

BASIC PRINCIPLES AND STAGES OF TREATMENT OF PATIENTS WITH MAXILLARY RESECTION

Ivan Gerdzhikov

Department of Prosthetic dentistry, Faculty of Dental Medicine, Medical University of Sofia
ivan_ger1971@abv.bg

Abstract: Introduction: Surgical treatment of maxilla tumours causes different defects depending of dimensions and location, which are usually treated by prosthetic methods and means.

Aim: The aim of the literature review is to present the basic principles and stages of process of making of prostheses in cases with maxillary resection.

Discussion: Prosthetic approaches and devices take a central place in the complex treatment and rehabilitation of patients with maxillary resection. The main purpose of prosthetic restoration and rehabilitation is to improve the nutrition, speech, breathing and aesthetics of patients. According to contemporary concepts, optimal results are obtained by three-step sequential treatment with a surgical, temporary and definitive obturator.

Conclusion: The design and making of specific prosthetic devices compliant with the individual needs and stage of the oncological disease allow optimal restoration of damaged functions, and ensure the maintenance of good quality of life throughout all stages of treatment.

Keywords: maxillary resection, maxillary defect, obturator, post resection denture.

1. INTRODUCTION

Disorders resulting from maxillary resection cause serious impairment of chewing, swallowing, speech, and breathing functions (1, 2). Very often they are also accompanied by changes in the appearance and aesthetics of the patients (3). This necessitates the use of specific prosthetic methods and means to restore damaged functions (2). Because of the involvement of a different volume of the maxillofacial area, the treatment has its own specificities, conditioned by the degree of disability and the time after surgery (4).

Most authors (5, 6) carry out a three-staged prosthetic rehabilitation after maxillary resection through a surgical, temporary and definitive obturator. Each construction has its own specificity and has a different impact on quality of life (7). It is believed that the application of the three-stage treatment method allows optimal recovery of nutrition, speech and aesthetics of patients (8).

Other authors (9) believe that optimal therapeutic results are achieved by applying a four-stage treatment method that includes patient care after completion of prosthetic treatment. The need for corrections and alterations of prosthetic structures due to the need for new treatment for various reasons has led some authors to use a five-step prosthetic rehabilitation scheme (10).

2. AIM

The aim of the literature review is to present the basic principles and stages of process of making of prostheses in cases with maxillary resection.

3. LITERATURE SURVEY

Treatment with a surgical obturator

Prosthetic treatment with a surgical obturator is the initial stage of the overall prosthetic rehabilitation of patients with maxillary resection. Numerous methods for making surgical obturators are described in the literature. Most authors (11, 12, 13) attribute priority to the instant treatment methods that allow immediate recovery of damaged functions. Their use provides for surgical dressing, and feeding and swallowing. The creation of a stable barrier between the oral and nasal cavities allows immediate speech restoration, while preserving facial contours and aesthetics improves the patient's self-esteem. Most authors (14, 15, 16) define immediate prosthetic implants as an important factor in maintaining the quality of life of the patients. Studies show that poor quality of life after surgical treatment is the cause of 34.1% of patients with head and neck cancer being

identified as disabled (17). This is the reason why some authors (5) determine the making of the surgical obturator as the most important stage of treatment.

Prosthetic treatment with an immediate obturator requires pre-planning of the denture prosthesis according to the type, localization and size of the tumour (18, 19). Close cooperation between the surgeon and the prosthetic surgeon is required to ensure continuity between the surgical and prosthetic stages of treatment (11, 12, 13). For this purpose, preliminary impressions are made and work moulds are made, on which the boundaries of the upcoming resection are outlined (20). The type, number and location of the supporting-retentive devices are determined. Most often the retention and stabilization of the surgical obturator is accomplished by ligature wire, which is fixed to the natural teeth or the zygomatic bone (16, 21). In the absence of preserved teeth, different fixation methods are used in which the obturator is held and stabilized by spiral wire to a splint on the lower jaw (22). Silicone materials are also very often used to allow good defect sealing (23). For additional stabilization of surgical obturators, some authors (24) place mini dental implants. Regardless of the means of retention, the main purpose of the treatment is the stable fixation of the post-operative dressing and the restoration of the nutrition, swallowing, speech, breathing and aesthetics of the patients (6, 25).

