate thoughtfulness and thoroughness."

Hair (42) "the most trying and difficult branch of dentistry today is that of full denture restoration."

Rowe (43) whose so tragic death occurred recently said: "today the construction of a denture


41 G. H. Wilson Dental Prosthetics, 1920. P.64.

42 I. M. Hair Journal of the American Dental Assoc. 1924, P.1176.

43 A. T. Rowe The Dental Cosmos. 1936, P.58.
has become a complicated procedure."

Doxtater,\(^{44}\) however, strikes a more optimistic note when he tells us that "the construction of satisfactory upper and lower dentures is a very simple procedure and a branch of dental science that any man with average intelligence can master if he is willing to adhere to a few fundamental principles."

Dr. Doxtater may be right, but he stands more or less along; C. N. Johnson\(^{45}\) thought the full denture worker merited a whole editorial in the form of an open letter; and the amount of literature generally on this subject is a testimony in itself that the matter may not be so airily dismissed as Dr. Doxtater would have us believe were possible; also, while discussions continue to range round 'rotation centres', 'occlusal curves', 'Bonwill's triangle', the 'Monson spherical theory', 'condyle paths', and whether the mandible is a lever of the first, second or third class, it is difficult to determine what really are the fundamental principles.

H. Lytton\(^{46}\) writing in 1931, found from a survey of ten years of five dental magazines that more writers were interested in articulation and occlusion than in any other phase of full

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44 T. W. Doxtater Dental Items of Interest, 1933. P.983

45 C. N. Johnson Journal of the American Dental Assoc. 1934, P.509

46 H. Lytton Journal of the American Dental Assoc. 1931, P.1220
denture construction; and forecast a time when the better understanding of the anatomy of the denture-seating areas would lead to as much attention being paid to those areas as was then being paid to the temporo-mandibular articulation.

In fulfilment of this prophesy, the work of E. C. Pendleton and E. C. Pendleton and H. Glupker on the minute anatomy of the denture-bearing and adjacent areas has appeared; and is a most valuable contribution to the dental profession, the prosthodontist particularly acquiring a knowledge of inestimable worth in planning dentures for every type of case.

Every constructive effort comprises two factors, the plan and the execution; and every completed structure rests upon a base or foundation; the denture bearing areas of the jaws become the foundations for the structures, full dentures, and the first step towards their construction is an understanding of the nature of the tissues concerned, and their possible reaction to the demands made upon them by the wearing of artificial teeth. The law of equal reaction for every action demands that we understand which areas are best suited to withstand the thrust delivered through dentures in function, that the thrust and recoil may serve the physiological requirements of tissue stimulation, and which parts must be protected from over compression or distortion, so avoiding anaemia, trauma, and atrophy of those tissues.

The last mentioned writers demonstrate the remarkable similarity in general arrangement of the tissues lying between the bone and oral epithelium
in the various cases examined, male and female, varying in age between thirty-eight and eighty years, and an infant six weeks old; individual differences there are, of course, but the edentulous case presents four main features.

1. Primary stress bearing areas.
2. Relief areas.
4. Valve producing areas.

1. In the maxilla, the primary stress-bearing area is the residual alveolar ridge; cancellous bone overlaid by dense fibrous connective tissue, extending from the point of insertion of the buccal and labial muscles to the compressible structures at the base of the ridge on the lingual surface, at the junction of the ridge with the vault of the palate. Fig. 14 illustrates the type of cancellous bony tissue upon which vertical thrust will fall; while Fig. 15 gives an idea of the character of the soft tissues upon which the denture will rest, there being an abundance of fibrous tissue.

47 E. C. Pendleton Journal of the American Dental Assoc. 1934, P.491
connective tissue interspersed with mucous glands and fat, assuring an elastic cushion, or 'shock absorber' between the denture and underlying bony tissue.

Fig. 16.

2. Relief areas may be subdivided into:
(a) the inter-maxillary suture, or median raphe, from the incisive foramen to the posterior border of the palate; the bone is dense and compact, usually covered by tense, inelastic mucosa, obviously a bar to the comfortable settling of a denture into the more resilient adjacent tissues. Fig. 16

Fig. 16.


clearly shows the marked thickening of the bone and the different character of the covering mucosa compared to the padded appearance immediately beyond the bony ridge.

(b) The rugae, a highly vascular area which it is unwise to compress unduly; the writer has found many cases of so-called 'rubber-sore-mouth' react in a quite remarkable way when fitted with a new vulcanite denture in which increased accommodation had been made for the rugae by relieving the impression prior to pouring the cast, the impression having been secured with minimum pressure.

(c) The anterior and posterior palatine foramina as may be seen on many skulls, are not always protected by a bony lingula; therefore compression over these areas would seriously affect the tone of the palatine and lingual ridge mucosa and periosteum. Also, there are cases where the outward curl of the bony lingulae over the posterior palatine canals require this relief to prevent trauma, possibly followed by ulceration, of the mucosa as it is pinched between the denture and lingulae.

3. Secondary stress-bearing areas have an additional importance in the excessively resorbed maxilla, and comprise all the vault of the palate other than the relief areas; the sub-mucosa of loose connective tissue, mucous glands and adipose tissue insures a resilient foundation which may, within limits, be compressed.

Figs. 17 and 18 give a good general idea of this elastic area and its value as an adjunct
to the primary stress-bearing area --- indeed it might be said that in many excessively atrophied cases to assume the whole burden of bearing the denture.

**Fig. 17.** (50)

**Fig. 18.** (51)

4. Valve producing areas lie, bucco-labially, between the base of the ridge and the points of muscle attachment, continuing round the tuberosities if the movable structures will permit. Lingually, just over the junction of the hard and soft palates the amount of loose connective tissue, mucous glands and fat running forward on either side of the

50 E. C. Pendleton  )  Journal of the American Dental  

51 E. C. Pendleton  )  Ibid. 1934, P.497.
median suture, yields a firm elastic base that will withstand considerable compression, and serves as a post-dam area. Fig. 19 shows the increase in thickness of the soft area adjacent to the ridge and explains why extra compression may be used.

1. In the Mandible the primary stress-bearing area is limited to that portion of the residual alveolar ridge situated between the muscle attachments bucco-labially and lingually.

2. Relief may be required over the lingual, labial, and buccal fraena, over the genial tubercles, the glosso-mandibular glands, and the mental foramina when excessive atrophy has reduced the height of the ridge to close approximation of these points; also, when Roentgenography discloses a thin serrated ridge crest, irrespective of the appearance of the ridge mucosa, this must be classed as a relief area, and provision made, either in the impression technique or by relieving the impression itself prior to casting. Relief over the buccal plate of the mandible between the ridge base and muscle attachments, if the denture may be carried out to the external oblique line, is a sound precaution.
when it is remembered how this plate thickens at
the expense of the cancellous bone; failure to
relieve excessive pressure in this region may explain
the 'bone weariness' experienced by wearers of
dentures that otherwise function satisfactorily.

