

Single Maxillary Complete Denture against Natural Dentition – Influence of the Palatal Vault of Selection of a Metal Denture Base

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Abstract Natural dentition consists of teeth that erupt into the oral cavity at different times. From the loss of a single tooth to loss of complete teeth, the position of the teeth keeps changing thus making an oral cavity as a dynamic entity. Loss of teeth in one arch with the concomitant presence of natural teeth in the opposing arch renders biomechanical issues that must be considered while designing the artificial denture. Different combinations of natural teeth and partial edentulous spaces can exist which need individual design considerations. We present a series of four clinical cases in which the maxillary arch was completely edentulous and the mandibular arch contained different Kennedy's partial edentulous situations. The biomechanics of natural teeth in respect of occlusal plane, axial inclination and type of arch have also been discussed. All cases enable a student to visualize a case scenario and help one to decide why the base metal denture base is indicated in such case. The role of palatal vault form and the need for clinical identification of such forms has also been discussed.

Keywords: base metal alloy, permanent denture base, partial edentulism, occlusal plane, supraeruption

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1. Introduction

The occurrence of a single maxillary or mandibular completely edentulous residual alveolar ridge (RAR) is not scarce. A single complete denture is the treatment of choice in such cases, although implant supported overdenture or implant supported fixed prosthesis will be more ideal. The presence of the opposing natural dentition poses a challenge not only in single complete denture construction, but also in the long term success of the prosthesis. The functioning of a complete denture (CD) prosthesis opposing natural teeth is a problem for two main reasons. One is the firmness and inflexibility of natural tooth retention in the bone and the scale of forces they can repel or send without causing discomfort. Other is the existing occlusal form of the natural teeth since it will dictate the occlusal form of the opposing denture. A maxillary single complete denture (MSCD) against mandibular natural teeth (with/without a fixed/removable partial denture) needs various clinical considerations. These include the amount of force exerted by natural teeth, the need of occlusal plane refinement, material selection and the modification in jaw relation procedures. These clinical decisions need to be taken during diagnosis and

treatment planning. One of the clinical consideration is selecting the type of denture base material that can fulfill the biomechanical requirements of a single complete denture to resist occlusal forces by natural teeth. Poor choice of material and design of single complete denture opposing natural teeth results in denture fracture which is due to flexural fatigue rather than impact fatigue. [1] The midline fractures in maxillary single complete dentures are mainly attributed to the uneven masticatory loads from opposing natural teeth. Once the forces are uneven and not along the long axis of the tooth, they automatically become heavy for a complete denture prosthesis. Besides occlusal plane analysis, individual inclination of opposing natural teeth must also be considered as it plays a significant role in the final design. Other factors that result in midline fractures in single complete maxillary dentures are poorly fit and presence of a high labial frenum. [2,3]

Metals and metal alloys inherit excellent strength to volume ratio, which allows them to be cast in thin sections as compared to the denture base acrylic resin which needs to be thick enough to have the required strength. Increasing thickness of acrylic denture bases in the mid-palatal region of the single maxillary denture to increase resistance to fracture has a direct effect on phonation. Other chief advantages of metal bases are for thermal conductivity, dimensional stability, accurate

casting adaptation to the residual ridge and enhanced mucosal health. [4-8] In addition to these, there are various types of palatal vaults that make an acrylic denture base resin prone to fracture when opposed by natural teeth.

With this background, this case series, which is a continuation of previously published case series, [9] represents four different cases of single complete maxillary denture that were opposed by four different types of complete dentulous or partial edentulous situations (Kennedy classification). This series will provide the reader, especially dental students a clinical picture of applying scientific knowledge into a case scenario. Various problems encountered under each clinical situation have also been discussed.

