A Novel Non-Phthalate Functional Dental Material

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ABSTRACT: This paper discusses various dental impression techniques and as to their pros and cons. It was found that the dental impression material Perfect-Fit™, a new-comer, has the highest fidelity of all dental impression materials tested, to date. Unlike other functional dental materials, Perfect Fit™ actually flows into the finest pin holes, capturing unprecedented impression fidelity. This enables the fabrication of exquisitely fitting dentures. In addition, Perfect Fit™ is the only functional dental material that flows, that is non-phthalate, FDA compliant, and non-toxic when reacted with the medical grade polymer powder included in the Perfect-Fit™ kit.

KEY WORDS: Selective-Pressure Impression Technique, Functional Impression Materials, Dentures, Dental, Prosthesis, Mucostatic Technique, Mucocompressive Technique, Functional Technique, Minimal Pressure Technique, Stomatitis, Ulceration, Non-Phthalate, Phthalate, FDA Compliant, Non-Toxic, Flow-Cast, Hydro-Cast

INTRODUCTION: Simply stated, the role of any functional dental impression material is to accurately replicate the dimensions of oral tissues and their spatial relationships (Powers, et al., 2013; McCord, et al., 2000). The higher the impression material's fidelity, (the faithfulness to reproduce a surface) the better the replication will be, which is directly related to the production of a prosthesis with superior stability, retention, support and aesthetics (Collett, 1965).

The general consensus for desirable properties of functional dental materials are as follows:

1. Excellent flow for maximum area coverage and intimate contact (which is especially important in obtaining an impression of the edentulous ridges)
2. Superior wetting properties
3. High dimensional accuracy
4. Stability over time
5. High level of mechanical integrity and resistance to shear
6. Easy to manipulate
7. Reasonable cost
8. Odor, taste, and color acceptable to the patient
9. Non-toxic and non-irritating
10. Compatibility with cast and die materials

11. Long shelf-life
12. The ability to be disinfected without degradation
13. Display strong anti-bacterial and anti-fungi properties

Boucher (1951) categorized and detailed pressure applied techniques for making dental impressions:

1. Mucostatic Technique (i.e., no pressure)
2. Mucocompressive Technique (i.e., pressure)
3. Selective Pressure Technique (Boucher, 1950, combines both pressure and minimal pressure techniques)

In 1946, Harry L. Page published the Mucostatic Technique (Page, 1946), based on Pascal's law, which states any pressure applied to a confined liquid is transmitted, undiminished and equally in all directions (Pascal, 1663). Page stated that all soft tissue is predominately fluid, of which 80% is water and since the soft tissue under a denture is confined, any pressure applied will be transmitted in all directions equally (Page, 1946).

The Mucostatic Technique, which Page contended was not a technique, but a principle (Page, 1946), relies on interfacial tension as the retentive mechanism in a complete denture (Portar, 1953). The only way to disrupt interfacial tension (i.e., surface tension, the tendency of a liquid's surface, at rest, to shrink into the minimum surface area possible due to the cohesion of liquid molecules to each other via hydrogen bonding), is through vertical displacement of an object, in this case, a denture.
In the Mucostatic Technique, the impression material has to account for every detail of the mucosa, without distortion. Page placed so much emphasis on achieving high-fidelity impressions, that that separating substances could not be used at any point during the procedure (Portar, 1953).

In 1910, the Mucocompressive Technique was published by the Greene brothers (Peter Thomas and Jacob Wesley Greene) with the goal of achieving better denture retention (Greene, et al., 1910). This was the first in a number of dental advances:

1. Introduction of a modeling plastic material
2. A method of manipulating the modeling material
3. First to employ the entire denture bearing area for denture retention
4. First to teach the closed mouth all modeling plastic technique (i.e., the Greene brothers' all compound technique)

Fabrication of complete dentures using the Mucocompressive Technique resulted in a denture that was in a continuous state of compression, which caused alveolar bone resorption. In addition, the high level of pressure caused by the dentures produced by this technique was applied to the center of the palate and the peripheral tissues, which are not suited for a maximum biting load. This excess pressure, the type of which that does not stimulate bone growth as in Wolff's law, resulted in decreased blood flow to the affected areas, with osteoclasts breaking down the bone (i.e., the mandibular residual ridge). The reduction in bone density (osteopenia) is called stress shielding. The author of this paper has conducted extensive research in stress shielding in human bone where there was a mismatch between the moduli of an implant and the bone.