3. Secondary stress-bearing areas in the
mandible are, in the main, conspicuous by their
absence; especially in the excessively resorbed case,
unless we except what may be an exceedingly narrow
strip of elastic tissue beneath which the lingual
and bucco-labial muscles are inserted:— Pendleton
describes the highly elastic nature of this layer
Fig. 20, as capable of bearing considerable compression.

4. Valve producing areas in the mandible are
limited to the retro-molar pads, when the muscle
attachments permit their inclusion in the denture
covered area. These pads should be used to the

52 E. C. Pendleton Journal of the American Dental
Assoc. 1934, P.501.

53 Ibid Ibid. P.489.
maximum extent, not only as seal or post-dam areas, but as the nearest approach to secondary stress-bearing tissue the 'flat lower' with closely approaching muscle insertions has to offer; the abundance of elastic tissue Fig. 21, underlying the mucosa will stand sufficient compression to justify the application of post-dam wax to the lower impression prior to casting.

The visible factors to be considered in full denture construction are

(a) The visible condition of the tissues to be used in supporting dentures.
(b) The oral secretions.
(c) The form and size of the denture base area.

(a) has already been discussed to some extent, and is more or less bound up with (b); both oral mucosa and secretions being affected by the patient's systemic condition; disturbance due to under-masticated food is invariably reflected in the quantity and quality of the saliva; while due to the wearing of ill-fitting dentures, the mucosa may show localised or diffuse inflammatory areas. An almost, if not quite, liquid diet, disuse of the dentures for a few days, and vigorous use of a mouth-wash will invariably produce a condition allowing the operator to proceed with taking impressions; it may be worth while, especially if the bite is to be opened to any extent, to line the existing dentures with modelling compound, thus gradually introducing the new jaw relations, and protecting the tissues from further trauma in the one operation.
The effect of self-consciousness engendered by floating dentures on the mental condition of the patient must not be overlooked; nervous reaction may play a considerable part in inhibiting the flow of saliva.

(c) the size and shape of the denture base must be determined by the border tissues, to be discussed in the next section under the general term 'Musculature'.
B. MUSCULATURE.

In proportion to the amount of alveolar resorption in the edentulous case, so does the question of the oral and facial musculature obtrude itself; the 'border tissues' of the ideal case are more or less easily managed by the intelligent application of a sound impression technique; but where alveolar atrophy has progressed toward, or down to the basal bone, those muscles whose fibres overflowed the conventional origin, or insertion, "at the junction of the alveolus with the body of the bone" and had attachment to the surface of the alveolus or maxillary tuberosities, are now left with only an insecure anchorage to the under surface of the movable mucosa. It is imperative then, that the operator be familiar with the normal arrangement of such muscles as may be affected by denture borders and surfaces, that departure from the normal may be taken into account when securing impressions and mapping denture outlines.

Ewell Neil\(^{(54)}\) has given us a concise summary from the detailed anatomy of such writers as Gray, Cunningham, and Spalteholtz of those muscles occurring as border tissues in full denture construction; stressing the importance of recognising the angle of insertion, or origin, of muscle fibres in action and their possible reaction to over-extended denture borders.

Muscles acting from an acute to a right angle to the perpendicular of the ridge crest are

54 E. Neil Full Denture Practice. 1924.
potential denture dislodging forces when deflected by the denture border; obtuse angled attachments, if encroached upon would be traumatised by compression between the denture and underlying bone, while muscle fibres running at an oblique angle may, on tension, break the denture peripheral seal, or may suffer trauma from compression between the denture border and underlying bone.

This view is of considerable importance in ridgeless restoration cases, explaining the ease with which dentures may become dislodged, and the difficulty of overcoming trauma of the soft-tissues.

The unique position of the oral and facial muscular groups is worthy of note; they are without a covering sheath, have no tendinous attachments, and do not move bone on bone. The two first characteristics lend themselves to aberration of fibres, while the third accounts for the interaction of various groups and gives the tongue and facial muscles their great mobility. Tait McKenzie (55) deals with this question, while the work of Drs. Lightoller (56) and Burkitt (57) is of considerable interest to the full denture prosthetist.


Ibid Ibid. 1928.

57 A. N. Burkitt G. S. Lightoller) Ibid. 1928.

Ibid Ibid. 1929.
These two last named writers, in their research on the facial muscles of European and aboriginal heads, disclose a much more intricate system than one gathers from the writings of the earlier anatomists. Fish\(^{58}\) gives a very clear outline of Dr. Lightoller's Modiolus, showing how muscles entering into its formation, especially the buccalis, may be used as a denture stabilising force by so shaping the denture bucco-labial surfaces that they receive the maximum support from these tissues with the tongue as counter.

A. T. Rowe\(^{59}\) deals with the same subject, but in a less detailed way.

There is, however, much more to be learned from Drs. Lightoller and Burkitt; the absence of muscle sheath, the tissue attachment of muscle fibres, together with the intimate association of the whole facial system, renders the dissection of the ultimate fibres of these groups so difficult as to be impossible (personal remark by Dr. Lightoller). The action and counteraction of labial, orbicularis oris, infra-orbital and nasolabial groups, the muscles of expression and phonation, together with the components of the modiolus as detailed by Dr. Lightoller is too lengthy and technical to attempt to quote here; but a study of the work explains, for instance, how, when pursing the lips as in whistling, or pronouncing such words as 'mouse',


59 A. T. Rowe The Dental Cosmos. 1936. P.50.
'make', 'why', 'when', the pull to an acute angle of the labial muscles by the contraction of the orbicularis oris, a potential denture dislodging force comes into play. Also, in those physiological exercises during which the angles of the mouth are drawn backward, the labial muscular groups are affected by muscles as remote, in the maxilla, as the infra orbitalis, and in the mandible by the quadratus lateralis inferiores and the pars labialis platysmae; in either case the denture peripheral seal may be broken, the dentures becoming unseated, or perhaps only slightly displaced; but the juggling back into position causes embarrassment and pain -- Sims(60) describes it as "great and intolerable pain."

Other writers, including Schlosser, give detailed accounts of the muscles involved in full denture construction, but the writer has failed to find any reference to the possible trauma and dislodging force resulting from the tensing of muscle fibres when the pendulous mucosa into which they are inserted is held in a distorted position by a denture developed from an impression in which this possibility has not been taken into consideration.

Dr. Lightoller's diagrams of the facial muscles that are of particular concern to the full

denture prosthetist are shown in Figs. 22, 23 and 24.

Fig. 22.  

Fig. 23.  

Fig. 24.

The writer is indebted to Dr. Lightoller for the loan of the works mentioned, and the gift of the copy from which these illustrations were taken.

Dr. Fish, who places so much emphasis on the value of the buccal and labial muscles as aids in stabilising dentures has interpreted Dr.
Lightoller's and Dr. Burkitt's work as shown in Figs. 25 and 26.