2. Case Series

Case no 1: An elderly female patient aged 63 years, reported to the department of Prosthodontics with chief complaint of fracture of maxillary complete denture which was fabricated by a local dentist 3 months back. The patient's medical, social and drug history was noncontributory. Existing denture was repaired by the same dentist and was correctly aligned in terms of fractured components. Extra oral examination showed normal clinical features (Fig 1A) except the maxillary lip being longer than the mandibular lip. Intra oral examination disclosed a maxillary completely edentulous residual alveolar ridge and mandibular Kennedy Class 2 Modification 2. Existing natural teeth were periodontally sound and showed no supra eruption. The mandibular

teeth made a three-point contact with the repaired maxillary denture (right second molar, right second premolar and left second premolar). The maxillary arch presented with a shallow and broad palatal vault anteriorly while the posterior RAR flared posteriorly with broad well-formed crest of the ridge. The patient was educated about the reasons of failure in her case by presenting her case on a diagnostic mounted cast. Treatment options presented to the patient included implant supported maxillary removable or fixed complete denture or MSCD (with metal base) and a treatment partial denture for mandibular arch. The patient consented to the latter option. Routine clinical and laboratory procedures were carried for the fabrication of both dentures. The maxillary metal denture base was prepared after preparing the final impressions with Zinc oxide eugenol impression paste (DPI), following which a refractory cast (Wirovest, Bego, Germany) was made on which prefabricated pattern wax (Bego, Wilhelm-Herbst, Germany) for metal denture base was designed and reinvested (Figure 1B, C). Once the maxillary metal denture base was cast (Wiron 99; Bego, Bremen, Germany), finished and polished (Figure 1D) it was tried following which the maxillary complete denture base was processed with heat cure denture base resin (DPI, India) (Figure 1E, F). A treatment, partial denture for mandibular arch was prepared and both were delivered to the patient (Figure 1G). The patient was put on regular follow up and did not have any problem of denture breakage in her successive follow ups. The patient was also satisfied with the functional outcome of the single maxillary complete denture, especially in terms of its esthetics (Figure 1H).



Figure 1. (A) Extra oral view without denture (B) Pattern resin adapted on refractory cast (C) Reinvested refractory cast (D) Finished maxillary metal denture base (E) Maxillary complete single denture and mandibular interim partial denture (F) Tissue surface of maxillary denture (G) Complete denture intra oral view (H) Extra oral view during follow up visit

