

### Prosthodontic principles in the framework design of maxillary obturator prostheses

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The Aramany classification system of postsurgical maxillectomy defects is a useful tool for teaching and developing obturator framework designs and enhancing communication among prosthodontists. This article describes a series of Aramany-obturator design templates and discusses the relevant considerations for each. In all situations, a quadrilateral or tripodal design is favored over a linear design because this allows a more favorable leverage design application that will aid in the support, stabilization, and retention of the prosthesis. (J Prosthet Dent 2005;93:405-11.)

In 1978 the late Dr Mohammed Aramany presented the first published system of classification of postsurgical maxillary defects.<sup>1</sup> He divided all defects into 6 categories based on the relationship of the defect to the remaining teeth and the frequency of occurrence of the defect in a relatively small patient population that he observed over a 6-year period at the Regional Center for Maxillofacial Rehabilitation in the Pittsburgh Eye and Ear Hospital.

Dr Aramany recognized that, in addition to being a communication tool, a classification that grouped particular combinations of teeth and surgical defects had relevance to the eventual design of a maxillary obturator prosthesis framework. The classification could be used to develop a series of basic obturator designs (templates) that have proven clinically successful and scientifically acceptable in particular situations. These templates could then be applied to other dental arches of similar classification or logically modified when slightly different situations presented. He also recognized that although the framework designs varied greatly with each group, the design objectives were always the same. Design and leverage were to be used to allocate, distribute, neutralize, or control the anticipated functional forces so that each supporting, stabilizing, or retaining element of the oral cavity could be used with maximum effectiveness without being stressed beyond its physiologic limits. Preservation of the remaining teeth, which is critical for support, stabilization, and retention of the prosthesis, is a primary goal in all classes.

Compromises frequently need to be made that may modify or even violate some of the principles followed in patients with more normal oral cavities.

#### GENERAL COMMENTS

The general principles of removable partial denture (RPD) design apply to obturator prosthesis design as well. Relevant among these are (1) the need for a rigid major connector; (2) guide planes and other components that facilitate stability and bracing; (3) a design that maximizes support; (4) rests that place supporting forces along the long axis of the abutment tooth; (5) direct retainers that are passive at rest and provide adequate resistance to dislodgment without overloading the abutment teeth; and (6) control of the occlusal plane that opposes the defect, especially when it involves natural teeth.

In addition, many unique considerations involved in the design are provided by the nature of the problem and the treatment required.<sup>2-4</sup> Among these are (1) the location and size of the defect, especially as it relates to the remaining teeth; (2) the importance of the abutment tooth adjacent to the defect, which is critical to the support and retention of the obturator prosthesis; (3) the usefulness of the lateral scar band, which flexes to allow insertion of the prosthesis but tends to resist its displacement; and (4) the use of the surveyor to examine the defect for the purpose of locating and preserving useful undercuts or eliminating undesirable undercuts.

Forces that are important in designing an obturator prosthesis framework have been discussed by Aramany.<sup>5</sup> Briefly, these are: vertical downward forces, because of gravity; vertical upward (occlusal) forces; rotational forces (which are multidirectional around constantly changing fulcrum lines); and anterioposterior forces, because of occlusal prematurities. The

Presented at the Academy of Denture Prosthetics meeting, Free-port, Grand Bahama Island.

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## Class I

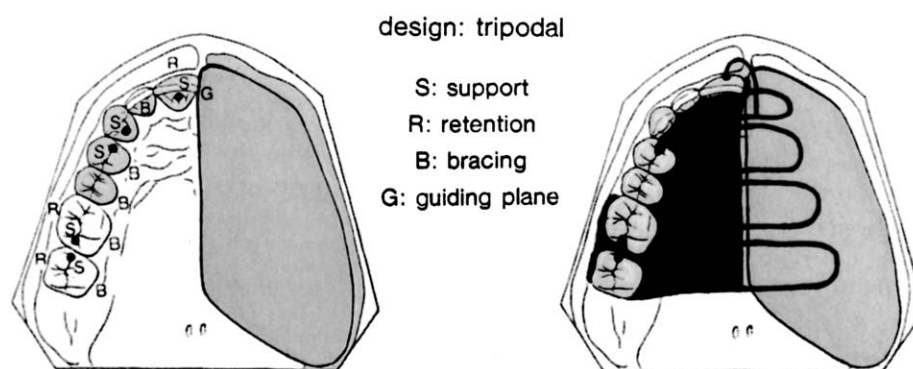


Fig. 1. Aramany class I tripodal obturator design for curved arches.

bony margin of the surgical defect often becomes an important fulcrum when the obturator is fully seated and loaded.

