Cast modification for immediate complete dentures: Traditional and contemporary considerations with an introduction of spatial modeling

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Cast modification for immediate complete denture applications has been based largely upon the recommendations of a few authors. While helpful, these recommendations are primarily subjective. This article reviews 2 long-standing methods for cast modification and, subsequently, introduces the concept of spatial modeling. Spatial modeling involves the application of anatomic norms to gain an improved understanding of oral tissues and their dimensional relationships. A cast modification process based upon spatial modeling is described. The foregoing cast modification methods are then compared. Indications and contraindications for the respective techniques are presented.

Despite significant improvements in tooth retention and the advent of predictable implant systems, immediate dentures remain an important treatment methodology in contemporary dentistry. These prostheses offer significant advantages in tissue-borne, tooth-tissue-borne, and implant-tissue-borne applications. Consequently, they are applicable to a wide range of commonly occurring clinical situations.

The advantages of immediate dentures have been accepted for many years.[1-13] Immediate dentures eliminate the need for potentially embarrassing periods of edentulism and permit uninterrupted function. Such prostheses also protect surgical sites and serve as templates for healing.

Authors have described various aspects of immediate denture service, ranging from diagnosis and treatment planning to postplacement care.[8-15] Impression procedures have been described.[16-18] Fabrication of tooth-placement indices and surgical guides have been presented.[12,13,19,20] Multiple flange designs have been proposed and evaluated.[13-15] Methods of cast modification have been proposed, yet a clear anatomic rationale for cast modification is noticeably absent. The remainder of this article deals with the background, rationale for, and modification of dental casts for immediate denture construction. Traditional and contemporary considerations are explored, with an emphasis upon spatial modeling.

Perhaps the most well-known methods for cast modification were published by Standard in 1958 and Jerbi in 1966.[1,2] These authors provided detailed instructions and sequential photographs to present their respective methods for cast modification in immediate denture applications. Their techniques were based upon years of clinical practice and observation. Both methods have been used successfully, and each has advantages and disadvantages.

Standard began the process by making an accurate polysulfide impression and generating a cast (Fig. 1, A).[1] He placed a series of pencil lines on the cast to guide proposed cast modifications. For each remaining tooth, Standard outlined the gingival margins on the facial and lingual surfaces of the cast. In turn, he scribed a second pencil line on the facial surface of the cast. This line was 2 mm apical to the line identifying the facial gingival margin. Standard placed a third pencil line on the facial surface of each cast to indicate the beginning of the undercut area.

Cast modification and tooth placement occurred in 4 distinct phases. In the first phase, a predetermined tooth was removed from the cast by cutting to the gingival margins with a plaster saw (Fig. 1, B). During the second phase, a rotary instrument was used to join the lingual gingival margin to the intermediate line on the facial surface (Fig. 1, C). The third phase involved placement of an artificial tooth in the appropriate position. This procedure was followed for alternating teeth until all artificial teeth were in the desired positions. In the fourth and final phase, the wax base was removed from the cast, and the stone contours were gently rounded with a sharp knife. This modification extended from the line identifying the undercut area to the line identifying the lingual gingival margin (Fig. 1, D).