Most studies prove the benefits of the immediate prosthetic treatment to improve the quality of life of patients with maxillary resection (5, 14, 15, 16). Results show optimal recovery of nutrition, speech, and swallowing (26). Other authors (27) consider that the immediate obturators are inaccurate and recommend to make surgical obturators several days after resection. There are different views on the duration of use of the surgical obturator, which range from 2-3 weeks to several months (5, 6, 26). Various methods of preserving and reproducing the shape of the teeth and the palate are applied to speed up the adaptation process to the obturator (28, 29). Other authors (30) use methods to stimulate the healing processes in the defect.

TREATMENT WITH A TEMPORARY OBTURATOR

Prosthetic treatment with a temporary obturator begins after completion of the initial healing processes in the defect. There are different and contradictory views on how long after the operation it has to be made, and how long to be used. According to most authors (31, 32), temporary obturator therapy should begin about 2 weeks to 2-3 months after the resection and continue until the final healing processes in the defect are completed. Others (28) believe that due to the dynamic changes in tissues, this period should be around 6 months after the surgery. Reasons for this are studies showing serious changes in the prosthesis field, which require an average of 12 to 14 prosthetic corrections during the healing process (33). This data supports some authors (14) to consider that there is no distinct difference between the surgical and the temporary obturator. In this sense, prosthetic treatment with a temporary obturator is seen as an intermediate stage in the rehabilitation of patients with maxillary resection, which confirms the results achieved with the surgical obturator (6, 14). Its important role in shaping the post-resection cavity in the course of the healing process is the reason for some authors (9) to define this stage as defining prosthetic treatment. It is assumed that its duration is about one year after the operation (20).

Numerous methods for making temporary obturators are described in the literature using different materials and techniques. Some authors (34, 35) prefer one-step methods in which the obturator is made directly into the patient's mouth. Others (36, 37) recommend the modification of the surgical obturator by using different types of materials. These methods are quick and easy to implement, provide good retention and stability, as well as the possibility of periodic rebasing (32). In the case of concomitant radiotherapy, when the temporary obturator is used for a prolonged period, the required maximum stability is achieved with the use of heat-cured acrylic resin (38). Good retention and sealing is achieved also with light-cured acrylic resin (39, 40). Their use allows a quick and easy modification of the shape and type of the obturator (41). Very often, the making and rebasing of the temporary obturator is hampered by the development of trismus (42, 43). This necessitates the use of silicone materials which ensure easy insertion into the defect and facilitate adaptation to the obturator (8). For this purpose, methods have been developed that allow the shape of the palate and natural teeth to be preserved (44, 45).

TREATMENT WITH A DEFINITIVE OBTURATOR

Prosthetic treatment with a definitive obturator begins after the healing processes in the defect are completed and is defined as the final stage of prosthesis in patients with maxillary resection (14, 28). The final defect formation allows accurate assessment and analysis of the prosthetic field, allowing the creation of an optimal plan for prosthetic treatment (11). For this purpose, the basic prosthetic principles for planning and constructing the prosthetic denture structures are applied (18). The individual features of each particular case, as well as the factors that affect the retention and stability of the obturator are considered (4, 6).

A number of methods have been described for making definitive obturators with different materials and technologies. Depending on the shape of the replacement part, the obturators are divided into two main groups - open and closed. Some studies have shown as advantageous the treatment with closed hollow obturators (46, 47). Various materials - salt (48), ice (49), sugar (50), asbestos (46), pumice (51) or pure acetate (52) are used to form the hollow replacement part. Various techniques are used to make a gypsum core that is fixed to the working model before packing (47, 53).