Fig. 25.

Fig. 26.

From the point of view of impression taking, the vestibular muscles, upper and lower, up to the maxillary tuberosities and as far back as the retro-molar region, may be considered together as border tissues; the buccinators and labial groups on tension, as with the mouth widely open, form an acute angle to the perpendicular of the ridge crest; lateral tensing from the action of the modiolus, orbicularis oris, and more remotely attached facial muscles creates an oblique angle; excursion in either direction must be permitted by a denture.

In the excessively resorbed ridge case, additional border tissues may require consideration; when the maxillary tuberosities have disappeared the aberrent fibres of the lower head of the internal, perhaps also the external, pterygoid may not only obliterate all trace of a pterygoid notch, but may prove a formidable denture dislodging force, if, unrecognised, they are confined in the impression in a relaxed condition. In the widely open mouth
position, these muscle fibres are extended, and palpation with a small mouth mirror or large ball burnisher will disclose the degree of encroachment upon the tuberosities; if the mouth be only partly open the yielding of the mucosa and the retreat of the muscle fibres before the instrument, mislead one into the belief that a pterygoid notch exists as an adjunct to the stabilising of a denture; tension on these muscles however, as they pass downward, outward and backward to the inner surface of the ramus, or body of the mandible, or both,\(^\text{61}\) is at an acute angle to the denture border; if the patient is to be permitted to yawn or laugh without disaster, provision must be made for the free play of these fibres in the impression technique.

R. Tench\(^\text{62}\) mentions "fraenum like bundles of dense tissue" in the tuberosity regions; Figs. 27 and 28 are photographs of a partly open, and widely open mouth clearly illustrating the different

\(^{61}\) H. S. Gray Human Anatomy. 1858.

degrees of tension of the strong muscular band referred to above, in this case unilateral; with the mouth only partly open, the muscle strand yielded to slight pressure from a mirror-head, and its presence right on to the occlusal surface of the tuberosity was not evident till, the mouth being held widely open, the blanching of the mucosa was sufficient evidence without the corroboration of the drum-like tension against the mirror-head that a strong dislodging force would operate against a denture not giving free play to the muscle in action.

Of the six pairs of palatal muscles, most writers suggest that only one pair, the tensor palati, is likely to be a disturbing factor at the posterior border of the upper denture; whilst, in most mouths the others are relatively inactive and may be employed in making a post-dam, an important factor in denture equilibrium, especially the middle pair running farther forward than the junction of the hard and soft palates, and so plentifully surrounded with fatty and loose connective tissue as to support a considerable degree of compression without being traumatised.
THE MANDIBLE.

In the edentulous mandible the arrangement of the border tissues differs so greatly from their normal disposition that, as MacMillan (63) says "the textbook description of the muscle attachments to the mandible does not apply to the edentulous case". The encroachment toward the ridge crest, in the excessively resorbed case creates the difficulty of constructing stable comfortable dentures, and the only solution of that difficulty is to apply an impression technique that will give freedom of action for those muscles requiring it, when we recognise which they are and how to locate them, being prepared to find irregularities either unilaterally or bilaterally.

Labially all those groups of muscles attached normally to the mandible 'at the junction of the alveolus with the body of the bone' including the mentalis, may appear, on stretching the lower lip upward and outward, to come almost from the ridge crest; the labial fraenum is the only portion of this system that will not support a certain amount of compression from a denture, the connective and adipose tissue surrounding the muscle fibres themselves give a certain amount of cushioning, provided the denture be kept thin and does not restrict the flexure of the tissues.

The buccal fraena usually proclaim themselves, but the muscle itself as it passes upward, backward and inward to its insertion in the pterygo-mandibular

ligament, may turn so far forward as to partly, or even completely obliterate the retro-molar triangle; Sims (64) quotes a case where this muscle was
stretched across the space usually occupied by the second molars.

With the mouth widely open the drum-head tension of the mucosa suggests the possible denture dislodging force that may be encountered if the denture is made on a cast developed from an impression with this muscle in a passive state; also, the widely open mouth brings into play those aberrant fibres of the buccinator that encroach beyond the external oblique line toward the ridge crest.

At this point the masseter, not ordinarily regarded as a border muscle, may require that the denture periphery be so shaped that it will not trauma\mize that powerful muscle during mastication; here the open mouth does not help us in determining the line of denture border, a well fitting trial base plate that may be trimmed away is required.

From the oclusal aspect, passing over the retro-molar triangle, the area may be quite free from encroachment, ready to be used as a valve seal area; or, a tendimons slip from the temporal muscle may not be restricted to the distal border of this area, but may extend farther forward, blending with the buccinator, or with the distal fibres of the mylo-hyoid; over extension of the denture border here would cause trauma during mastication on the acutely tensed temporal fibres while the acute to oblique

stretch of the buccinator in the open mouth position would provide a denture dislodging force.

From the retro-molar triangle into the retro molar fossa, or lateral throat area, the pterygo-mandibular ligament with its associated structures may allow a considerable extension of the denture lingual flange; or, the superior constrictor of the pharynx with perhaps an accompanying slip from the pterygo-glossus may be attached as far forward as the second molar region, Gray.\(^{(61)}\) With the mouth widely open and the tongue raised or drawn backward, one may often detect this muscle as a hard, cord-like structure passing outward and backward at an oblique angle to the ridge-crest; being associated with the tongue, during the raising of the floor of the mouth as in phonation and deglutition, a denture not constructed to give freedom of movement would meet a strong dislodging force; while, in the passive state, compression, during mastication, of the muscle between the denture and underlying bone

![Fig. 29.](image)

produces intense pain, the traumatised area readily becoming ulcerated. In Fig. 29 at S.O.M. Pendleton\(^{(65)}\)

shows the superior constrictor approaching the residual alveolar ridge, R.A.R., in the second molar region. It might be noted also, that Pendleton points out the marrow spaces, B.M., that denote an absence of cancellous alveolar bone.

Fig. 30 is the photograph of a cast of a practical case in which there was no possible extension of the denture flange into the lateral throat area; the retro-molar triangles were both obscured by muscle attachments, and on the right side, with the mouth only partly open, a fibrous band, indicated by pencil marks, could be caught by tweezers and moved from side to side; with the mouth widely open, and the tongue raised, the tensing of this band could be clearly felt by a palpating ball burnisher, the blanching of the mucosa being further evidence of tension.

The next border tissue to be considered is the mylo-hoid muscle which, as Neil points out rises and falls with the action of the tongue through the association of the hyoid bone attachment of both the mylo-hyoid and the hyo-glossus; normally, the right angled inclination to the perpendicular of the ridge-
crest would insure freedom of action for this muscle unless it were deflected downward by the denture border; but here again text book description of this muscle does not convey an idea of the drift toward the ridge crest of aberrent fibres, and the passing upward along the inner surface of the ramus, of vertical fibres that may become continuous with the temporal tendon in excessively resorbed cases; this area, then, requires that an impression be secured with open mouth, raised protruded tongue, and restricted depth of impression tray.