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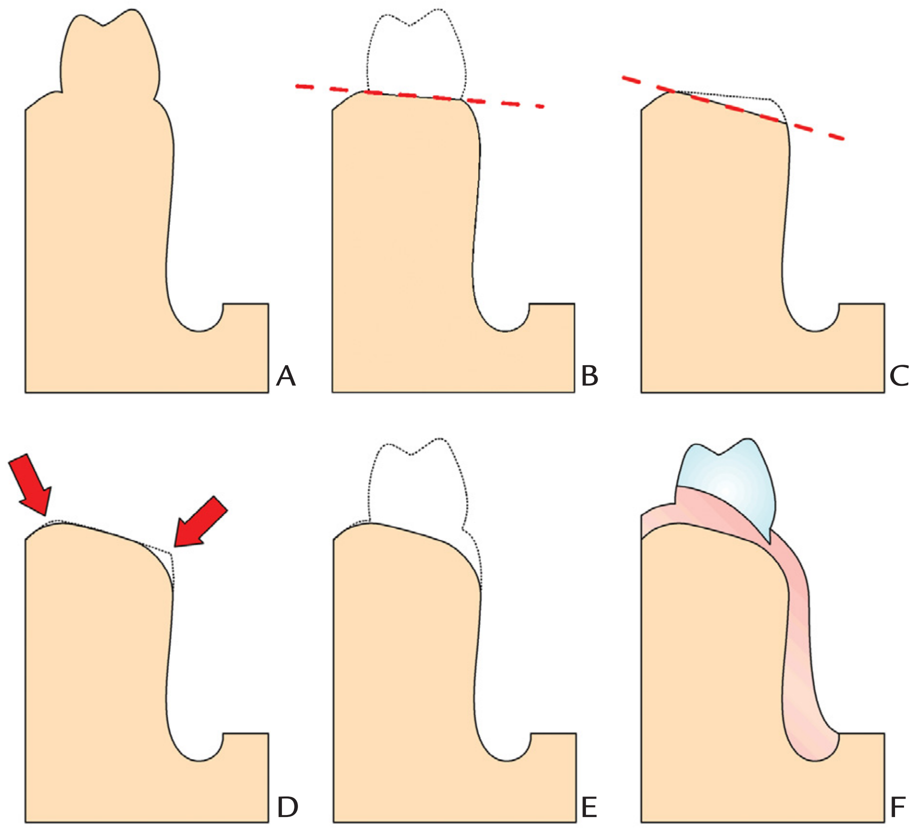


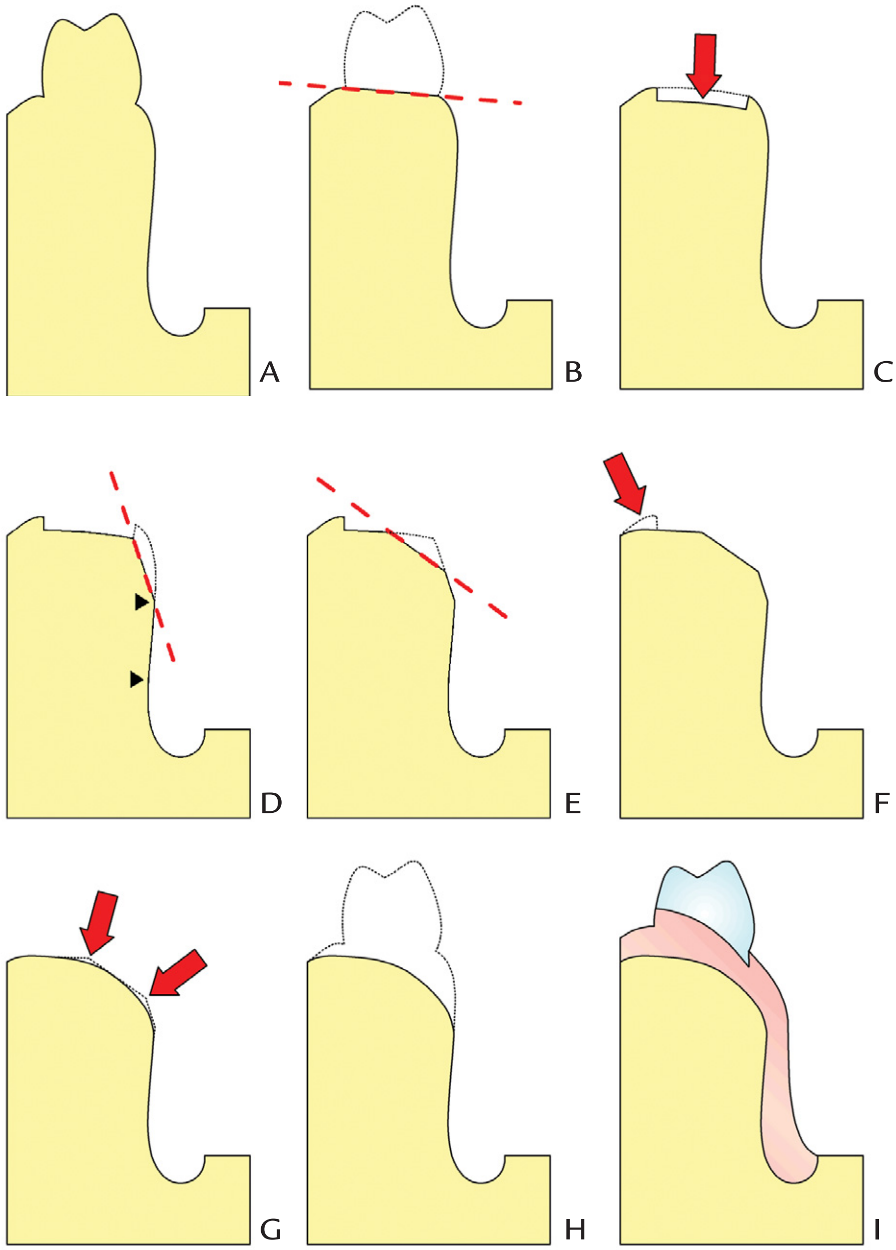
1 Cast modification technique proposed by Standard. A, Cross-sectional view of cast in posterior region. B, Coronal segment is removed using saw or laboratory engine. C, Subsequent cut joins lingual gingival margin to intermediate line on facial surface of cast. Intermediate line is parallel and 2 mm apical to facial gingival margin. D, Stone contours are gently rounded at facial and lingual surfaces. On facial surface, rounding extends to soft tissue height of contour. E, Resultant reduction is shown. Dotted line indicates premodification contours. F, Cross-sectional view of tooth placement and denture base contours proposed by Standard.