Research has shown that closed obturators creates a number of difficulties and problems that require replacement with open obturators (54, 55). Their main advantage is reduced weight and volume, which makes it easier to insert into the defect and provides greater comfort for patients (55). Weight reduction is from 6.55% to 35.06% compared to closed obturators (56). Electromyographic studies show better clinical results when using the buccal flange form of the replacement part (54, 57). Various technologies are used for its production (55, 58). A major disadvantage of the buccal flange obturator is the difficult cleaning and maintenance of good oral hygiene (59).

Very often, prosthetic treatment is hampered by radiotherapy, resulting in trismus. This requires the application of specific methods in which two-piece obturators are made (60). In most cases, these are two-step methods in which the plate is made of heat-cured acrylic resin, and the obturator part of silicone material (61). Cobalt-samarium magnets fixed on both sides of the obturator are used to connect them (62). Other connecting fittings such as plastic locks or press button are applied too (63).

The invention of new dental materials and the development of the technologies led to the development of modern methods of prosthetic treatment. In some of them the obturator is made of thermoplastic acrylic, which ensures optimal defect sealing (64). In others, the plastic is injected under pressure, allowing the production of homogeneous and non-porous obturators (65). To achieve the same effect, argon with controlled pressure and volume are also used (66). Other authors (67) recommend the production of multiple silicon chambers to ensure the retention and stability of the obturator. Complex technology and expensive equipment limits their mass use and is the cause of the use of abridged treatment methods (68, 69). In some of them (70), the temporary obturator is modified into the definitive, while in others (71, 72) a silicone or latex balloon is used to fill the defect.

4. DISCUSSION

Literature sources show understanding and common opinion on the view that prosthetic treatment of patients with maxillary resection is a difficult and prolonged process. Most authors (5, 6) believe that optimal results are obtained with a three-stage treatment method. It is assumed that the sequential elaboration of a surgical, temporary and definitive obturator ensures the maintenance of a relatively good quality of life during the different stages of treatment (1, 3, 8). There is a predominant understanding that to provide optimal results, prosthetic rehabilitation should be planned prior to surgical treatment (11, 18, 19). It is generally accepted that the construction of the obturators should correspond to the basic prosthetic principles of the construction of the prosthesis (4, 11, 13). It is necessary, however, to take into account the individual specifics of each case, to ensure optimal retention and stability of the prosthesis (4, 6, 18).

There are contradictory views about the duration of treatment with different types of obturators. The prevailing view is that immediate prosthetization provides optimal healing results (14, 15, 16). According to most authors (5, 6), its effectiveness is within 2-3 weeks to one month after surgery. It is unanimously agreed that treatment with a temporary obturator is an intermediate stage in prosthetic rehabilitation, which should continue until the healing

processes in the defect have been completed (6, 14). The resulting changes require the obligatory creation of a definitive obturator. There are a number of methodologies for making it by using different materials and techniques. There is no single treatment protocol, but there is a predominant view that optimal results are achieved using buccal flange obturators (55, 56, 57). However, it is generally accepted that the choice of the type of obturator and the means of retention depends on the size and localization of the defect and the presence of preserved teeth (4, 18). This, according to most authors (2, 11) provides maximum effectiveness of prosthetic treatment. It is also unanimously accepted that patient care is needed to preserve the achieved therapeutic results even after the completed prosthetic rehabilitation (9, 10).

5. CONCLUSION

The design and making of specific prosthetic devices compliant with the individual needs and stage of the oncological disease allow optimal restoration of damaged functions, and ensure the maintenance of good quality of life throughout all stages of treatment.