The prognosis of the obturator will improve with (1) the size (amount remaining after surgery) and curvature of the arch; (2) the quality of the tissue covering the ridge and lining the defect; (3) an abutment alignment that is curved instead of linear; and (4) the availability of teeth on the defect side for support and retention. Many designs require full coverage of the remaining palate for maximum support. In all instances, the gingival margins should be relieved when they are crossed by the major connector to avoid impingement during function. The uncovering of the gingival margins in such a design should be discouraged because it is not a replacement for good oral hygiene and is probably not necessary for tissue stimulation if good hygiene is practiced.

### CLASS I. CURVED ARCH FORM (Fig. 1)

The class I category represents the classic maxillary resection defect where the hard palate, alveolar, ridge, and dentition are removed to the midline. This unilateral defect is the one most commonly seen in the maxillofacial rehabilitative practice. Aramany made several recommendations regarding the framework design for this class, proposing a linear design if the remaining anterior teeth were not to be used for support or retention and a tripodal design if the anterior teeth were used.

#### Support

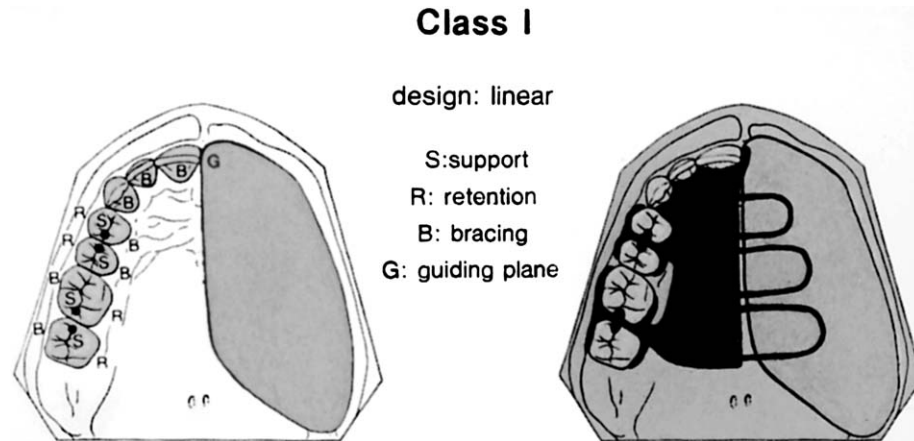
Support is provided and shared by the remaining natural teeth, the palate, and any structures in the defect that may be contacted for this purpose. The goal is to ensure that the functional load is distributed as equally as possible to each of these structures via a rigid major connector. The natural teeth are aided in this action when the support regions of the palate and the defect are

loaded to their maximum, without physiologic overload. A broad square or ovoid palatal form aids by providing a greater tissue-bearing surface to resist upward forces (such as may be supplied by an occlusal load) and a greater potential for tripodization to improve leverage. A tapering arch is less of an aid.

Rests are placed on the most anterior abutment (closest to the defect) and the mesio-occlusal surface of the most distal abutment tooth when alignment and occlusion will permit. The mesio-occlusal posterior rest, most often located between adjacent posterior teeth, is accompanied by a rest on the disto-occlusal surface of the more anterior adjacent tooth. This additional rest will prevent wedging and separation of the 2 adjacent teeth and will decrease the possibility of periodontal damage from food impaction.

The completed obturator often requires a compound path of insertion as undercuts and support regions within the defect will be negotiated before the teeth are engaged. Guide planes will assist in the precise placement of the prosthesis once the teeth have been contacted. They will also ensure more predictable retention and add a greater degree of stability to the prosthesis. Guide planes on the anterior abutment should be kept to a minimum vertical height (1 to 2 mm) to limit torque on the abutment teeth and should be physiologically adjusted. This is important since movement can be expected during function because of the extensive lever arm provided by the defect and the dual nature of the support system. This consideration becomes more important as the curvature of the arch decreases and the potential mechanical advantage of the indirect retainer is decreased. In this instance, it is especially important to use the palatal surfaces of the posterior teeth for additional bracing and stability.

