

Restoration of the Severely Compromised Maxilla Using the Multi-Cup Denture

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Abstract

Among the millions of edentulous Americans, a persistent minority have not been able tolerate wearing dentures. Complicating factors may have precluded surgical intervention with grafts or dental implants to improve the physical and anatomic limitations of these unfortunate patients. A heat-cured polymer liner containing multiple small suction cups has been used for decades to successfully restore many such debilitated individuals. Two middle-aged female patients with edentulous maxillae and near fully dentate mandibles had both reached a point where they could no longer retain a maxillary complete denture, or function with it. Both had experienced multiple failed surgical attempts to improve their situations. They were both successfully restored with maxillary complete dentures containing heat-cured silicone liners with multiple small suction cups. Two young female maxillectomy patients had significant difficulties wearing maxillary obturators due to defect size and absence of defect undercuts. One had an edentulous maxilla, while the other had no axial undercuts on her few remaining maxillary teeth. Without an obturator, both suffered considerable air and fluid leaks, unintelligible speech, and swallowing problems. They too were successfully restored with obturators containing a heat-cured, multi-cup, silicone liner. The multi-cup, silicone denture liner has offered an economic, noninvasive alternative for patients unable or unwilling to undergo surgical intervention to facilitate prosthesis retention.

There have been times when the most logical solutions to the most difficult clinical problems have come from the distant past rather than the cutting edge of dental technology. Approximately 18 million adult Americans have been rendered totally edentulous. An additional 12 million have lost all teeth in one arch.1 Among those millions, a persistent minority have not been able to tolerate wearing dentures. Complicating factors, such as high surgical risk, underlying pathology, compromised blood supply, economics, or simply unwillingness on the part of the patient to undergo any surgery, may have precluded improvement of their situation by grafting and/or placement of dental implants.

This clinical report presents four patients who were successfully treated by prostheses lined with a heat-cured, soft polymer material (Multi-cup Prolastic®, Pollard Dental Products, West Lake Village, CA) containing multiple small suction cups covering the basal seat area.

The concept of multiple small suction cups incorporated into the intaglio surface of a denture is not a revolutionary idea. Incredibly, three early US patents were granted for complete denture designs based on such a concept. Two of these were issued in 1885.^{2,3} The third was awarded in 1907⁴ (Fig 1).

Even though similar approaches have been proposed since,⁵ the concept of suction cup retention has, for the most part, faded into oblivion.

With more than 20 patents to his credit, Dr. Arthur C. Jermyn, originally from Rochester, NY, was one of the most prolific dental inventors of the twentieth century.⁶ He resurrected the idea of suction cup-retained dentures with research that began in 1952.⁷ By 1963, after experimenting with many polymer materials and suction cup designs, he finalized his technique. He settled on a high molecular weight dimethylpolysilane because of its physical properties, ease of handling, and survivability. This material, coupled with Dr. Jermyn's unique suction cup design, has been used for decades to produce dentures with significantly enhanced retention and stability.

Despite Dr. Jermyn's impressive success with his multi-cup dentures, his technique and material have never enjoyed their deserved popularity due mostly to lack of effective marketing. His material, however, has remained available. It was used to successfully treat the following four patients who prior to treatment could not wear or function with a prosthesis and whose problems were not amenable to a surgical solution.



Figure 1 (Left) A nineteenth century US patent was granted to Joseph Spyer for a suction cup denture. (Center) Drs. Joseph Spyer and Robert S. Ingalls, both of Newton, KS, received a US patent in 1885 for their suction cup denture design. (Right) Dr. Gordon W. Morgan of Salem, VA, was awarded a US patent in 1907 for his multi-suction cup denture design.