REFERENCES

- [1] Irish, J., N. Sandhu, C. Simpson, R. Wood, R. Gilbert, P. Gullane, D. Brown, D. Goldstein, G. Devins, E. Barker. Quality of life in patients with maxillectomy prostheses. *Head Neck*, 2009, Jun, 31 (6), 813-821.
- [2] Lethaus, B., N. Lie, F. de Beer, P. Kessler, C. de Baat, H. Verdonck. Surgical and prosthetic reconsiderations in patients with maxillectomy. *J. Oral Rehabil.*, 2010, Feb, 37 (2), 138-142.
- [3] Rogers, S. N, D. Lowe, D. McNally, J. Brown, E. Vaughan. Health-related quality of life after maxillectomy: a comparison between prosthetic obturation and free flap. *J. Oral Maxillofac. Surg.*, 2003, Feb, 61 (2), 174-181.
- [4] Borlase, G. Use of obturators in rehabilitation of maxillectomy defects. *Ann. R. Australas Coll. Dent. Surg.*, 2000, Oct, 15, 75-79.
- [5] Huryn, J. M., J. Piro. The maxillary immediate surgical obturator prosthesis. *J. Prosthet. Dent.*, 1989, vol.6, 3, 343-347.
- [6] King, G. E., J. Martin. Complete dentures for the obturator patient. *Dent. Clin. North Am.*, 1996, Jan, 40 (1), 217-237.
- [7] Lin, F. H., T. Wang. Prosthodontic rehabilitation for edentulous patients with palatal defect: report of two cases. *J. Formos Med. Assoc.*, 2011, Feb, 110 (2), 120-124.
- [8] Depprich, R., C. Naujoks, D. Lind, M. Ommerborn, U. Meyer, N. Kübler, J. Handschel. Evaluation of the quality of life of patients with maxillofacial defects after prosthodontic therapy with obturator prostheses. *Int. J. Oral Maxillofac. Surg.*, 2011, Jan, 40 (1), 71-79.
- [9] Mihailov, Tr. Prosthetic treatment of oncological patients with upper jaw defects. Dissertation for PhD, Plovdiv, 1992, 74-81.
- [10] Gerdzhikov I. Quality of life in patients with maxillary postoperative defects - analysis and optimization. Dissertation for Ph D. 2015, Sof., FDM, MU- Sofia.
- [11] Abadiq, B. J., J. Johnson. The prosthodontic management of cleft palate patients. *J. Prosthet. Dent.*, 1982, Sep, 48 (3), 297-302.
- [12] El Fattah, H., A. Zaghoul, E. Pedemonte, T. Escuin. Pre-prosthetic surgical alterations in maxillectomy to enhance the prosthetic prognoses as part of rehabilitation of oral cancer patient. *Med. Oral Patol. Oral Cir. Bucal.*, 2012, Mar, 1, 17 (2), 262-70.
- [13] Rahn, A. O., B. Goldman, G. Parr. Prosthodontic principles in surgical planning for maxillary and mandibular resection patients. *J. Prosthet. Dent.*, 1979, Oct, 42 (4), 429-433.
- [14] Carl, W. Preoperative and immediate postoperative obturators. *J. Prosthet. Dent.*, 1976, Sep, 36 (3), 298-305.
- [15] Garg, A. K., M. Malo, L. Dorado, F. Duarte. Postsurgical management with maxillary obturators after maxillectomy. *Gen. Dent.*, 1998, Jan-Feb, 46 (1), 75-78.
- [16] Marker, P., V. Svane-Knudsen, K. Jørgensen, A. Nielsen, O. Hansen. Immediate obturation of the surgical defect after partial maxillectomy in the edentulous patient. *Acta Oncol.*, 1997, 36 (1), 41-44.
- [17] Terrell, J. E., K. Nanavati, R. Esclamado, C. Bradford, G. Wolf. Health impact of head and neck cancer. *Otolaryngol. Head Neck Surg.*, 1999, Jun, 120 (6), 852-859.
- [18] Aramany, M. A., E. Myers. Prosthetic reconstruction following resection of the hard and soft palate. *J. Prosthet. Dent.*, 1978, Aug, 40 (2), 174-178.