An indirect retainer is usually located perpendicular to the fulcrum line (which connects the most anterior and most posterior rests) and as far forward as possible. This is usually a canine or first premolar. Strategically



**Fig. 2.** Aramany class I linear obturator design is used for class I defect when there are no anterior teeth present or when one does not desire to use anterior teeth and remaining posterior teeth are in a relatively straight line. Many design considerations are similar to Aramany class IV obturator design.

placed indirect retainers allow maximum use of leverage to resist movement of the prosthesis in a downward direction by the pull of gravity acting on the defect side.

### Retention

Retention is supplied by direct retainer designs that allow maximum protection of the abutment teeth during functional movements. On the anterior abutment, a 19- or 20-gauge wrought wire clasp of the “I-bar” design is often used to engage a 0.25-mm undercut on the midlabial surface of this abutment. Additional protection is afforded to this tooth by splinting it to 1 or 2 adjacent teeth with full crowns when possible or acid-etch composite resin techniques when crowns are not possible. Other possibilities include a variety of cast clasp assemblies located on the height of contour for frictional retention only.

The posterior retainer is most often a cast circumferential clasp using 0.25 mm undercut on the buccal surface. The placement of posterior clasps facing in both an anterior and posterior direction will aid in retaining both the anterior and posterior portions of the prosthesis.

### CLASS I. LINEAR ARCH FORM (Fig. 2)

The linear design is used for the class I defect when there are no anterior teeth present or when one does not desire to use the anterior teeth. The remaining posterior teeth are usually in a relatively straight line.

### Support

In the linear design, support is provided by the remaining posterior teeth and the palatal tissues. The palate becomes more important in the linear design because the use of leverage to resist vertical dislodging forces is decreased.

### Retention

Retention is usually provided by the combined use of buccal premolar retention and lingual molar retention.<sup>6</sup>

### CLASS II (Fig. 3)

Class II includes arches in which the premaxilla and the premaxillary dentition on the contralateral side is maintained. A single, unilateral defect is located posterior to the remaining teeth. This arch is similar to a Kennedy class II in that a bilateral, tripodal design can always be used. Presurgical consultation with the surgeon is an important aspect of care. Surgeons should be informed of the improved prosthetic prognosis when a class I situation can be converted to a class II situation by carefully planned surgery, assuming that tumor removal is not compromised.

### Support

Support is similar to that in class I and is provided by rests (located on the abutment nearest to the defect and farthest from the defect) as well as the palate. Support and stability are maximized by generating the largest tripodal design possible and again will be aided by a square or ovoid palatal form. Double rests are used between adjacent posterior teeth.

Guide-plane location and size is similar to the class I situation with full use of the palatal surfaces of the posterior teeth.

An indirect retainer located opposite the fulcrum line and as far forward as possible usually is located on the canine or first premolar and completes the tripodal design.

### Retention

Retention is provided in a fashion similar to that in the class I design. The abutment tooth located closest

## Class II

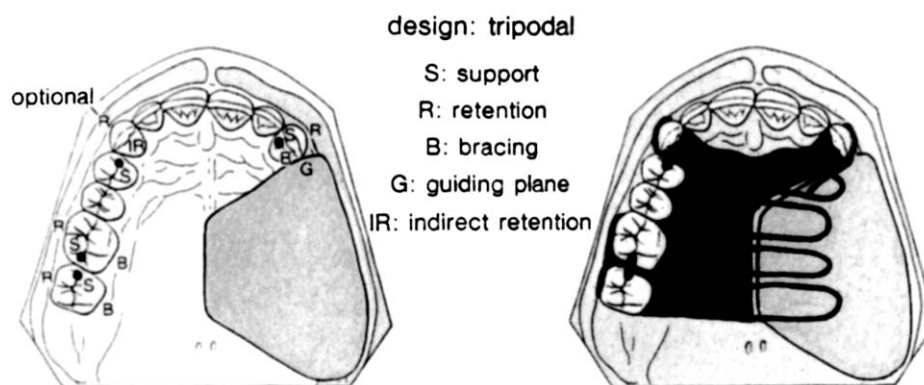


Fig. 3. Aramany class II obturator design.

to the defect is critical for retention and should be engaged with a direct retainer design that resists downward displacement but tends to rotate, disengage, or flex when upward forces are applied. A cast circumferential clasp or an I-bar clasp is frequently used in a 0.25 mm undercut when the retentive terminus can be located on the fulcrum line. A 19-gauge wrought wire clasp in a 0.5 mm or less mesiofacial undercut is also a frequent choice. Additional protection can be provided for this tooth by splinting it to the 1 or 2 teeth adjacent to it.