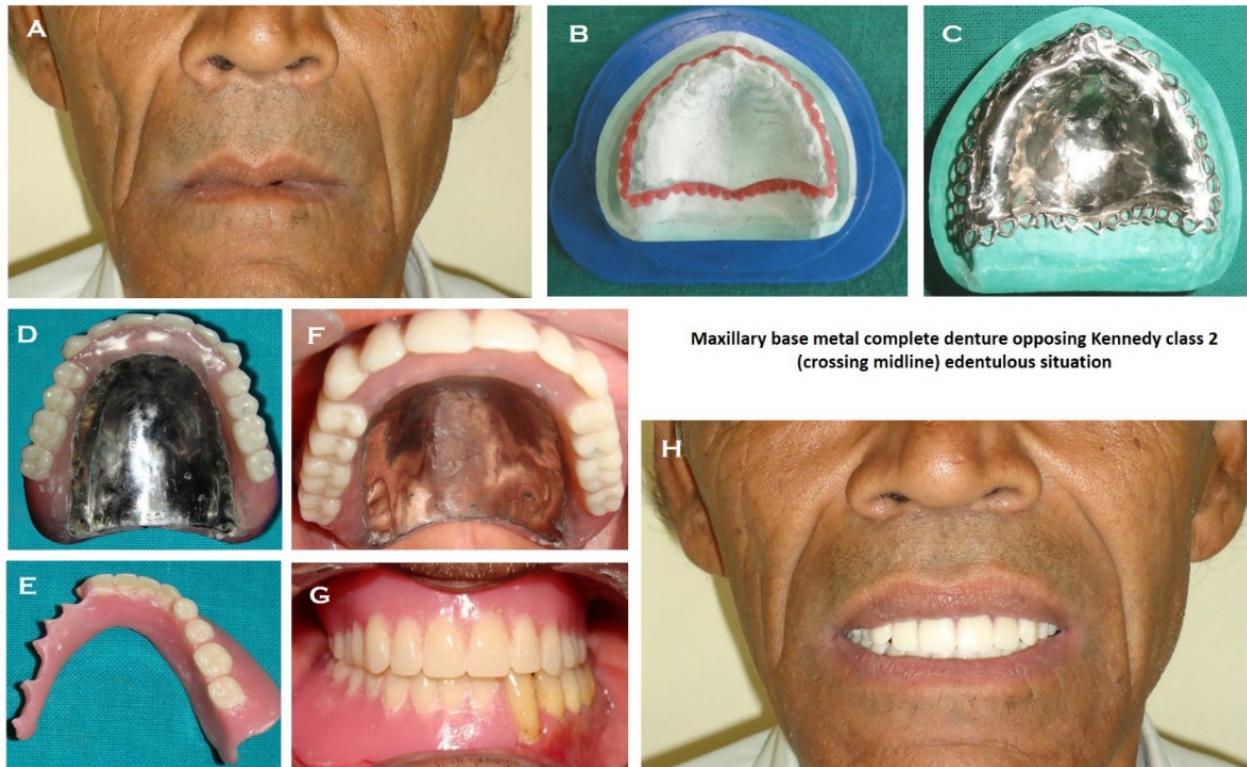


Figure 2. (A) Extra oral view showing a very long maxillary lip (B) Primary cast with extent of metal denture base (C) Finished metal denture base (D) Finished maxillary single complete denture (E) Finished mandibular interim partial denture (F) Denture in mouth (G) Both dentures in occlusion (H) Patients high lip line showing excess visibility due to hypermobility of the maxillary lip

Case no 2: An elderly male patient aged 62 years reported to the department of Prosthodontics with chief complaint of inability to eat since he had lost his natural teeth. Medical, social and drug history was noncontributory. Dental history revealed the patient had his maxillary and mandibular teeth extracted due to either mobility or decay over a period of ten years. The sequence of extraction was mandibular posterior teeth followed by maxillary posterior teeth and maxillary anterior teeth. Extra oral examination disclosed a very long face with increased lower third of the face (Figure 2 A). The maxillary lip was long and hypermobile, both of which were significant for placement of the lower lip line. Intra oral examination revealed maxillary completely edentulous RAR and a mandibular Kennedy class 2 situation that crossed the midline up to left lateral incisor. The natural teeth beyond left side mandibular canine were present and in good condition except for slight recession in relation to left canine. The maxillary arch showed similar shallow palatal vault with flared posterior ridges, while the crest of the ridge on both sides was broad. Treatment options presented to the patient included implant supported fixed/removable prosthesis which was rejected due to the economic viability of the patient. The treatment consented by the patient was a single maxillary complete denture with metal base and a mandibular interim partial denture. Cast partial denture was advised as definitive mandibular prosthesis. Routine clinical and laboratory procedures for complete denture fabrication were performed. The extent of the metal denture base was designed on the primary cast to evaluate the possibility of placing the retentive extensions within the vestibule, since the vestibular depth was low (Figure 2B). The maxillary complete denture base was cast (Wiron 99; Bego, Bremen,

Germany) followed by finishing and polishing (Figure 2C). Heat cure denture base resin (DPI, India), was processed to the metal denture base using routine laboratory procedures (Figure 2 D). An interim partial denture was fabricated of purely heat cure denture base resin (DPI, India) (Figure 2E). The denture was tried in the patient's mouth and necessary corrections in the post dam were made (Figure 2F). The mandibular denture was retained by the remaining natural teeth (Figure 2 G). The long lip of the patient mandated the incisal exposure of maxillary complete denture to be 2 mm below the lower lip line (Figure 2 H). The patient was satisfied with the outcome of the prosthesis.