- [19] Devlin, H., G. R. Barker. Prosthetic rehabilitation of the edentulous patient requiring a partial maxillectomy. *J. Prosthet. Dent.*, 1992, Feb, 67 (2), 223-227.
- [20] Tomer, L., A. Tomer, A. Gupta, A. Sachdeva, Y. Bakshi. Customised obturator prosthesis: A case report. *J. Indian Dent. Assoc.*, 2010, Dec, 4 (12), 570-573.
- [21] Omondi, B. I., S. Guthua, D. Awange, W. Odhiambo. Maxillary obturator prosthesis rehabilitation following maxillectomy for ameloblastoma: case series of five patients. *Int. J. Prosthodont.*, 2004, Jul-Aug, 17 (4), 464-468.
- [22] Patil, P. G., R. Parkhedkar. New spring retained surgical obturator. Clinical report for total maxillectomy patient. *J. Indian Prost. Soc.*, 2009, Jan, 9, 33-35.
- [23] Wood, R. H., W. Carl. Hollow silicone obturators for patients after total maxillectomy. *J. Prosthet. Dent.*, 1977, Dec, 38 (6), 643-651.
- [24] Bohle, G. C., W. Mitcherling, J. Mitcherling, R. Johnson, G. Bohle. Immediate obturator stabilization using mini dental implants. *J. Prosthodont.*, 2008, Aug, 17 (6), 482-486.
- [25] Rogers, W. A., T. Salinas, A. Novoselsky. Maxillary definitive obturators: rationale of design. *J. Dent. Technol.*, 1996, Nov, 13 (9), 19-26.
- [26] Lapointe, H. J., H. Lampe, S. Taylor. Comparison of maxillectomy patients with immediate versus delayed obturator prosthesis placement. *J. Otolaryngol.*, 1996, Oct, 25 (5), 308-312.
- [27] Park, K. T., H. Kwon. The evaluation of the use of a delayed surgical obturator in dentate maxillectomy patients by considering days elapsed prior to commencement of postoperative oral feeding. *J. Prosthet. Dent.*, 2006, Dec, 96 (6), 449-453.
- [28] Frame, R. T., G. E. King. A surgical interim prosthesis. *J. Prosthet. Dent.*, 1981, Jan, 45 (1), 108-110.
- [29] Patil, P. G. New technique to fabricate an immediate surgical obturator restoring the defect in original anatomical form. *J. Prosthodont.*, 2011, Aug, 20 (6), 494-498.
- [30] Чуркин, А. Ю. Реабилитация больных после резекции верхней челюсти с применением модифицированных комбинированных формирующих конструкций непосредственного и отдаленного протезирования. Канд. дис., Воронеж, 2010, 77-91.
- [31] Jacob, R. F., J. Martin, G. King. Modification of surgical obturators to interim prostheses. *J. Prosthet. Dent.*, 1985, Jul, 54 (1), 93-95.
- [32] Wolfaardt, J. F. Modifying a surgical obturator prosthesis into an interim obturator prosthesis. A clinical report. *J. Prosthet. Dent.*, 1989, Dec, 62 (6), 619-621.
- [33] King, G. E., M. Chambers, J. Martin. Patient appointments during interim obturation: is it cost-effective? *J. Prosthodont.*, 1995, Sep, 4 (3), 168-172.
- [34] Beder, O. E., J. Todo. Rapid technique for constructing a hollow-bulb provisional obturator. *J. Prosthet. Dent.*, 1978, Feb, 39 (2), 237-239.
- [35] Parel, S. M., H. La Fuente. Single-visit hollow obturators for edentulous patients. *J. Prosthet. Dent.*, 1978, Oct, 40 (4), 426-429.
- [36] Radcliffe, G. J., S. Mady, R. Burr, A. Cheesman, D. Wilson. A new immediate temporary lightweight obturator for maxillectomy cavities. *Br. J. Oral Maxillofac. Surg.*, 1984, Feb, 22 (1), 50-53.
- [37] Tanaka, Y., H. Gold, S. Pruzansky. A simplified technique for fabricating a lightweight obturator. *J. Prosthet. Dent.*, 1977, Dec, 38 (6), 638-642.
- [38] Kaplan, P. Stabilization of an interim obturator prosthesis using a denture duplicator. *J. Prosthet. Dent.*, 1992, Mar, 67 (3), 377-379.
- [39] Fischman, B. The use of light-cured material for immediate hollow obturator prosthesis. *J. Prosthet. Dent.*, 1989, Feb, 61 (2), 215-216.
- [40] Gardner, L. K., G. Parr, D. Richardson. An interim buccal flange obturator. *J. Prosthet. Dent.*, 1991, Jun, 65 (6), 862.
- [41] Wang, R. R., R. Hirsch. Refining hollow obturator base using light-activated resin. *J. Prosthet. Dent.*, 1997, Sep, 78 (3), 327-329.
- [42] Lauciello, F. R., D. Casey, D. Crowther. Flexible temporary obturators for patients with severely limited jaw opening. *J. Prosthet. Dent.*, 1983, Apr, 49 (4), 523-526.
- [43] Shaker, K. T. A simplified technique for construction of an interim obturator for a bilateral total maxillectomy defect. *Int. J. Prosthodont.*, 2000, Mar-Apr, 13 (2), 166-168.