The posterior retainer is most frequently a cast circumferential clasp using a 0.25-mm distobuccal undercut. The placement of posterior clasp assemblies facing in both an anterior and posterior direction will aid in retaining both the anterior and posterior portions of the prosthesis. The anterior facing clasp will also serve to aid any additional clasps placed opposite the fulcrum line from the defect. The canine is frequently the location of the indirect retainer and also serves as an additional (but optional) retentive site, engaged with a 19-gauge wrought wire clasp in a 0.25-mm undercut. The canine is important in resisting occlusally directed forces and will receive severe stress. If an additional clasp is required on the canine, it should be a more flexible clasp in less than the normal amount of undercut or a less flexible clasp on the height of contour so that frictional retention will be supplied.

A combination of buccal and palatal retention is almost never indicated for this classification for several reasons. Among these are (1) additional bracing and cross-arch stabilization will be lost when lingual retention is engaged; (2) increased rotation will be noted with an actual decrease in retention because to the short length and shallow gingivally located curvature of the palatal surfaces of the molar teeth and disengagement of the lingual undercut on slight displacement; and (3) the location of lingual retentive clasps often results in

a major connector that has multiple small regions that trap food or irritate the tongue.

Occlusion on the defect side is important because the occlusally directed forces can be destructive. Occlusal schemes with fewer, smaller teeth, located further toward the anterior and devoid of premature or defluctive contacts is desirable.

## CLASS III (Fig. 4)

Class III involves a midline defect of the hard palate and may include a variable portion of the soft palate as well. The dentition is usually preserved, making this obturator prosthesis design simple and effective. The classification and design closely resemble the Kennedy class III RPD design.

### Support

Support is supplied by the remaining natural teeth via widely separated and bilaterally located rests. The canines and molars are usually selected to generate the largest quadrilateral shape possible while avoiding alignment and occlusion and hygiene problems, and providing good esthetics. Little or no support is expected from the palate or the defect. Bilateral symmetry of the major connector design and avoidance of the rugae area is desirable when possible.

Guide planes are usually short because they are located on the palatal surfaces of the posterior teeth. The proximal surfaces may be liberally used if edentulous spaces are present. Very little movement of the prosthesis should occur in function; therefore, these guide planes may be long and physiologic adjustment should not be necessary.

Indirect retention is not required because each terminus is supported by a direct retainer; therefore, rotation around a common fulcrum should not occur.



## Class III

design: quadrilateral

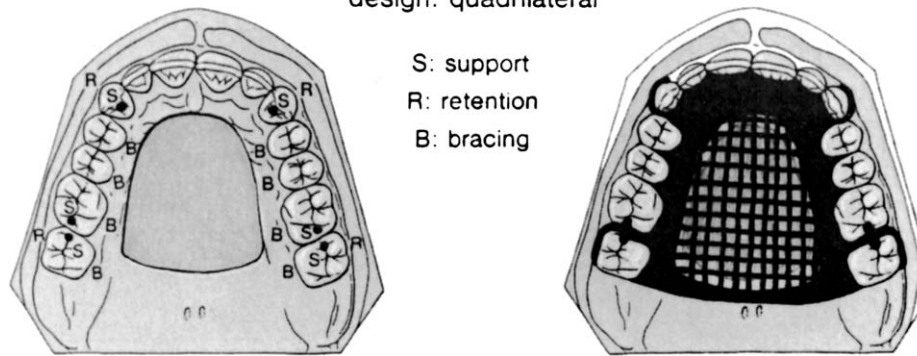


Fig. 4. Aramany class III obturator design.

## Class IV

design: linear

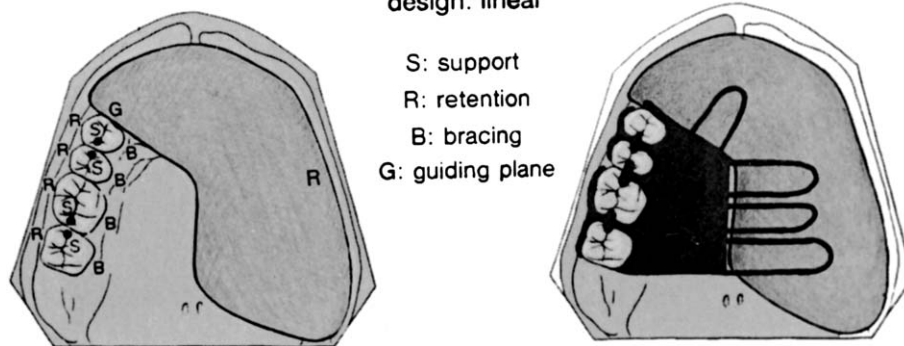


Fig. 5. Aramany class IV obturator is a linear design because of presence of only posterior teeth in a straight line. Retention is problematic. Combination of buccal and lingual retention may be necessary if useful retention cannot be found within defect.