The completed cast modification was intended to provide space for placement of an artificial tooth, while eliminating the need for aggressive alveoloplasty (Fig. 1, E and F).

Jerbi also recognized the need for an accurate impression and a suitable dental cast (Fig. 2, A).[2] Upon generating the desired dental cast, Jerbi placed a series of pencil lines to guide cast modification. The first of these lines denoted the level of the gingival margin for each tooth. Subsequent lines were scribed on the facial surface of the cast, dividing it into cervical, middle, and apical thirds.

The first phase of Jerbi's cast modification procedure required the elimination of a selected stone tooth by cutting away those portions of a tooth which projected incisal/occlusal to the gingival margins (Fig. 2, B). The second phase of cast modification involved the creation of a 1-mm recess in the area occupied by the root (Fig. 2, C). During the third phase of the procedure, Jerbi made a relatively vertical cut extending from the facial extent of the prepared socket to the line denoting the junction of the cervical and middle thirds of the facial surface (Fig. 2, D). To facilitate the fourth phase of cast modification, an additional pencil line was added. This line followed the crest of the ridge, bisecting the prepared sockets faciolingually. The accompanying cut extended from the crestal line to the midway point of the modification described in phase 3 (Fig. 2, E). The fifth phase required modification of the lingual contours. This was accomplished by extending the floor of the prepared socket lingually to mimic the collapse of soft tissues into an extraction site (Fig. 2, F). The sixth and final phase of cast modification was to smooth the surfaces of the cast that were modified during the foregoing procedures (Fig. 2, G). Again, cast modification was intended to provide space for placement of a prosthetic tooth, while eliminating the need for aggressive alveoloplasty (Fig. 2, H and I).

Both Standard and Jerbi based their respective cast modification procedures upon clinical observations, and each technique yielded reasonable success. Difficulties generally occurred as a result of overzealous reduction at the facial, lingual, and interproximal aspects of the associated dental casts. Denture bases fabricated on such casts would "bind" in these areas during placement (Fig. 3). This prevented complete seating



2 Cast modification technique proposed by Jerbi. A, Cross-sectional view of cast in posterior region. B, Coronal segment is removed using saw or laboratory engine. C, One-mm-deep recess is created in area occupied by root. D, Vertical cut extending from facial extent of prepared socket to line denoting junction of cervical and middle thirds of facial surface. E, Cut extending from faciolingual center of socket to midway point of cut described in Figure 2, D. F, Floor of prepared socket is extended lingually. G, Stone contours are gently rounded at facial and lingual surfaces. H, Resultant reduction is shown. Dotted line indicates premodification contours. I, Cross-sectional view of tooth placement and denture base contours proposed by Jerbi.

of denture bases, and necessitated adjustment of the denture bases, the supporting hard and soft tissues, or both.