In addition, with the Mucocompressive Technique the teeth stayed in a functional state continuously, and the denture only fit well during mastication but becoming loose (i.e., not closely adapted to the tissue) due to tissue rebounding (Filler, 1971; Ferro, Editor,1999). A spacer in the custom tray might have helped to alleviate some of the disadvantages.

From Bio-Medical mechanics, we have learned that the mouth is lined with displaceable tissues that range in rigidity and thickness, all of which affects the degree of tissue displacement, as does the vector of forces applied. The crest of the alveolar ridge and the horizontal plate of the palatine bone are the areas of primary stress in the maxilla, while the buccal shelf the area of the primary stress concentration in the mandible (see Appendix I). Secondary stress bearing areas of the maxillary are the rugae area, while the slopes of the ridge in the mandibular formation act as secondary stress areas. A review of C. M. Seipel's paper, ***Trajectories of Jaws*** (1948), and F. G. Evens' book, ***Stress and Strain in Bones***, (1957) go into greater detail; however, it suffices to state that no force vector is ever lost. It is dealt with by the physical laws of inertia, momentum and interaction (see Newton's laws of motion). Masticatory loads are distributed to the craniofacial complex via stress vectors and are not adsorbed in the maxillary or mandibular geometry (Seipel, 1948). The mandible, the anvil of the jaw, has four force vectors possible in masticatory loading:

1. The angle of the mandible, up the posterior border of the ascending ramus to the condyle
2. Obliquely from below the molars, through the body of the mandible and ramus, to the condyle
3. From the molar alveolar crests, up the anterior border of the ascending ramus, towards the coronoid process
4. Along the margin of the sigmoid notch, between the coronoid process and the condyle

These four force vectors, when transferred to the maxilla, follow an upward direction, running through the middle third of the face to reach the frontal bone. The muscular force applied to opposing teeth, known as the occlusal force, involves the entire viscerocranium and most of the neurocranium (Kumagal, et al., 1999), and comprises three main force vectors acting on the following:

1. Maxillonasal
2. Maxillopterygoid
3. Maxillozygomatic

The aforementioned biomechanics led C. O. Boucher in 1950 to develop the selective pressure technique, which combines both pressure and minimal pressure techniques (Levin, 1984).

In 2004, J. P. Duncan, S. Raghavendra and T. D. Taylor developed a method of improving the Selective Pressure Technique for palatal adaptation of maxillary complete dentures (Duncan, et al., 2004).

T. P. Hyde, et al. prior to 2010, conducted a randomized controlled trail for the Selective Pressure Technique that proved the superiority of this method. This research provided dentists with actual clinical evidence for the Selective Pressure Technique superiority. (Hyde, et al., 2010).

Dentures are prosthetic devices constructed to replace missing teeth and have been used starting in the 7th century B.C. by the Etruscans (Donaldson, 1980). These early partial dentures were constructed out of human or animal teeth fastened together by gold bands (Donaldson, 1980).

There are three categories of dentures:

1. Fixed Partial
2. Removable Partial
3. Complete

Whatever the denture type, proper fit is vital. This is achieved by the functional impression material which enables fabrication of a denture that has a close adaptation of the denture bases to the tissue. The key to denture retention is a border seal and posterior palatal seal, combined with positive pressure exerted on the broader tissues.

Improper fitting dentures can lead to denture trauma, a condition referred to as denture stomatitis, which is an inflammatory condition of the tissue under the dentures (Ireland, Editor, 2010). Stomatitis can affect both complete and partial denture wearers (Lamont, et al., Editor, 2019). It is most commonly found on the palatal mucosa and consists mainly of the pathogenic yeast ***Candida albicans*** (90%), with a number of Gram-positive bacteria, such as ***Staphylococcus aureus***, and members of the genus ***Streptococcus*** (Gram-positive), ***Fusobacterium*** (Gram-negative), and ***Bacteroides*** (Gram-negative) (Lamont, et al., Editor, 2019; Bagg, et al., 2006; Arora, et al., 2017). Patients with denture stomatitis are more likely to have angular cheilitis (Puryer, 2016).

Clinically denture stomatitis is classified three ways (Lamont, et al., Editor, 2019; Bagg, et al., 2006; Arora, et al., 2017):

1. Type 1: Simple localized inflammation
2. Type 2: Generalized erythema covering the denture bearing area
3. Type 3: Inflammatory papillary hyperplasia

Over time poorly fitting dentures, including over-extension of a denture over time will cause denture trauma, often leading to ulceration (Lamont, et al., Editor, 2019; Bagg, et al., 2006; Arora, et al., 2017). This why a functional dental impression material with high fidelity is vital in fabricating dentures.