Patient #1

EC was a 65-year-old female who lost all her teeth following considerable facial trauma sustained in a 1980 automobile accident. Since then, two unsuccessful attempts had been made to graft autogenous bone in her maxilla. By the time she presented at the University of Texas-Houston Dental Branch, she had an extremely atrophic maxilla with virtually no alveolar ridge. Her palatal tissue was notably traumatized. She had been building up the intaglio surface of her denture with multiple "denture pads" in an attempt to recapture some of her lost vertical dimension. Her radiographs suggested that areas of the hard palate were devoid of bone. She actually had two small oral/nasal fistulas which confirmed her paucity of remaining bone (Fig 2). With help from generous amounts of denture adhesive, she was able to wear her maxillary denture for esthetics only. Though most of her mandibular teeth were present and restored with porcelain-fused-to-metal units, she suffered from moderate to severe generalized periodontitis, Class III furcation involvements, and significant mobility of all unsplinted teeth. This patient's maxilla could be classified as ACP Prosthodontic Diagnostic Index (PDI) Class IV at the time of initial examination.8

Phase I of her treatment plan included grafting both maxillary sinuses, placement of two $4 \times 4 \text{ mm}^2$ flanged craniofacial implants in the approximate locations of teeth #6 and #11, and finally, the extraction of all remaining mandibular teeth. The second phase of her treatment was to place two endosseous implants into each grafted maxillary sinus. The two canine implants were lost in short order. She later lost both sinus grafts, so the posterior implants were never placed. She and her surgeon agreed that any additional attempts to graft her maxilla would be futile. The decision was made to fabricate a maxillary complete denture with a silicone multiple suction cup liner. Despite the fact that her remaining maxilla offered too little surface area to accommodate the recommended number of suction cups, her new prosthesis offered enough retention to allow normal speech, restored function, acceptable vertical dimension of occlusion (VDO), and support for her facial soft tissues. The patient has been satisfied with her restoration for more than 3 years.

Patient #2

YS was a 60-year-old female with extreme atrophy of her maxilla and significant trauma to her palatal mucosa. She also attempted to build up the intaglio surface of her maxillary denture with "denture pads" in an attempt to enable display of her maxillary anterior teeth when she smiled. She had a prior history of two maxillary subperiosteal frameworks. The first was placed in 1989. When it failed in 1994, a second framework was implanted. It also failed within 5 years. Two unsuccessful attempts to graft her mutilated maxilla followed. By the time she presented at the University of Texas-Houston Dental Branch, she could only wear her maxillary denture briefly for esthetics. Even that required the use of multiple "denture pads" and copious amounts of denture adhesive. Initial radiographs suggested a number of areas in her palate where there was no bone. Indeed, one could palpate her "hard" palatal mucosa and indent into the nasal cavity. This patient's maxilla could also be classified as an ACP PDI Class IV at the time of initial examination.⁸



Figure 2 (A) Occlusal view of an extremely atrophic maxilla. Note the two oral-nasal fistulas. (B) Cephalometric radiograph illustrating this patient's severe maxillary resorption.

Her mandibular arch was restored with 12 fixed units on her ten remaining teeth. The mandibular periodontium was healthy. She only had slight horizontal bone loss. Her oral hygiene was excellent.

An attempt was made to graft both maxillary sinuses to enable placement of two posterior, wide diameter dental implants 1 month later. During that procedure, several residual pieces of hardware (from past surgical procedures) were removed. Two $4 \times 4 \text{ mm}^2$ flanged craniofacial implants were placed in the approximate areas of teeth #6 and #11 at a later date. During the sinus graft procedure, the surgeon noted that the patient had no infraorbital foramina, because her maxilla had resorbed beyond that point. Her infraorbital neurovascular bundles coursed through soft tissue. Within 3 months, both sinus grafts and one of the posterior implants were lost, leaving two to three small oral-nasal fistulas. She complained of air and fluid leakage through her nasal cavity. Her speech was slightly hypernasal. In addition, she subsequently lost both craniofacial maxillary implants and the remaining posterior wide diameter implant. Both she and her surgeon agreed that any additional grafting attempts would most likely be in vain.

The decision was made to fabricate a maxillary denture with a multi-cup liner after her oral/nasal fistulas had been closed. One oral-nasal fistula did reopen but has since been reclosed successfully. Over the past 4 years, her prosthesis has served her well, and she has enjoyed normal speech, acceptable VDO, adequate soft tissue support, and remarkable retention considering the extent of her maxillary atrophy (Fig 3).