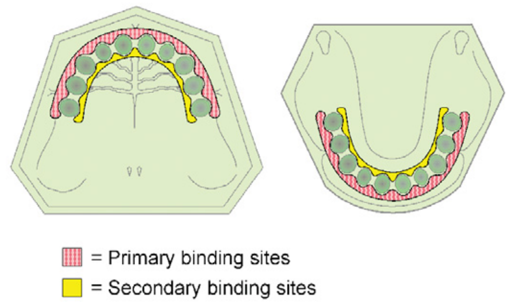
To address the difficulties associated with binding, subsequent authors recommended the use of surgical guides.[6,12,13,19,20] These rigid, transparent templates duplicated the intaglio contours of the associated denture bases and permitted rapid visual assessment of denture base adaptation. Areas of binding were clearly identified by blanching of the underlying soft tissues. Clinicians used this information to guide osseous recontouring at the time of tooth removal. This allowed improved seating of the associated immediate denture and minimized damage to the soft tissues. Unfortunately, modifications were performed at the expense of valuable osseous tissues.

The purpose of this article is to

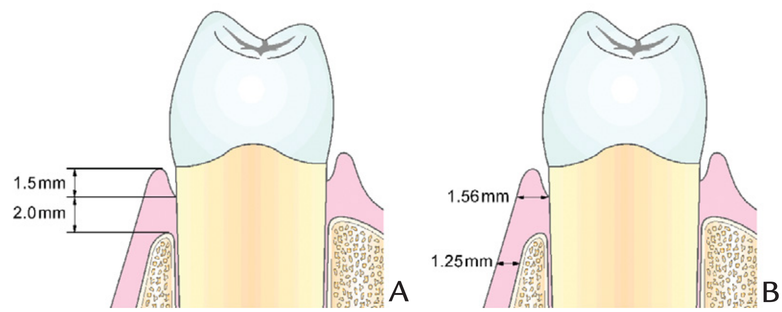
introduce the concept of spatial modeling for immediate denture applications. Extension of the spatial modeling concept permits development of an objective method for cast modification. The resultant technique is intended to minimize prosthesis-induced soft tissue injury, decrease the need for osseous recontouring, and promote clinical efficiency. The current cast modification procedure is based upon a clinical model derived from values presented in the dental literature. It is intended as a guideline for cast modification in immediate denture applications. The technique may be altered as dictated by clinical conditions.

The model is based upon a cross-sectional view in the maxillary or mandibular posterior region (Fig. 4). Osseous support is provided by a relatively thin facial plate, and a more substantial lingual buttress. Facial and lingual sulcus depths of approximately 1.5 mm are included, based upon information provided by Vacek et al[21] and Smith et al.[22] Mean biologic widths of approximately 2 mm are included, based upon the results of investigations by Gargiulo et al[23] and Vacek et al.[21] Representative soft tissue coverage is based upon the findings of Goaslind et al[24] and Eger et al.[25] Therefore, the thicknesses for free and attached gingivae within this model are 1.56 mm and 1.25 mm, respectively.

The minimal sulcus depths and negligible bone loss within this scenario represent challenging conditions for immediate denture fabrication. Occlusal positioning of the osseous architecture minimizes soft tissue collapse, which occurs immediately following tooth removal. Minimal soft tissue thickness provides little opportunity for soft tissue compression. As a result, these conditions necessitate conservative, yet accurate, cast modification. A dental cast which corresponds to the preceding spatial model is provided for purposes of illustration. Facial and lingual bone levels are superimposed upon this transverse section of the cast to facilitate discussion (Fig. 5, A). The resultant model serves as the basis for cast modification.