### Retention

Retention is often provided with cast retainers using 0.25-mm undercuts on the facial surfaces of the teeth. These may be circumferential retainers, I-bars, or modified T-bars, depending on the location of the retentive sites, the esthetic requirements, and the presence of tissue undercuts. Combination-type retainers can be used to an esthetic advantage because they can engage a deeper undercut (0.5 mm) and may thus be placed in a less conspicuous region.

### CLASS IV (Fig. 5)

Class IV situations involve the surgical removal of the entire premaxillae, leaving a bilateral defect anteriorly and a lateral defect posteriorly. There are often a few remaining posterior teeth located in a relatively straight line, creating a unilateral linear design problem where leverage cannot be used to an effective degree.

### Support

Support is usually provided by rests located centrally on all of the remaining teeth. Channel rests or multiple mesio-occlusal and disto-occlusal results are often designed. The defect should also be engaged to use, as much as possible, any sites within the defect that may be contacted. These are the midline of the palatal incision, when palatal mucosa has been preserved to cover this region, the floor of the orbit, the bony pterygoid plates, and the anterior surface of the temporal bone.<sup>7</sup> If these regions are covered by respiratory mucosa from the nasal cavity, little added support can be achieved.

### Retention

Retention in this classification is problematic. Often a mixture of buccal retention on the premolars and palatal retention on the molars is used in a fashion similar to the class I linear design. This leads often to the same

## Class V

design: tripodal

S: support  
R: retention  
B: bracing  
G: guiding plane  
IR: indirect retention

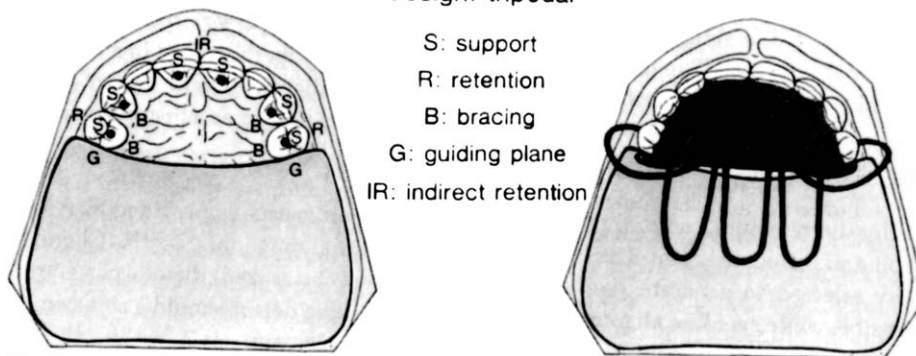


Fig. 6. Aramany class V obturator design template.

## Class VI

design: quadrilateral

S: support  
R: retention  
B: bracing  
G: guiding plane

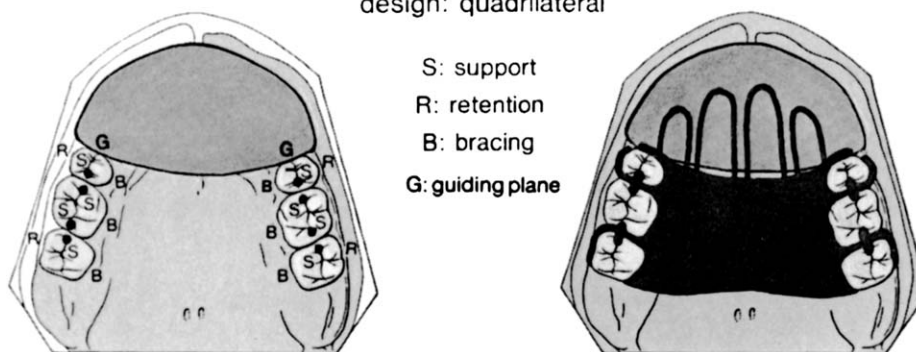


Fig. 7. Aramany class VI obturator design template.

problems discussed in class II situations when a combination of buccal and palatal retention is used: loss of bracing and stabilization, increased rotation, and the creation of small irritating spaces in the major connector design.