- [44] Haraguchi, M., H. Mukohyama, H. Taniguchi. A simple method of fabricating an interim obturator prosthesis by duplicating the existing teeth and palatal form. *J. Prosthet. Dent.*, 2006, Jun, 95 (6), 469-472.
- [45] Kouyoumdjian, J. H., V. Chalian. An interim obturator prosthesis with duplicated teeth and palate. *J. Prosthet. Dent.*, 1984, Oct, 52 (4), 560-562.
- [46] Worley, J. L., M. Kniejski. A method for controlling the thickness of hollow obturator prostheses. *J. Prosthet. Dent.*, 1983, Aug, 50 (2), 227-229.
- [47] Buckner, H. Construction of a denture with hollow obturator, lid, and soft acrylic lining. *J. Prosthet. Dent.*, 1974, Jan, 31 (1), 95-99.
- [48] Bawa, R. K., K. Kaur, S. Kaur, I. Singh. Prosthodontic management of dentate hemimaxillectomy patient - a case report. *Indian Journal of Comprehensive Dental Care*, Jul, 2011, Vol. 1, Issue 1, 75-77.
- [49] Schneider, A. Method of fabricating a hollow obturator. *J. Prosthet. Dent.*, 1978, Sep, 40 (3), 351.
- [50] Matalon, V., H. La Fuente. A simplified method for making a hollow obturator. *J. Prosthet. Dent.*, 1976, Nov, 36 (5), 580-582.
- [51] Minsley, G. E., D. Nelson, S. Rothenberger. An alternative method for fabrication of a closed hollow obturator. *J. Prosthet. Dent.*, 1986, Apr, 55 (4), 485-490.
- [52] Habib, B. H., C. Driscoll. Fabrication of a closed hollow obturator. *J. Prosthet. Dent.*, 2004, Apr, 91 (4), 383-385.
- [53] Knapp, J. G. A simplified approach to the fabrication of a maxillary hollow obturator prosthesis. *J. Prosthet. Dent.*, 1984, Jan, 51 (1), 67-69.
- [54] Hasanreisoglu, U., A. Gurbuz, M. Beyazova. Electromyographic evaluation of different types of obturators constructed after maxillary resections. *Ankara Univ Hekim Fak Derg.*, 1989, May, 16 (1), 45-51.
- [55] Oh, W. S., E. Roumanas. Optimization of maxillary obturator thickness using a double-processing technique. *J. Prosthodont.*, 2008, Jan, 17 (1), 60-63
- [56] Wu, Y. L., N. Schaaf. Comparison of weight reduction in different designs of solid and hollow obturator prostheses. *J. Prosthet. Dent.*, 1989, Aug, 62 (2), 214-217.
- [57] Gerdjikov, I., Y. Kamenova, Y. Jotova. The measurement of electrical action potential of nervus facialis after treatment with maxillofacial prostheses. III congres BaSS, Sofia, 2-5.04.1998, 121, 71.
- [58] Shifman, A. A technique for the fabrication of the open obturator. *J. Prosthet. Dent.*, 1983, Sep, 50 (3), 384-385.