Patient #3

LC was a 19-year-old female diagnosed with a large mixoma of the right maxilla. An intraoral approach was used to perform a maxillectomy. As the tumor crossed the midline, the osseous







Figure 3 (A) Occlusal view of an extremely atrophic and mutilated maxilla. (B) Pretreatment radiograph showing extreme maxillary resorption. (C) Basal seat area after 4 years of wear of a suction cup liner. This one remaining implant was used only as an overdenture abutment in an attempt to preserve bone until it was also lost.

incision passed through the socket of tooth #9. Her soft palate was intact, but she was left with only teeth #10–15 and what remained of the left maxilla to support a prosthesis. None of the remaining teeth had facial or lingual undercuts. The defect was grafted with an acellular, dermal matrix (Alloderm[®], Biohorizons, Birmingham, AL) supported by a surgical obturator (Fig 4A,B). This patient could be classified as an ACP PDI Class IV⁹ at the time of initial examination.

The patient retained excellent facial symmetry without any facial scars. The soft tissue graft remarkably grew to cover and close nearly the entire oral nasal defect during the first 9–12 months postsurgery. An interim obturator was adjusted and relined regularly to readapt it to the healing defect. By 1 year postsurgery, the graft provided a thick, firm basal seat for a prosthesis; however, there was no scar band formation or residual defect undercuts to facilitate obturator retention and stability. The denture base was thinned as much as possible, and the right posterior teeth eliminated to reduce the weight of the definitive obturator. Retention was a major problem. The significant cantilever created by the obturator exerted excessive oblique forces on her few remaining teeth. A multi-cup liner

was placed in the intaglio surface of the obturator to offset these two problems. The patient has been comfortable for more than 3 years. Her speech has been excellent, and she has had no complaints regarding retention (Fig 4C,D). Perhaps the greatest advantage of the liner in this case was the significant reduction of torquing forces on her few remaining teeth.

Patient #4

HG was a 27-year-old female who survived a rhabdomyosarcoma, which was discovered in her maxilla at age 4. She was treated aggressively with a maxillectomy, chemotherapy, and radiation therapy. She has since undergone multiple reconstructive surgical procedures. When she presented at the University of Texas—Houston Dental Branch, she was suffering from severe facial deformity and hemiatrophy, unintelligible speech, and significant functional limitations. Due to caries and severe periodontal disease, her four remaining maxillary teeth were nonrestorable and very mobile. Her existing obturator was no longer serviceable. She had an osseous defect of her left orbital rim and zygomatic arch (Fig 5A). Her goals in treatment were a



Figure 4 (A) Occlusal view of patient's defect 1 month postsurgery. (B) Occlusal view of patient's defect 1 year postsurgery, the time of definitive obturator fabrication. Note lack of scar band and defect undercuts. (C) Intaglio view of patient's definitive obturator with suction cups. (D) Basal seat area after 3 years of wear of suction cup liner.

Α



Figure 5 (A) Stereolithographic skull (generated by a CT scan) showing the patient's osseous defect. (B) Intaglio view of interim obturator with multi-cup liner.

stable, retentive obturator to restore her speech and acceptable dental esthetics. This patient could be classified as an ACP PDI Class IV at the time of initial examination⁸

Phase I of her reconstructive surgical treatment plan was aimed at reorientation of the mandible to reestablish the occlusal plane. Bilateral L-osteotomies with iliac crest grafts were performed. In addition, the remaining hopeless maxillary teeth were extracted. An interim obturator/Gunning splint was fixed in place at the time of surgery to assure the planned outcome.

Phase II of the surgical plan was to reconstruct the maxilla to a point where five to six endosseous implants could be placed to support a stable, definitive obturator. Fibular microvascular free grafts were used for the reconstruction. Maxillary vestibuloplasties with soft tissue grafts were accomplished at the time of Phase II implant surgery. As a significant amount of time had to pass between the mandibular orthognathic surgery and the heroic maxillary reconstruction, the patient was furnished with a new interim obturator. Retention was a huge problem. She had less than half of her right maxilla remaining. The entire premaxilla was gone. Her right alveolus was rounded at both ends, which promoted anterior–posterior rocking of the prosthesis. The entire intaglio surface of the interim obturator was inlaid with a multi-cup liner. Stability and retention were remarkable considering her lack of basal seat anatomy. Once the interim obturator was delivered, her speech was restored to an acceptable level (Fig 5B).