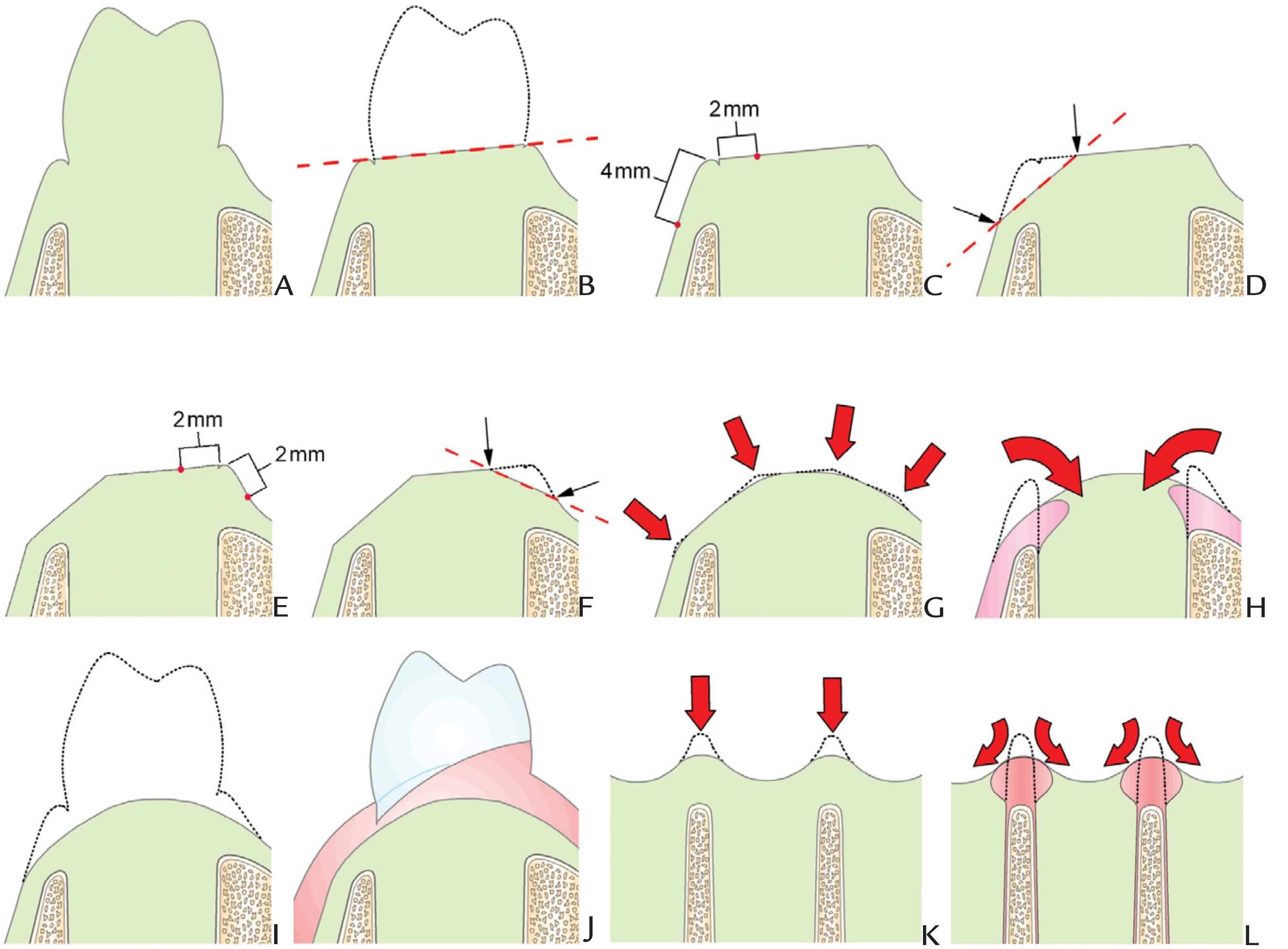
3 Binding at time of prosthesis insertion occurs most commonly at facial and interproximal surfaces. Binding at lingual aspect occurs less often.



4 Spatial modeling was accomplished using values from dental literature. A, Representative values of 1.5 mm and 2.0 mm are used for facial sulcus and biologic width, respectively. B, Thicknesses for free and attached gingivae are 1.56 mm and 1.25 mm.