The sub lingual groups of muscles entering into the formation of the floor of the mouth, the genio glossus, genio hyo-glossus, also the lingual fraenum, the terminal point of this converging system also require restricted tray depth; the possibility of some fibres of the genio-glossus and genio-hyo-glossus being attached above the genial tubercles must also be taken into account; compression between the denture and underlying bone being followed by painful ulceration.

The writer's technique, to be detailed later, developed over a number of years permits these border tissues and aberrent muscle fibres to register themselves, under tension, in a semi-fluid impression material, allowing freedom up to the point of greatest tension, minimising danger of trauma from compression in the passive state between the denture and underlying bone.
C. OCCLUSION.

Whatever technique may be followed for securing impressions, and there are many varieties, having obtained casts, the subsequent procedure is usually divided into seven steps:

1. Determination of lip line and fullness.
2. Securing the occlusal plane.
3. Registering the vertical spacing of the jaws.
4. Establishing centric relation.
5. Plotting the occlusal curve.
7. Selection and arrangement of artificial teeth.

1. Determination of the lip line and fullness is a matter of the operator's judgment in the absence of pre-extraction records.

2. The plane of occlusion is generally accepted as running backward from the incisal angle parallel with a line drawn from the ala nasi to the tragus of the ear, and is usually obtained by the trial and error method of softening the upper bite rim, squaring it off on a flat surface, and testing it in the mouth with a ruler; the pupillary level being taken as the guide line.

Gillis\(^{66}\) suggests a line from the corners of the mouth to the base of the ear; Rowe\(^{67}\) also

gives this line, and places the face-bow stops at the base of the ear. Most writers on full denture prosthesis, and many, Kennedy, Roach and other partial denture authorities stress the imperative need of securing this measurement.

3. The importance of obtaining, and maintaining, proper vertical spacing of the jaws has been discussed by many prosthetists; W. H. Wright's finding some years ago led to the general adoption of the term "Wright's traumatic deafness", a condition sometimes arising from degeneration of the inter-articular cartilage when, through shortened bite, the backward stroke of the heads of the condyles may result in a thrust against the posterior wall of the glenoid fossae causing pressure upon, or even perforation of, the tympanic plate; the Eustachian tubes become involved through thickening of the membranes preventing that free normal drainage so essential to the health of the middle ear and mastoids.

Another reason why normal vertical spacing should be maintained is given by Sauer "abnormal movements and positions of the mandible may result in reflex pressure on a branch of the auriculo-temporal nerve with exceedingly painful results."

Ohn suggests that abnormally closed jaw

relationship produces a state of collapse in the oral cavity; the tongue being forced to the posterior part of the mouth interferes with the normal function of swallowing, resulting in spongy and inflamed mucosa, a partial closure of the Eustachian tubes, and various types of nose and throat disturbance.

That the proper spacing of the jaws does more than smooth out the wrinkles and give character to the face is the experience of all observant prosthodontists; it makes mastication more natural, and tends to stabilise dentures better than if the bite were open too little, while too great an opening gives a strained appearance, produces a 'clacking' of the teeth when talking, and the patient complains of a feeling of fatigue.

Willis(71) says: "for thousands of years artists have accepted that the distance from the bony shelf under the nose to the bottom of the bone of the mandible should be equal to the distance from the pupil of the eye to the rima oris, or opening of the mouth."

In the absence of pre extraction records

Fig. 31.

Fig. 32.

the "Willis Bite Gage" Figs. 31 and 32, a simple instrument, is excellent for determining the height of bite in average cases; at the same time we must not let our enthusiasm for restoring facial contour lead to the oversight of the value of maintaining a level of the lower bicuspids in relation to the Modiolus whereby every advantage may be taken of the denture stabilising force to be obtained from that source; also, the level of the lower posterior teeth must be such as to render it not impossible for the manipulation of food from the buccal sulcus by the patient's tongue; the older the patient the greater the care necessary; it was better to retain a few wrinkles than sacrifice this freedom, nor must we overlook the fact that all faces do not conform to classic measurements.

R. Gillis\(^{(66)}\) takes the distance from the eyebrows to the naso-labial junction as equal to that from the naso-labial junction to the bony border of the mandible; the "Willis Bite Gage" may be used to record these values, either measurement being a starting point to be increased or decreased as the operator may deem expedient for the case in hand.

It might be said that nature has provided two types of 'shock absorbers' to prevent trauma from the stress of mastication; the oral mucosa under artificial dentures cannot supply the 'spring' formerly obtained from the cancellous bone in which the natural teeth were held, but the 'bumper' action offered by the cartilagenous inter-articular pads in the glenoid fossae may continue to act by careful
spacing of the jaws and the selection and arrangement of the posterior teeth; the 'bumper' action being lost when the condylar heads are forced too far back and out of their normal rest position if the vertical height be unduly shortened. A. M. Bradley (72) deals with this point.

4. Establishing centric relation of the jaws as an indispensable item in full denture construction is the sole point upon which all prosthetic writers are absolutely in agreement; centric relation being that position from which the mandible makes lateral and protrusive excursions, when the heads of the condyles rest gently in their sockets. But, as Lane (73) says, "there are so many interesting ways of arriving at the correct results in registering maxillo-mandibular relation, but no one way seems to have the greatest number of followers"; pointing out that this relation is the primary concern in full denture construction, arrangement of teeth and impressions taking second and third places respectively.

The Gysi Gothic arch tracing in one of its many modifications is undoubtedly the most popular method of securing this so indispensable relation, when the patient can be induced to make the necessary jaw movements; D. Campbell and other writers point out, however, that the tracing differs with different vertical openings.

Gillis (66) thinks there is no infallible

72 A. M. Bradley The Dental Digest. 1935. P.299.
method of securing centric relation, while Rowe\textsuperscript{(67)}
developed a system of observation of the temporal
and masseter muscles; if centric relation has been
established both muscles will contract evenly, if
only the masseter is felt to tense, there is some
degree of protrusion of the mandible.

With elderly people, especially those wearing
unstable dentures, it is sometimes impossible to
register a Gothic arch tracing even though they are
instructed to practice the necessary mandibular
movements before a mirror between visits; the
established habit of masticating with the least
possible movement of the mandible in the direction
of minimum discomfort must be overcome by strategy
rather than technique; well fitting bite plates being
a valuable aid in inducing confidence and banishing
the dread of traumatised tissues.

5. The occlusal curve, or compensating curve,
may be established by the use of a template
representing a segment of a sphere having a radius
of from four inches upward, according to the school
of thought one follows. That this is an arbitrary
arrangement cannot be gainsaid; the lowest point of
the curve has an important bearing on denture
stability and comfort, also on the maintenance of
the angle of the mandible; obviously the further
forward the point of greatest stress, the greater the
leverage, therefore, the greater the danger of
increasing the mandibular angle which would result in
loss of equilibrium, destroying that balanced contact
of the posterior teeth so essential to comfort and
masticating efficiency, and creating a condition of
traumatic occlusion whereby absorbed ridges are given a further downward impetus.