Discussion

The multi-cup denture liner was developed to enhance retention, stability, and comfort for complete denture wearers, particularly those with significant resorption of their alveolar ridges. This material was never intended to make up for under-extended or inaccurate impressions. On the contrary, the exacting multicup technique has always required accurate impressions. Precise Trefine holes had to be carefully prepared in the master cast with a special drill (Multi cup/Treline Drill, Pollard Dental Products) and contra-angle handpiece. The holes were 2 mm in diameter, approximately 1 mm deep, and had walls with a 12.5° taper. They were spaced 1 to 1.5 mm apart, and prepared perpendicular to the palatal and ridge surfaces. They were not prepared over frenum attachments or within 2 mm of the denture borders. The manufacturer has recommended at least 200 holes for a maxillary cast and 150 for a mandibular cast (Fig 6).⁷ Drilling the holes is the most sensitive part of this technique. The holes must be drilled perpendicular to the mucosal surface so that the hole core is not broken.

The prolastic liners were either added to processed dentures by creating space for the material in the base prior to making reline impressions or processed at the same time as the acrylic base of new dentures using a shim during packing. In the latter case, the Prolastic material was added prior to final flask closure. The liner space was prepared 2 mm short of all denture borders with 90° butt joint margins and 1 to 2 mm deep. When liner space was limited, preventing denture teeth and base acrylic from directly touching the master cast was still important.

Material-specific denture cleaners (Prolastic Denture Cleaner and ProKleen Stain and Tarter Solution, Pollard Dental Products) have been recommended by the manufacturer to prevent breakdown of delicate suction cups, which usually happens when stronger commercial cleaners are used. As per the authors' instructions, none of the patients in this report have used denture adhesives with their multi-cup liners. Without further study, the authors have speculated that denture adhesives would probably clog the suction cups and prevent their intended spreading over the basal seat mucosa. The effect of denture adhesive on the Prolastic material is unknown

The basal seat tissues of the above patients wearing multicup liners have developed the expected shallow imprints of the suction cups; however, they have not shown signs of inflammation over the past 3 to 4 years. During his research, Dr. Jermyn biopsied many such patients. He only found focal areas of slight inflammation where a hole had been drilled too deeply. Holes of proper depth did not displace tissues to the point where the suction cups caused inflammation or pathology.⁷ The multi-cup denture liner, when properly placed, has offered a viable alternative to enhance denture retention when preprosthetic surgery may not have been feasible or desired by the patient.



Figure 6 (A) Cross sections of suction cup in relaxed and compressed positions. (B) Special Trefine drill for preparing multi-cup holes. (C) Drilling Trefine holes in the master casts. (D) Multi-cup prolastic liner in a maxillary denture before trimming and finishing.

References

- Misch CE: Contemporary Implant Dentistry (ed 2). St. Louis, MO, Mosby, 1999, pp. 3-12
- 2. Spyer J: Dental suction plate former. U.S. Patent Number 331,840, December 8, 1885
- 3. Spyer J, Ingalls RS: Dental plate. U.S. Patent Number 310,233, January 6, 1885
- Morgan GW: Dental plate. U.S. Patent Number 869,191, October 22, 1907
- 5. Whyman E, Valbuena L: The valve principle in denture retention,

making palateless dentures possible. Dent Items Interest 1933;55:206-211

- A Tribute to Dr. Arthur C. Jermyn. Oral Implantol 1995, 21: 262
- 7. Jermyn AC: Multiple suction cup dentures. J Prosthet Dent 1967;18:316-325
- McGarry TJ, Nimmo A, Skiba JF, et al: Classification system for complete edentulism. The American College of Prosthodontics. J Prosthodont 1999;8:27-39
- McGarry TJ, Nimmo A, Skiba JF, et al: Classification system for partial edentulism. J Prosthodont 2002;11:181-193

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