TECHNIQUE

1. Remove a chosen crown from the dental cast using a laboratory engine and a suitable bur. Connect the facial and lingual gingival margins in a linear fashion (Fig. 5, B).
2. Using a pencil, draw 2 lines to guide facial reduction of the cast. Place the origin of the first line at the mesiofacial line angle, arc to a point 2 mm lingual to the midfacial surface, and continue to the distofacial line angle. Draw the second line on the facial surface of the cast, parallel to and 4 mm from the gingival margin (Fig. 5, C).
3. Use a sharp blade or rotary instrument to connect the lines drawn during the preceding step (Fig. 5, D).
4. Draw 2 lines to guide lingual reduction of the cast. Place the origin of the first line at the mesiolingual line angle, arc to a point 2 mm facial to the midlingual surface, and continue to the distolingual line angle. Draw the second line of the lingual/palatal surface of the cast, parallel to and 2 mm from the gingival margin (Fig. 5, E).
5. Use a sharp blade or rotary instrument to connect the lines placed during the preceding step (Fig. 5, F).
6. Eliminate distinct angles and lines by scraping the modified surfaces with a bladed instrument. Gently round the associated crestal contours (Fig. 5, G).
7. Examine the cast to ensure that modifications mimic the projected collapse of soft tissues (Fig. 5, H). Avoid aggressive recontouring of the cast, since this may prevent complete seating of the resultant prosthesis.
8. Place an artificial tooth in the desired position (Fig. 5, I and J). Duplicate desirable tooth positions to maintain the patient's preextraction appearance and minimize phonetic impact.



5 Cast modification based upon spatial modeling. A, Bone levels superimposed upon cross-section of a representative posterior segment. B, Coronal segment is removed using saw or laboratory engine. C, Two lines are placed on surface of cast. One line arcs from mesiofacial line angle to distofacial line angle, and is located 2 mm lingual to midfacial surface. Second line is parallel to and 4 mm from gingival margin. D, Sharp blade or laboratory engine is used to connect lines drawn in Figure 5, C. E, Two lines also guide lingual reduction. One line arcs from mesiolingual line angle to distolingual line angle, and is located 2 mm facial to midlingual surface. Second line is parallel to and 2 mm from gingival margin. F, Sharp blade is used to connect lines drawn in Figure 5, E. G, Sharp angles and lines are eliminated, thereby creating gently rounded faciolingual contour. H, Foregoing cast modifications permit natural collapse of soft tissues into extraction site to minimize likelihood of binding or tissue compression during placement of prosthesis. I, Resultant reduction shown. Broken line indicates premodification contours. J, Cross-sectional view of tooth placement and denture base contours as determined by spatial modeling. K, Mesiodistal cross-section of cast with osseous contours superimposed. Papillae are shortened and rounded to simulate collapse that occurs following extraction of adjacent teeth. Broken line indicates premodification contours. L, Papillae may collapse due to their relationships with underlying interradicular bone. Papillae also may "roll" as depicted in Figure 5, H.

9. Repeat steps 1 through 8 until all artificial teeth have been properly positioned.

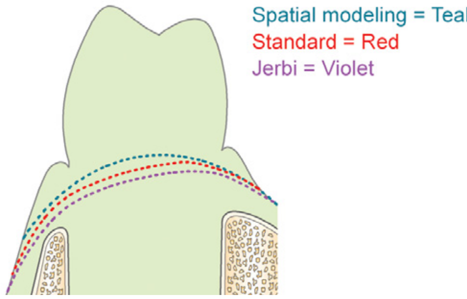
10. Complete the associated waxing, contouring, investment, and wax elimination procedures.

11. Upon completion of the wax elimination process, round and smooth areas representing the interdental papillae (Fig. 5, K and L) using 400-grit silicon carbide paper.

DISCUSSION

A comparison of the Standard, Jerbi, and proposed cast modifications is presented in Figure 6. Examination indicates the 3 methods of cast modification are similar at the lingual surface, but different as they project facially. The differences have significant clinical ramifications which are worthy of consideration.