- [59] Asher, E. S., J. Psillakis, J. Piro, R. Wright. Technique for quick conversion of an obturator into a hollow bulb. *J. Prosthet. Dent.*, 2001, Apr, 85 (4), 419-420.
- [60] Wang, R. R. Sectional prosthesis for total maxillectomy patients: a clinical report. *J. Prosthet. Dent.*, 1997, Sep, 78 (3), 241-244.
- [61] Padmanabhan, T. V., V. Kumar, K. Mohamed, N. Unnikrishnan. Prosthetic Rehabilitation of a Maxillectomy with a Two-Piece Hollow Bulb Obturator. A Clinical Report. *J. Prosthodont.*, 2011, Jul, vol. 20, 5, 397-401.
- [62] Mitchell, D. L., J. Gary, A. Khan. Rehabilitation of a patient with a bilateral partial maxillary resection. A clinical report. *J. Prosthet. Dent.*, 1989, Nov, 62 (5), 497-499.
- [63] Elangovan, S., E. Loibi. Two-piece hollow bulb obturator. *Indian J. Dent. Res.*, 2011, May-Jun, Vol. 22, Issue 3, 486-488.
- [64] Hayashi, J., M. Nishiyama, M. Miyake, I. Kudo, K. Nakazawa. Construction of a maxillary prosthesis with a hollow obturator by the balloon technique and a case report. *J. Nihon Univ. Sch. Dent.*, 1989, Dec, 31 (4), 585-596.
- [65] Cotert, H. S., C. Cura, A. Kesercioglu. Modified flasking technique for processing a maxillary resection obturator with continuous pressure injection. *J. Prosthet. Dent.*, 2001, Oct, 86 (4), 438-440.
- [66] Iramaneerat, W., F. Seki, A. Watanabe, H. Mukohyama, Y. Iwasaki, K. Akiyoshi, H. Taniguchi. Innovative gas injection technique for closed-hollow obturator. *Int. J. Prosthodont.*, 2004, May-Jun, 17 (3), 345-349.
- [67] Engelmeier, R. L., M. Gonzalez, M. Harb. Restoration of the severely compromised maxilla using the multi-cup denture. *J. Prosthodont.*, 2008, Jan, 17 (1), 41-46.
- [68] Palmer, B., K. Coffey. Fabrication of the hollow bulb obturator. *J. Prosthet. Dent.*, 1985, Apr, 53 (4), 595-596.
- [69] Gardner, L. K., G. Parr, A. Rahn. Simplified technique for the fabrication of a hollow obturator prosthesis using vinyl polysiloxane. *J. Prosthet. Dent.*, 1991, Jul, 66 (1), 60-62.
- [70] Haider, K. G., G. Lewis. A denture replication technique following partial maxillectomy: a case report. *Quintessence Int.*, 1994, Jan, 25 (1), 23-26.
- [71] Hou, Y. Z., Z. Huang, H. Ye, Y. Zhou. Inflatable hollow obturator prostheses for patients undergoing an extensive maxillectomy: a case report. *Int. J. Oral. Sci.*, 2012, Jun, 4 (2), 114-118.
- [72] Coffey, K. W. Obturation of congenital or acquired intraoral anatomic defects. *J. Prosthet. Dent.*, 1984, Oct, 52 (4), 559-560.