The writer's method of obtaining centric relation and the individual occlusal curve at the same time is detailed farther on.

6. From the comparative calm of the general agreement on centric relation, varying procedures notwithstanding, we step into a veritable maelstrom of argument and differences when the word 'articulator' is used, associated as it is with the problems of condylar paths, condylar guidance, mandibular movements, balanced occlusion, rotation centres, and other abstruse studies.

From Gariot's plane line articulator to the Bonwill, Gysi, Hanau, Monson, Homer, Wadsworth, and a host of others, there is a wide field from which to choose, and a voluminous literature wherein the various instruments, anatomical and non-anatomical, have their enthusiastic supporters.

Hall\(^{(74)}\) thinks an enormous amount of work and money have been wasted in an endeavour to imitate mandibular movements and balance occlusion.

C. Sowle\(^{(75)}\) some years ago deplored the attitude of many denture specialists in almost overlooking the proper maxillo-mandibular relation, the occlusal surfaces of the posterior teeth and their arrangement on the mandible for the study of condyle

74 R. Hall Journal of The Amer. Dental Assn. 1929 P.1642

paths, mandibular movements, and "some complicated instrument that no one but a professor of geometry and trigonometry would successfully comprehend in the course of half a century."

C. W. Benson (76) thinks the term 'condylar guidance' should be "ruled out"; that the examination of a number of skulls will never reveal the controlling factor of mandibular movements, and that a condylar mechanism is unnecessary for reproducing human dental occlusions.

The finding of Castimir Parma (77) with his method of taking close Roentgenograms of the tempero-mandibular joint is of interest; his examination of the condyles in different phases of articulation shows that only wide openings or extensive movements of the mandible require such positions of the condyles as involve the tempero-mandibular joint.

R. Gillis (78) in more recent Roentgen Ray studies of this area differs from the last named writer, stating that there is considerable condylar excursion during the various movements of the mandible, but finds that denture wearers generally, show a much more restricted range of movement than dentate persons. Incidentally, Gillis cannot find such changes in the interarticulare cartilage as Wright and

77 C. Parma Journal of Dental Research 1934. P.208
Monson describe, but agrees with Sauer that abnormal backward thrust of the condyle may bring it dangerously close to the auriculo-temporal nerve.

A dispassionate review of the years since the writer first began making artificial dentures, using a plane line articulator and non-anatomic posterior teeth, suggests that though Jordan(79) may be right in saying "plane line articulators are no more applicable for full denture cases than a universal prescription would be for the grinding of the lenses of the glasses we wear", there seems to have been an endeavour to fit the human edentulous mouth to the anatomic posterior tooth, via the articulator, rather than grasp the fact that we, ourselves, by the acceptance and continued use of these teeth have reared a monster which we have tried to overcome by means of complicated instrumentation; we have been persistently attacking symptoms and ignoring the cause; for, despite improved impression techniques and materials, the uncertainty of this branch of dentistry may be gauged by the number and diversity of journal articles that have appeared during the last twelve or fourteen years.

The human mandible having lateral and protrusive, as well as hinge movement, the logical procedure in constructing easily running dentures is to avoid placing obstruction to that easy running; recognising the vast difference between deep interlocking cusps that may be made to ride easily over

each other in a machine held under finger pressure, and the same interlocking, or interdigitating cusps in a denture seated on movable tissue and subjected, not to finger pressure, but to the action of powerful masticating muscles. We have been expecting mechanical articulators to solve this problem for us, going from one instrument to another in the blind hope that salvation was at hand with each new implement furnished with additional adjustments, only to find a repetition of past experiences; ignoring the while, the finding of Wright\(^\text{80}\) and Greene\(^\text{81}\) that "every mouth must be its own ultimate articulator"; a truth tacitly admitted by every operator who practises the 'milling in', with carborundum paste, of dentures in the patient's mouth.

D. D. Campbell,\(^\text{82}\) who predicts that in the future we shall hear less and less of condyle paths, incisal guidance, and mandibular movements, suggests the use of an articulator having opening, closing, lateral, and protrusive mechanism, with the incisal guide pin used only as a stop to preserve the vertical opening during the setting up of the teeth on the trial base plates; (In a personal letter, Oct. 1936, Dr. Campbell states he is now using a plane line articulator in the construction of full dentures). It is significant that, as reported by Dr. Tuckfield on his return from the


81 J. W. Greene *Dental Prosthesis.* 1916.

82 D. D. Campbell *Full Denture Prosthesis.* 1924.
United States last year (1936), that such men as Dr. Jaffe and Dr. R. Hall have reverted to a simple form of articulator.

R. Hanau(83) had grasped the situation when he warned the dental profession that human jaw movements can only be simulated, not reproduced by an engineering device.

Inseparable from the problem of the anatomical articulator is that of the face-bow; F. W. Frahm(84) and many other writers consider a face-bow indispensable to the mounting of casts on an articulator; F. M. Hight(85) says the face-bow that can be purchased commercially serves a useful purpose, but will not secure a correct hinge axis; M. M. House(86) demonstrates by means of numerous mandibular bones F. 34, how great may be the

Fig. 34.

84 F. W. Frahm Full Denture Construction. 1934.
86 M. M. House Ibid. 1931. P.338.
divergence due to asymmetry of form, from Bonwill's equilateral triangle, which is the basal plan of all anatomical articulators and consequently of face-bows. M. H. Hellman (87) calls the acceptance of this triangle a 'creed', quoting M. H. Cryer's exposure of the fallacy of adopting this theory as a basis for any deductions of consequence.

The writer finds the 'Hanau' the most satisfactory of the many instruments tried so far in full denture construction, for two main reasons; the depth between the jaws allows the use of moderately deep casts, while the absence of springs permits testing and fine adjustment of the occlusal surfaces of the posterior teeth prior to trying in the mouth.

The question of face-bow or no face-bow had exercised the writer's mind for many years till a series of measurements of dentate and edentulous persons, aesthetic centre to face-bow position over the condyles, revealed the rarity of the perfectly proportioned face, explaining why, on transferring the face-bow from face to articulator, with the condyle stops equally spaced, the facial, or aesthetic centre seldom coincides with the articulator centre; in short, in such cases as do not conform to ideal conditions and measurements, a line bisecting the angle subtending the sagittal condylar line, and having its apex at the central incisal junction or aesthetic centre, does not fall upon the sagittal base line of the articulator at

right-angles, thus throwing the aesthetic centre to right or left of the articulator centre incisal guide pin; in the hands of skilled operators the necessary adjustment is made almost sub-consciously; but this point probably explains the avoidance of the face-bow by so many operators. The average articulator being built to the four-inch equilateral triangle plan, once having registered the occlusal plane which must be mounted parallel to the base of the instrument, the position of the casts with relation to the hinge joint is merely a matter of measurement of one side; the incisal mark on the guide pin determines the vertical level of the occlusal plane, with or without the face-bow; then the angle, condyle to occlusal plane varies only as the case is moved from or toward the hinge joint of the articulator.