In conclusion, this author has analyzed numerous functional dental materials, and to date, Perfect Fit™ has proved to be superior in obtaining high fidelity impressions. Simply put, Perfect Fit™ has outperformed all functional dental materials currently on the market and facilitates the production of supremely fitting dentures, resulting in less problems for the patient. Perfect Fit™ scored the highest marks in obtaining the thirteen desirable properties of functional dental materials. Unlike other functional dental materials, Perfect Fit™ actually flows into the finest pin holes, capturing unprecedented impression fidelity, thus enabling the fabrication of exquisitely fitting dentures.

In addition, unlike Flow-Cast, the runner-up, Perfect Fit™ is non-phthalate based, FDA compliant, and non-toxic when reacted with the medical grade polymer powder included in the Perfect Fit™ kit. Perfect Fit™, due to being phthalates free has a pleasant taste, which patients appreciate. Perfect Fit™ is produced using only food grade and pharmaceutical grade reagents.

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SUGGESTED READING

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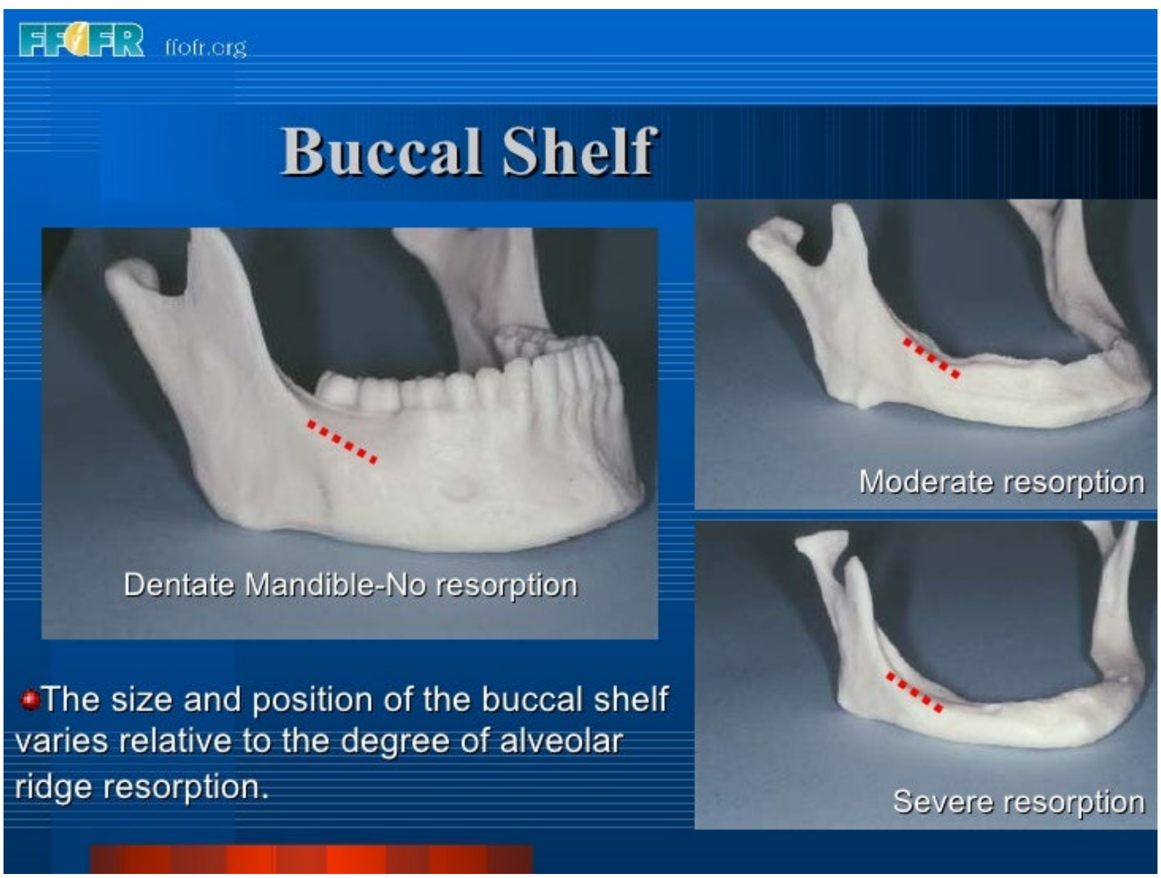
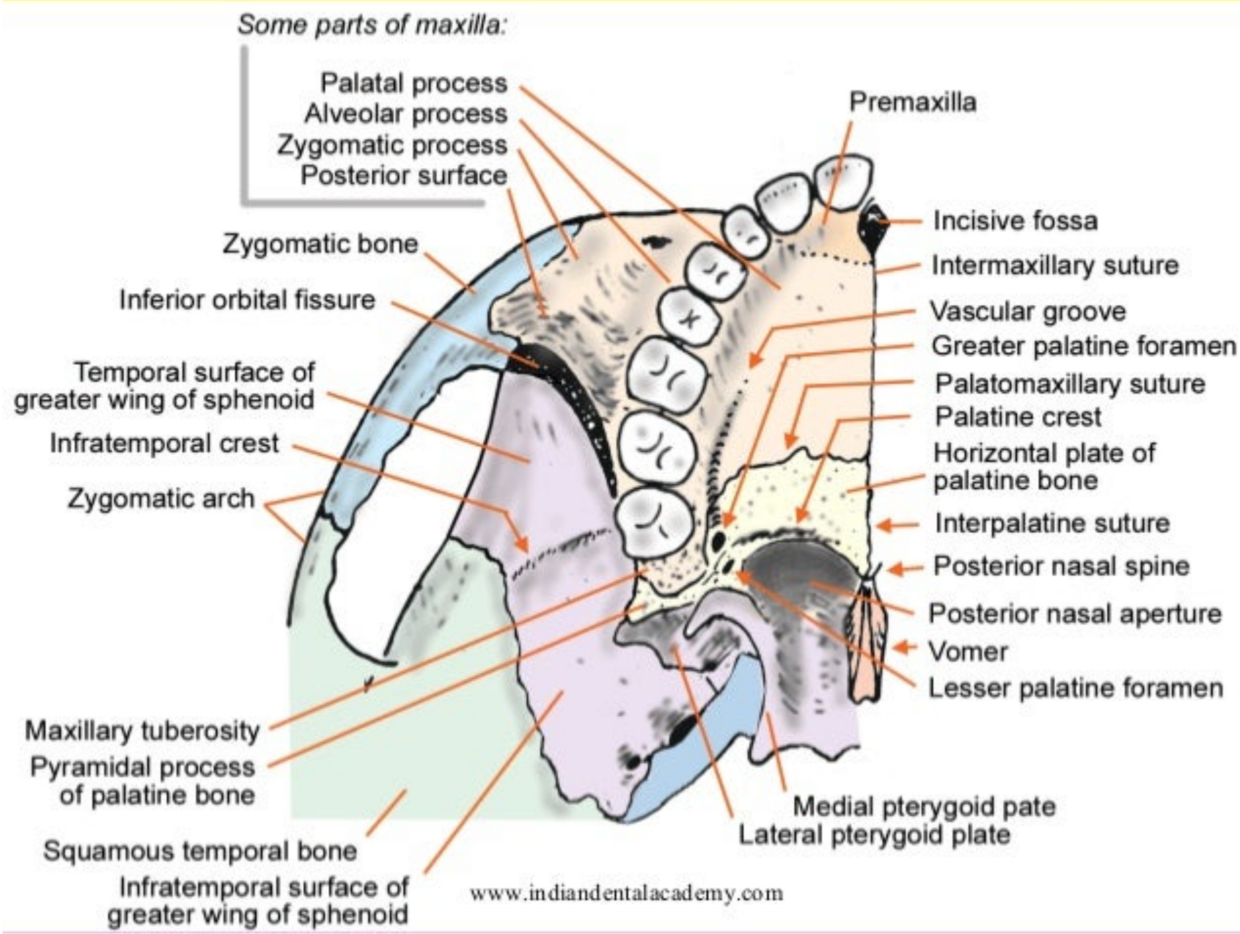
APPENDIX I




Some parts of maxilla:
Palatal process
Alveolar process
Zygomatic process
Posterior surface
Premaxilla
Incisive fossa
Intermaxillary suture
Zygomatic bone
Inferior orbital fissure
Vascular groove
Greater palatine foramen
Temporal surface of greater wing of sphenoid
Palatomaxillary suture
Palatine crest
Infratemporal crest
Horizontal plate of palatine bone
Zygomatic arch
Interpalatine suture
Posterior nasal spine
Posterior nasal aperture
Vomer
Lesser palatine foramen
Maxillary tuberosity
Pyramidal process of palatine bone
Medial pterygoid pate
Lateral pterygoid plate
Squamous temporal bone
Infratemporal surface of greater wing of sphenoid
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