Case no 3: An elderly female patient reported to the department of Prosthodontics with chief complaint of inability to masticate non vegetarian food because of loss of teeth. Patient medical history revealed that she was taking medicines for controlling blood sugar and she was diagnosed with the condition about 3 years back. Social history disclosed frequent gathering with friends and relatives. Dental history included loss of mandibular posterior teeth followed by loss of maxillary posterior teeth and then maxillary anterior teeth over a period of 10-15 years. Extra oral examination did not present any negative finding that would impact fabrication of a complete denture prosthesis. Patient had a normal low lip line, although during mild smiling the mandibular teeth were visible and showed an occlusal plane discrepancy on the right side (Figure 3A). Intra oral examination revealed maxillary completely edentulous residual alveolar ridge and a Kennedy class 1 partial edentulous situation in the mandibular arch that extended from first molars posteriorly. The maxillary arch was rounded with short vestibular depth. Palatal vault was shallow while the RAR

flared distally with the crest of the RAR being well formed. Treatment plan suggested to the patient was an implant supported fixed or removable maxillary denture with an implant supported mandibular fixed prosthesis or a definitive cast partial mandibular denture. Due to economic and time restraints the patient opted for a single maxillary complete denture (metal denture base) and a treatment partial denture. Routine clinical and laboratory procedures for the fabrication of single complete denture were carried. To decide the extent of metal denture base, an arbitrary extension was first

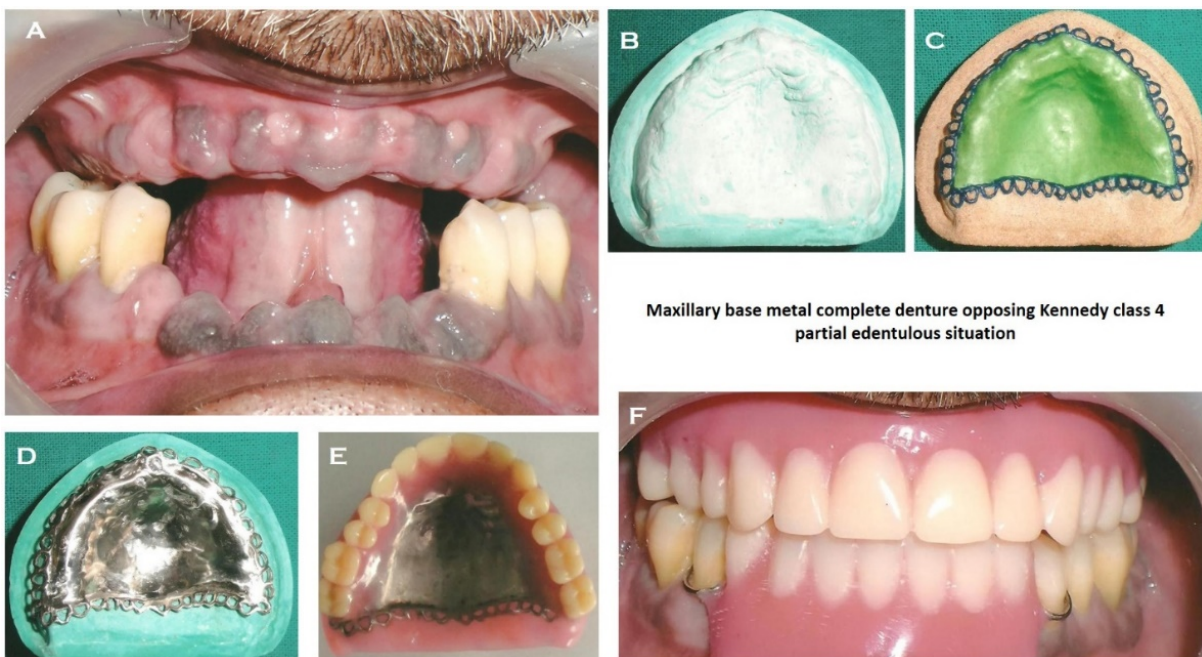
prepared on the diagnostic maxillary cast (Pankaj Industries, Mumbai, India) (Figure 3B).