As we are unable to change the angles of an articulator to conform to the asymmetrical edentulous case, we must accept both fixed-angle articulators and face-bows as, at best, a compromise; in mounting teeth a fixed centre is necessary, and we can always make our corrections with the ultimate articulator, the mouth itself.
D. ARTIFICIAL TEETH.

So much has been said by able writers, Frahm, Elphinstone, House, Tench, and many others, on the selection and arrangement of anterior teeth to meet the requirements of aesthetics and phonation, that one feels there is little to add; but, great as has been the improvement in the present day anterior moulds over many of the pre-anatomic era, one hopes that in the near future we may have a less perfect tooth, more suited to edentulous persons of mature years than the youthful, unworn samples at our disposal today; also, that we may have a type of anterior tooth with longer lingual cusp clearance in both upper and lower, allowing a lesser bulk of denture base material to be encountered by the tip of the tongue.

Of the posterior anatomic tooth much has been, and still more may be, said in condemnation.

The profession may be said to have been taken by storm when it is remembered that at the end of the Great War tooth stocks were very low, and platinum pin teeth, posteriors particularly, practically unprocurable owing to the high price of platinum; the diatonic tooth, never before in favour with the better class practitioner had, perforce, to be accepted; but it was presented in a new guise, accompanying the so greatly improved anterior tooth bearing the imprimatur of Gysi and Leon Williams, and so skilfully introduced by the manufacturers' eloquent demonstrators as to convince the most sceptical that interdigitating cusps and broad oclusual
surfaces were essential to the construction of efficiently functioning dentures. Had the mandible been confined to a simple hinge-joint movement, all would have been well as far as the interdigitating cusps were concerned; and if the anatomy of the mandible did not show a diminishing bucco-lingual width of cancellous bone from above downwards, broad teeth would not have worked the havoc seen -- and experienced -- by many of us; but operators finding their most carefully constructed cases requiring lining or remodelling after a very few years' wear -- perhaps months only -- became perturbed; something had gone wrong with the full denture in spite of improved impression techniques and materials. That full denture troubles were spreading like a blight through the profession may be deduced from the flood of articles appearing in the dental journals from about fifteen years ago for several years, dealing with the problem and suggesting various ways of stabilising dentures, improving impression techniques, methods of securing jaw relation, the superiority of certain anatomical articulators -- everything but elimination of exaggerated cusps from the anatomic posterior tooth and the reduction of its bucco-lingual width.

Among the first to suspect the new tooth form were Hall, Sears, and French, who began a crusade against the anatomic posterior tooth, and though, as Hall found, treated in the beginning with ignomony, now have a steadily mounting number of followers who realise that, while knowing and admitting full denture construction to be a matter of applied mechanics, prosthetists had been flouting
all mechanical laws by preventing the free gliding of the oclusal surfaces of the teeth over each other during the jaw's lateral and protrusive movements, and ignoring the relation necessary between bucco-lingual tooth width and denture stress-bearing extent.

R. Hanau, (83) well qualified to speak on matters mechanical advises: "provide a permissible maximum of supporting surfaces for the plates upon the tissues, and place the teeth as far as possible within the supporting area of the dentures .... Stability of dentures is enhanced by eliminating interference of the oclusal surfaces during masticatory movements".

In the shape and arrangement of teeth, certain mechanical laws must be observed; interdigitating cusps in balanced contact as already mentioned, under vertical thrust, with the horizontal base as counter, must certainly be more effective as food cutting agents than cuspless teeth; also, with the vertical thrust of balanced contacting surfaces falling within the denture stress-bearing areas we have a denture seating force; the alternate pressure upon, and recoil of the mucosa resulting in its healthy stimulation; which stimulation, incidentally, may be obtained equally well with a modified or no-cusp posterior tooth; as soon, however, as the mandible moves laterally or protrusively, their being no vertical base, or counter, to the horizontal thrust of cusp against cusp, though there may not be immediate dislodgment of the dentures, displacement or torsion of the movable mucosa upon its base must follow
in proportion to the amount of horizontal stress, or shear, resulting in trauma, with atrophy of the residual alveolar ridge as demonstrated by the need for reconditioning dentures having interdigitating cusped teeth; a compromise must be effected between masticatory efficiency and tissue tolerance.

Regarding artificial dentures as a crushing unit having two components, one fixed and one motile, we might note that in crushing machinery where one component is fixed, the other revolves or stamps; in cogged (cusped) units, both components revolve, and in neither case is the effective working surface wider than the bed, or rim, on which it is supported.

That cusped teeth in the adult are not essential to the trituration of food may be deduced from an examination of the teeth of museum specimens of primitive adult skulls which show a remarkably uniform absence of persistent occlusal cusps, though sulci and facets denoting wear may be quite marked; anthropologists generally comment on this cusp obliteration in the primitive adult; also, whence the term 'molar', Latin, Molis, a mill? Sir A. Kieth, (88) discussing the Piltdown Man says: "the molar teeth are worn flat and smooth exactly as in primitive races."

Sims Wallace (89) thinks that interdigitating


89 S. Wallace Variation in the form of the Jaws. 1927.
cusps to some considerable extent assure the correlated growth of both dental arches, but considers the adult has no further need of them.

Workers in the field of periodontoclasia accept 'traumatic occlusion' as either an exciting or contributing cause, and where the disproportion between the depth of cusp and width of sulci results in a 'trip' impeding the free sliding of the contacting occlusal tooth surfaces, remove the source of the trip by grinding the cusps or building up the sulci with fillings or inlays -- and this where the teeth are held by their roots in their bony sockets! How much greater then is the need for avoiding, in dentures resting upon a displaceable oral mucosa, cuspal interference that must, of necessity, be transmitted to the underlying tissues?

The writer drew attention some time ago\(^{(90)}\) to the fact that lower molar teeth have their tapering roots placed parallel with the mandible, indicating a diminishing area of bone to be affected by direct thrust upon their occlusal surfaces. In the natural dentition, the inclination of the molars, the uppers buccally, the lowers lingually, combined with the marked buccal and lingual coronal convexity suggests an elaborate scheme in the Divine Plan whereby the gingivae are protected from friction by food during mastication; the edentulous case not having gingivae that require protection, and with the denture stress bearing area less, perhaps, than the former bucco-lingual root measurement, the logical

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90 A. Praed The Dental Journal of Australia 1931. P.547.
assumption is that the bucco-lingual width of lower molar occlusal surfaces should not exceed that of the denture stress-bearing area.