Retentive sites should be located on the facial surfaces of the remaining teeth and the lateral wall of the surgical defect via the superiolateral extension of the obturator section in the engagement of the lateral scar band. Reduced posterior occlusion (size and number of teeth) is also a useful suggestion. If no lateral scar band exists, because a split-thickness skin graft was not placed or because one could not be maintained, the prosthodontist may have no choice but to use a combination of buccal and palatal retention.

### CLASS V (Fig. 6)

This situation involves a bilateral posterior surgical defect located posterior to the remaining teeth. Many

or all of the teeth are present anterior to the defect. Labial stabilization and the use of splinting, especially of the terminal abutments, is desirable.

### Support

Support is provided by rests located on the mesio-occlusal surface of the most posterior abutment. These rests define the fulcrum line around which most of the expected movement will occur. If adjacent posterior teeth are involved, double rests are used for reasons outlined earlier. Stabilization and bracing is provided by broad palatal coverage and contact with the palatal surfaces of the remaining teeth.

Indirect retention is provided by rests located as far forward of the fulcrum line as possible. This usually places them on the central incisors, which often presents an occlusal problem that may require minor occlusal equilibration. The location of the indirect retainer essentially converts the design to an efficient large tripod

that uses leverage to resist downward displacement of the prosthesis. Positive rest seats are a critical necessity to eliminate the strong labial force generated by the downward movement of the prosthesis.

### Retention

The I-bar retainer is ideally suited for this situation. Located in a 0.25-mm midbuccal undercut very close to the fulcrum line, it provides for resistance to dislodgment and rotates in function. When the remaining soft palate is scarred and relatively immobile it can also be used to provide added retention for the posterior portion of the prosthesis.

A swing-lock type of prosthesis is a design possibility in this situation, especially if the patient can tolerate splinting of all of the remaining teeth.<sup>8,9</sup>

### CLASS VI (Fig. 7)

The class VI defect is a rare surgical creation. Most often it results from a congenital anomaly or trauma such as an automobile accident or a self-inflicted wound that removes the entire premaxillae (and may include a portion of one or both of the maxillae), leaving a single bilateral defect located anterior to the remaining teeth. Surgical defects of this nature are usually small. Nonsurgical defects are usually large and difficult to manage.

### Support

Support is provided by rests located on the disto-occlusal surfaces of the most anterior abutment teeth. Double rests are used when adjacent posterior teeth are involved. Greater stability is provided by placing additional rests as far posteriorly as possible. The most posterior rests, similar to the Kennedy class IV situation, may be considered indirect retainers, resisting the vertical downward displacement of the anterior segment of the prosthesis. In extremely large class VI situations, indirect retention may not be possible.

The remaining natural teeth provide all of the support, with little support derived from the defect.

Guide planes are usually located on the proximal surfaces adjacent to the defect and should be kept to minimal length (1 to 2 mm) to avoid trauma to the abutment teeth during expected movements of the prosthesis.

Splinting with a cross-arch tissue bar is also a possibility.

### Retention

Retention is most often provided simply with cast retainers using 0.25 mm of facial undercut. The I-bar located on the anterior abutment in a midfacial undercut close to the fulcrum line can function effectively. Combination retainers may also be used on the anterior abutments for esthetic reasons or when protection of the anterior abutments is a consideration.

Effective accessory retention can also be achieved by extending the prosthesis anteriorly into the nasal aperture. Cosmetic support of the nose and upper lip is also possible when adequate retention is present.

### SUMMARY AND CONCLUSION

The Aramany classification system of postsurgical maxillary defects is a useful tool for teaching and developing framework designs for obturator prostheses and for enhancing communication among prosthodontists. A series of obturator prosthesis design templates and the relevant considerations for each has been discussed. In all situations, a quadrilateral or tripodal design is favored over a linear design because this allows a more favorable application of leverage design for the support, stabilization, and retention of the prosthesis.

The templates provided should be considered basic types that can be applied in similar situations or logically modified by using the design principles presented when the situation warrants. Some of these situations may be medical necessity, the presence of modification spaces, periodontal considerations, opposing occlusion, location of hard or soft tissue undercuts, contingency planning, or the desire to simplify the design.

Although some dentists may disagree with the various facets of the templates presented, there is value for the student, teacher, or practitioner in the development of a systematic analysis of the design of maxillary obturator prostheses.

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0022-3913/\$30.00

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doi:10.1016/j.prosdent.2005.02.017