The wax pattern for casting the CDMB was done on a refractory cast (Begosol, Bego, Germany) (Figure 1C), following which a finished and polished metal base (Wiron 99; Bego, Bremen, Germany) (Figure 1D) was tried in the patient. This was followed by routine jaw relations and denture processing (DPI, India). The final denture was delivered to the patient, which brought her satisfactory occlusal function (Figure 3E) and esthetics (Figure 1F).



Maxillary base metal complete denture opposing Kennedy class 1 partial edentulous situation

Figure 3. (A) Extra oral view showing visible mandibular anterior teeth (A) Wax pattern showing extent of final denture base (A) Pattern wax on refractory cast (A) Finished denture base (A) Occlusal scheme incorporated (A) Extra oral view showing the esthetic outcome



Maxillary base metal complete denture opposing Kennedy class 4 partial edentulous situation

Figure 4. (A) Intra oral view showing the relation of arches (B) Primary cast showing palatal vault type and RAR (C) Pattern wax on refractory cast (D) Finished denture base (E) Finished denture (F) Occlusal relationship of two dentures

Case no 4: An elderly male patient aged 52 years reported to the department of Prosthodontics with chief complaint of inability to chew food due to absence of teeth. Patients medical, social and drug history were noncontributory. Dental history revealed the patient had lost maxillary and mandibular front teeth due to trauma while maxillary posteriors were lost over a period of time due to decay and mobility. The patient had not worn any type of prosthesis in the past. Extra oral examination didn't reveal any negative clinical findings, intra oral examination showed the presence of a very irregular but well formed residual alveolar ridge in the maxilla and a Kennedy class four partial edentulous situation in the mandible with remaining natural teeth in healthy condition (Figure 4A). The last two molars on the mandibular right side were slightly buccally placed. The maxillary palatal vault was shallow with RAR flaring posteriorly with a well formed broad crest of the RAR (Figure 4B). After thorough investigations, the patient was presented with treatment option of implant supported fixed /removable complete denture for maxilla and a cast partial denture for mandible while second option was a conventional complete denture (metal denture base) for maxillary arch and a cast partial denture /interim partial denture for the mandible. The patient consented for the latter option. Routine clinical and laboratory procedures for fabrication of complete denture were done.

The metal denture base (Wiron 99; Bego, Bremen, Germany) was designed, cast, finished, polished and then tried on the patient first (Figure 4C, D), following which the denture was processed using heat cure denture base resin (DPI, India) (Figure 4E). Occlusal refinement was done at the time of denture delivery through a clinical remount procedure, and the patient was given instructions regarding denture maintenance. At successive follow ups, the patient was happy and satisfied with the outcome of the prosthesis and had adapted readily (Figure 4F).

3. Discussion

Multiple causes are attributed to denture fractures. Clinical factors predominate laboratory related factors and must be carefully analyzed. The choice of the material to be used as the single complete denture base is critical for successful wearing and longevity of single complete denture that opposes natural teeth. Fracture of maxillary complete denture base resin is a common complaint in clinical office, the mode of failure being flexural fatigue failures caused by cyclic deformation due to masticatory forces. [9] All the cases presented in this case series are single maxillary completely edentulous arch that is opposed by a natural dentition. Although in the first two cases, the opposing occlusion was in a more favorable position than the other two cases, any mandibular tooth posterior to second premolar is capable of causing a fracture of maxillary single complete denture. When mandibular posteriors are present the forces on both sides are compressive in the region of the opposing maxillary molars and this leads to increased tensile stresses in the midline of maxillary denture. [10] The fatigue failure of maxillary complete denture ultimately fails in midline creating a fracture, [11] since the crack propagation in