Prior's illustrations\(^{91}\) of some early tooth forms, and one's own memory of the pre-war posterior tooth make us realise that those earlier workers' designs were not the result of ignorance, but rather of wisdom and close observation.

Any suggestion that absence of posterior tooth cusps allows a forward drift of the mandible may be countered by pointing out that the musculature of the jaws is definitely adequate to prevent such happening when dentures are constructed with correct vertical spacing of the jaws, true centric relation, proper width and alignment of the teeth, balanced occlusal contact, unimpeded lateral and protrusive excursions of the mandible, and with the masticatory force falling distal to the first bicuspids; failure in one or more of these details being far more likely to force the mandible into seeking a position of least discomfort.

While awaiting the advent of what Phillips\(^{92}\) calls "the true anatomic tooth", the writer has been selecting from the limited posterior tooth moulds procurable locally, a fairly narrow type having steep cusps and deep sulci; the cusps of the uppers are ground till the occlusal surfaces may be adapted to


the lower bite-block plaster template; the sulci being deepened, and food escapement channels provided by grinding where necessary, with emery powder and glycerine paste on a copper wire held in a chuck on the lathe; the sharp angles of sulci to occlusal surface yielding adequate food cutting edges.

The lower molars are reduced bucco-lingually by grinding from both aspects till their occlusal surfaces do not exceed the width of the combined primary and secondary stress-bearing areas of the mandibular ridge; any remaining cusps are flattened beyond a possibility of engagement of the sulci of the upper molars. If the grinding be done on a green carborundum stone 'lubricated' with a small quantity of beeswax, subsequent polishing of the raw surfaces with tin oxide on a felt buff is a simple matter; the lathe stone may be occasionally reconditioned by cleansing with ether and a stiff brush.

The bicuspid s accompanying these molars are fortunately sufficiently slender not to require reduction of the bucco-lingual width of the lowers. By flattening the lingual cusps of the uppers, and the buccal cusps of the lowers as a preliminary measure to preclude the possibility of cuspal interference during mandibular excursions, the articulation of these teeth for efficient functioning while preserving the aesthetics is a simple matter.

Since the molars designed by Dr. Fish have been available the writer has had rather less grinding to do, but deplores the fact that tooth manufacturers consider that increased vertical height
must be accompanied by increased bucco-lingual width. The bicuspids accompanying these molars are a great disappointment; being joined in one section, the worker is not allowed any latitude in arrangement of first and second bicuspids to suit the case in hand; also, they do not lend themselves to an aesthetic line, so desirable during excursions of the lips in speech and laughter, a source of self-consciousness that must not be added to existing disabilities of all edentulous cases, not only those with excessively resorbed ridges.
1. WHAT IS REQUIRED OF AN IMPRESSION.

The many able writers on full denture construction have given the profession so great a variety of impression techniques that it should be possible to select one in its entirety to suit every type of case presenting.

The writer however, has come to the conclusion that for journal articles and demonstration purposes, the ideal, or nearest-the-ideal, case is chosen; and while the excessively resorbed case presents the same fundamental requirements as the ideal, some modification of accepted techniques must be made if we are to obtain what G. H. Wilson describes as "a negative likeness of an object or part taken in a plastic material from which a cast or positive likeness may be produced." The same author states as an axiom, "a base plate cannot rest upon a muscle which impinges upon or draws over the periphery of a plate, the contractile power of a muscle being greater than the retention of adhesion by contact."

Lane, Tench, Cotterell, Stainsbury and many others agree that a denture should cover the maximum area of mucosa; being limited only by the movable reflected tissues, so that the denture may not become unseated by muscular action.


94 Ibid P.325.
R. O. Schlosser (95) thinks freedom for physiological function, with retention of the denture base and non-interference with soft structures may be secured if the impression be properly taken and developed.

The question then is, what would constitute a properly taken impression where, in addition to abnormal border muscle arrangement there is a fold of sessile tissue capable of being distorted to a greater or less degree from its position overlying the ridge crest?

Obviously such a method as R. Hall's (96) stiff plaster of Paris would be unsuitable; a closed mouth procedure is inadequate when it is clear that the main muscle interference, in the maxilla, is when the mouth is open, and in the mandible both during deglutition and when the mouth is open; also, as impression materials do not possess selective powers, closed mouth impressions do not permit equality of pressure on hard and soft tissues alike.

The logical approach seems to be the construction of individual trays which, while resting on the secondary stress-bearing areas, will permit the reproduction, in a fluid medium, of the limit to which denture borders may be carried; and the recording of soft pendulous ridge tissue in a state


96 R. Hall Journal of the American Dental Assoc. 1933. P.1215.
of rest; it being a well known fact that distorted tissue tends to return to its rest position, thereby creating a denture dislodging force, with possible trauma, and further atrophy of the underlying bone, or hypertrophy of the soft tissue itself, or both.

The writer's impression technique as outlined at the Adelaide Dental Congress in 1933 has been modified in some respects, but remains the same in principle, in that it aims to secure freedom of all peripheral muscle fibres, absence of distortion of sessile tissue, and maximum registration of secondary stress-bearing areas. All illustrations are of practical cases in course of construction.
2. THE MAXILLARY IMPRESSION.

A shallow flanged tray of suitable size is chosen, the projecting handle reduced to a stub, and a one-eighth of an inch perforation drilled in the post incisal region; Fig. 34.

Fig. 34.

A pencil roll of modelling compound is sealed round the periphery of the tray, a small mass, to act as a 'stop' being placed in the

Fig. 35.

centre of the palate. Under moderate pressure, the warm compound is moulded down by the lips and cheeks, the tray withdrawn and chilled; the posterior denture limit is marked out in the mouth, the marking being transferred to the compound by pressing the tray up sharply, Fig. 35. Excess material is trimmed away,
the posterior portion to just beyond the mouth marking, the labial flange reduced in thickness to the limit of safety, the buccal portions being left with a greater horizontal width to prevent the too ready flow of plaster into the cheeks; any compound running into the ridge trough is removed, and the height of the whole bucco-labial flange reduced with an inward slope, Fig. 36; the reduction in height insuring against impingement upon the buccal wall of the antrum or the zygomatic process.

![Fig. 36.](image)

of the malar bone; pressure upon either of these areas causing, if not actual trauma, a bone weariness destructive to the comfortable wearing of a denture.

With ordinary impression plaster a 'snap' impression is secured, the tray being gently rotated into position and held under minimum pressure, the patient being instructed to open the mouth as widely as possible, so insuring tensing of the bucco-labial and tensor palati muscles, together with absence of compression upon aberrant fibres from the bucco-labial groups and the pterygoids, should such be necessary.

From the resulting plaster cast an individual
tray is constructed; hard vulcanite being the most suitable for the following reasons; it is so much lighter than cast metal, it may be easily trimmed and pierced, beeswax additions may be attached with ease and security, it will not warp at the temperature necessary to soften beeswax additions as would the shellac base-plates.