Aggressive trimming of the cast's facial surface may result in binding or soft tissue compression upon initial placement of the resultant prosthesis. As previously noted, this may necessitate osseous recontouring, relief of the denture intaglio, or both. Insufficient adjustment commonly results in incomplete seating of the denture base and an uncontrolled change in the occlusion. Subsequent mastica-



6 Comparison of cast modification methods dictated by Standard, Jerbi, and by spatial modeling.

tory loading drives the prosthesis toward its fully seated position, trapping the soft tissues between the denture base and the supporting bone. This may result in "stabbing" or "crushing" discomfort, depending upon the surface characteristics of the underlying bone.

Because it calls for the most aggressive reduction at the facial surface of the dental cast, the method described by Jerbi is most likely to result in binding or soft tissue compression during insertion of an immediate denture. The method described by Standard requires intermediate reduction, and therefore is less likely to produce facial binding or soft tissue compression. The method introduced in this article yields the least facial reduction, and is least likely to hinder the clinical placement process.

While transparent surgical guides are an indispensable component of immediate denture therapy, they should not mandate unnecessary reduction of the supporting bone. Instead, cast modification should be performed with a thorough appreciation for the spatial arrangement and physical characteristics of the supporting hard and soft tissues.

Cast modification should provide sufficient space for the arrangement of artificial teeth, yet must allow for structural rigidity of the associated denture base. Cast modification also must permit the development of suitable functional and esthetic contours. As a result, modification should be based upon relevant scientific information in conjunction with clinical assessment. The current recommendations for spatial modeling are based upon anatomical averages from the dental literature.

As with any clinical procedure, the clinician must carefully evaluate the oral conditions for each patient. Thicker gingival tissues, increased sulcus depths, and increased bony resorption may warrant the use of Jerbi's technique for cast modification. Thinner gingival tissues, lesser pocket depths, and diminished bony resorption will be better served by a more conservative approach. When the clinician is uncertain about the oral conditions or desires to minimize hard and soft tissue reduction during placement of an immediate denture, the most conservative method for cast reduction should be used. This will minimize binding and soft tissue compression, and generally will result in greater clinical efficiency.

SUMMARY

Cast modification procedures associated with immediate denture therapy have been primarily anecdotal. Recommendations have been based upon expert opinion and clinical experience. While these recommendations have been useful, the growing body of evidence-based information permits new opportunities such as spatial modeling.

In this instance, spatial modeling was used to plan and execute a series of cast modifications central to the immediate denture fabrication process. Modeling was based upon accepted norms from the dental literature. The model supported development of a predictive cast modification technique intended to minimize the binding of denture bases, decrease the necessity for osseous recontouring, and enhance clinical efficiency.

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Noteworthy Abstracts of the Current Literature

The firing procedure influences properties of a zirconia core ceramic

Oilo M, Gjerdet NR, Tvinnereim HM.
Dent Mater 2008;24:471-5.

Objectives: High-strength ceramics for dental restoration are used as an understructure (core) that subsequently is covered by veneering ceramic. The veneering process involves a firing procedure at high temperatures at least once, usually two to five times. The aim of this study was to investigate whether these firing procedures affect the mechanical properties of a zirconia ceramic.

Methods: Thirty-three specimens of an industrially sintered yttria-stabilized zirconia ceramic (DC Zircon, DCS Dental AG, Allschwil, Switzerland) were cut into bars (1.2 mm × 4 mm × 20 mm). One set of specimens (n=13) remained untreated (controls). Another set of specimens (n=10) was heat-treated once, corresponding to the first step of the veneering process. The third set of specimens (n=10) was heat-treated five times to mimic the full veneering process. Flexural strength, microhardness, dimensions and surface roughness were measured. The fracture patterns were assessed by light microscopy.

Results: The untreated specimens showed a statistically significant higher flexural strength (20%) and microhardness (9%) than both of the test groups ($p \leq 0.001$). No significant differences were found for fracture patterns, dimensions or surface roughness.

Significance: The heat treatment associated with the veneering procedure on a zirconia core material reduced the flexural strength of the core after the first firing. Subsequent firings were not detrimental to the properties measured.