maxillary denture is quick due to a high tensile stress and shear stress. [9,12] These problems are applicable to conventional complete denture base which is generally made of heat cure denture base resin. Metal bases for complete dentures are indicated in such cases and should be used as a rule when opposing natural dentition of the mandible has posterior teeth. The selection of the denture base material also depends on the existing position of second premolar in relation to maxillary denture, the mesial inclination of teeth that have progressively migrated medially, the number of modification spaces in addition to the original class of a partially edentulous situation, the point at which the mandibular natural teeth contact the maxillary denture and the amount of supraeruption of opposing natural teeth. [5,8,9,13] The establishment of occlusion and articulation between the final denture and natural teeth should be accomplished without forces from any malposed tooth, severely tipped tooth, supraerupted tooth or even when the occlusal plane is irregular. Mouth preparation may range from simple occlusal equilibration to the crown placement. ¹⁴ Once it is established that the occlusal forces are within biological tolerance, one needs to decide only about the longevity of the single complete denture without any failure. Metals and metal alloys that can be used in denture bases for complete dentures are either noble or base metal alloys. Since noble alloys are expensive, base metal alloys also display similar properties like excellent strength to volume ratio, which allows the maxillary complete denture base to be cast in thin sheet without losing the advantage of strength. [9] The disadvantages with base metal alloys are additional cost, esthetics, difficulty in fabrication and inability or difficulty to rebase such prosthesis. One of the less common, although not rare in the use of base metal denture base is the possibility of patient being allergic to some component of the alloy. In one of the cases, the patient reported a history of allergy to some medications and ornaments. Therefore, before indicating a base metal denture base one must make sure that the patient is not allergic to the alloy. [15] Nickel is known to produce allergy and one must determine it by doing a standard patch test described by Menne T. [16] Their effect on the survival of fibroblast is well established. [17]

A significant finding among all the cases presented is the type of palatal vault that was common to all cases. A shallow palatal vault with a U shaped anterior ridge that flared posteriorly with the well - formed crest of the RAR. According the classification given by Johnson et al, [18] the palatal vaults are of three different types (shallow, medium and deep). Others have described the same shapes as square, tapering, arched or flat. [19] differences in fracture loads have been found between the shallow and medium vault or shallow and deep vault forms while less differences have been found between medium and deep vault forms. [20,21] in shallow palate, the lingual flange depth is less as compared to other two types of palate. Forces on either side are transferred in a plane that has more horizontal component than the vertical component. On the contrary, in case of a deep palatal vault, the lingual flange is deep and thus the forces generated on either side have to travel more in a vertical plane than in the horizontal one. [18] Horizontal forces generated tensile stress within the denture while vertical forces are

compressive in nature. It is these horizontal forces in a shallow palatal vault form, that results in more tensile stress within the denture which is highly concentrated in the midline of the denture. Repeated and cyclic forces contribute to early failure while the presence of natural teeth in the opposing arch also does the same. This also explains the reason why the failures of maxillary single complete denture can take place if the opposing natural teeth are posteriorly located. Residual ridge resorption of the maxillary arch can increase the magnitude of these forces. With resorption of the ridge, the tissue thickness over the bone increases, which also results in vertical movement of the denture. The principle of preserving the RAR has been termed as mandatory under all circumstances and should be planned right from diagnosis till the last followup. [22] In cases of complete denture with metal bases, it is mandatory to design the framework design on the diagnostic cast during treatment planning. Extension of the metal framework on the crest of the RAR should be avoided as it may hamper teeth placement and contribute to increasing the vertical dimensions in the denture. Vertical dimensions must be thoroughly evaluated using multiple recording methods (mechanical and physiological) and the amount of interocclusal space must be visualized once complete dentures are ready. The second case in the current series depicts one such example of poor visualization during diagnosis. The metal framework was extended over the residual alveolar ridge which later hampered placement of the teeth and resulting in increased vertical dimensions. Although the interocclusal space of two millimeters was present when mandible was observed at rest position, the amount was not sufficient to perform the normal functions like speech and swallowing.

4. Conclusion

Base metal alloy denture base provides a clinician with economical and efficient option to fabricate a durable complete denture prosthesis that is opposed by natural teeth. Since fracture of the dentures is common complications in such cases, clinical examination should focus on the palatal vault shape/form. The presence of the shallow palatal vault should alert the clinician and indicate a base metal denture base or a reinforced acrylic denture base.

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Conflict of Interest

None

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