The central palatal line of the cast is heavily pencil marked, as is also the crest of the ridge; the distance between the incisive centre

Fig. 37.

ridge, and the posterior denture limit is halved, and lines drawn down the sides of the cast opposite this measurement, Fig. 37.

One sheet of base-plate wax is adapted to the cast and heavily reinforced all round the bucco-labial flange, keeping below the periphery to facilitate any necessary trimming of the vulcanite tray; also keeping outside the ridge-crest marking which shows through the pink wax. Narrow strips of wax are sealed down either side of the centre palate marking to provide extra rigidity and form a little trough as a guide when piercing the tray for pressure vents; thickening of the wax over the
tuberosities is avoided, as the tray is to be used as a bite-plate later on.

Finger rests about six M.M. high are placed at right angles to the crest of the ridge opposite the half-way marks on the cast, after the manner of Stainsbury's potlegs; sections cut from an old mirror handle, wax filled and coated are excellent for this purpose, being easily withdrawn when boiling out the wax, and serving to standardise one's technique; a third projection about ten M.M. square and two M.M. thick may also be a standardised piece of metal and is secured just inside the ridge in the central incisal region; serving as a conveying handle, and with another use to be explained later.

Fig. 38.

The waxed up tray, Fig. 38, is vulcanised off the cast, very little finishing beyond trimming the edges being necessary if moderate care has been taken in waxing up.

The tray is tested for muscle interference, relieved if necessary, and the posterior limit checked. A piece of modelling compound is sealed to the central lug, carried to the periphery, and
while still soft, moulded to the lip countour; central and lip lines are clearly marked, the compound chilled and squared off at the lip line; these markings enable the operator to piece the tray when plaster-wash filled, in the correct position.

By digital pressure the amount of vertical compression of the pendulous ridge is now estimated in terms of sheets of beeswax, one, two or three, two usually being sufficient.

The required number of pieces of beeswax are cut, superimposed, and adjusted to the palatal portion of the tray, keeping away from the tuberosities, also the post incisive area including the rugae; the wax being chamfered off toward the palatine groove and rugae.

A piping of beeswax run from a sprue former is attached all round the bucco-labial flange at the estimated ridge base, missing out any areas

**Fig. 39.** **Fig. 40.**

with visibly marked muscle attachments; Fig. 39. The
beeswax bushed tray is then dropped into water at 125° F., and while the wax is softening, all relief areas and posterior denture limit are marked out in the mouth; the tray is pressed sharply home, removed and chilled. The beeswax is cut out with a sharp knife along the transferred markings down to the tray surface, the central portions chamfered toward the median line, and any drift of wax toward the palatine groove removed, also any encroachment of the buccal-lingual piping toward the ridge trough or periphery, Fig. 40.

The tray is now pierced from the tongue side with a fine tapering fissure bur along the median palatal line and ridge crest, keeping the direction of those eminences and making pressure vents about two M.M. long, sufficiently well spaced not to weaken the tray, and allowing the tiny burred edges to remain on the palatal side of the tray.

Should one be uncertain of the adequacy of the deeply ridge trough to accommodate any pendulous ridge without distortion, clearance or otherwise may be ascertained by re-inserting the tray and testing with a fine probe through the slits; more wax being added in case of need.

The tray is now ready for the actual impression.

A moderately thin mix of plaster wash is loaded into the dried tray, care being taken not to tap or jar the wash into position; it being undesirable that the plaster wash begin to escape too soon through the pressure-vents, the slight
burring from the piercing having been done from the tongue side being sufficient to prevent a too ready leak, provided the tray is quite dry.

With a short, circular, vibratory motion, the tray is rocked to place, slight pressure being placed on the finger rests, their position insuring an even distribution of pressure; the absence of a steadying alveolar ridge might easily allow either a backward or forward displacement of any soft tissue present, and defeat one's object; i.e., the securing of the best possible registration of the secondary stress-bearing areas with soft or pendulous tissue held in a state of rest.

While the plaster wash is still curling through the pressure vents, the patient is asked to open the mouth 'as widely as possible', drawing the lips back at the same time; thereby tensing those troublesome border tissues and aberrant muscle fibres, giving a record in the impression material unequalled for accuracy by any method of individual muscle manipulation by the patient; the tensed buccal-labial muscles holding the impression material against the peripheral tissues.

Should one have reason to doubt the patient's whole-hearted co-operation, a small mouth-mirror, or finger, judiciously placed, is a material aid in securing a spasmodic tensing of the muscular groups that require registration in the impression medium.

The labial fraenum should be registered before the plaster-wash becomes too stiff by drawing the lip down and moving it from side to side; then
steady, but slight, even pressure is maintained on the finger-rests till the check wash in the bowl breaks with an audible snap.

The patient may now wash out the mouth with cold water; any plaster covering the central lug is removed, the centre and lip lines verified, and the impression dislodged by passing a forefinger along the periphery toward the tuberosity on one side, stretching out the buccal muscle with the knuckle, while pressing downward with the tip of the finger.

Any broken fragments, with the impression, are well washed under running water, and the impression left in water while the post-dam and relief areas are marked out in the mouth; the impression is inserted, pressed up, removed, and the marked areas outlined in pencil, Fig. 41.

Fig. 41.

When sufficiently dry, broken fragments are waxed on; the rugae, central palatal area, and muscle fraena are relieved slightly, preferably with fine sandpaper. The bony lingualae anterior to the posterior palatine foramina are sometimes sufficiently prominent to show out in the impression; these must be relieved sufficiently to prevent trauma, (sometimes
ulceration), by the mucosa being pinched between the denture and these bony spines.

Fig. 42.

The way in which the buccal tissues mould down the impression material may be noticed in Fig. 42.

The writer prefers to apply a wax post-dam to the impression rather than trim the cast, and uses a sheet of gold casting wax softened between the hands or on a plate over warm water, patting the wax to place without thinning or distortion, so reproducing the natural inequalities of the surface mucosa; the wax is feathered off to disappearance anteriorly, and trimmed posteriorly with a very sharp narrow-bladed knife.

The impression is now ready for rimming, boxing, varnishing and pouring in artificial stone or plaster as the denture base material to be used may require.

If, upon removal of the boxing, centre and lip lines are recorded from the central lug to the cast, there need be no guess-work about the height of bite to which to build the bite block anteriorly;
also, a line carried round the cast at right angles
to the centre line, gives an approximate measurement
for the rest of the bite block.

The stripped cast, without farther trimming
or relief should yield a denture base that will:

1. Accommodate a pendulous ridge without
distortion.

2. Rest a little more heavily on the secondary
stress-bearing areas than upon the primary
stress-bearing areas of the ideal case.

3. Clear the regions requiring relief sufficiently
to prevent rocking of a denture, inter-
ference with the blood and nerve supplies
without creating vacuum areas.

4. Allow freedom of border muscle action during
mastication, phonation, and the physiological
exercises.