CASE REPORT

Three-dimensional precise orientation of bilateral auricular trial prosthesis using a facebow for a young adult with Crouzon syndrome

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SUMMARY

Facial deformity can be debilitating, especially in the psychological and cosmetic aspects. Although surgical correction or replacement of deformed or missing parts is the ideal treatment, prosthetic replacement serves the purpose in case of surgical limitations. Prosthetic rehabilitation of a missing auricle is an acceptable option as it provides better control over the tortuous anatomical shape and shade of the missing portion. Improper spatial orientation of the prosthetic ear on the face can damage the results of even the most aesthetic prosthesis. This case report describes a simple and innovative method for precise spatial orientation of auricular trial prosthesis using a facebow and custom-made adjustable mechanical retention design using stainless steel wire.

BACKGROUND

The fabrication of ear prosthesis is considered by many prosthodontists to be one of the more difficult replacements in maxillofacial rehabilitation.¹ The severe undercuts and pronounced convolutions of the ear's surface present a challenge in simulating a naturally proportioned ear.² The ears are vital organ for hearing and contribute towards facial aesthetics, so missing or malformed ears are sources of psychological and emotional stress.

The craniosynostosis syndromes constitute a group of conditions each characterised by premature craniosynostosis occurring in association with a variety of other abnormalities.³ These may or may not occur with syndactyly, anomalies of hands and feet. The most common of the craniosynostotic syndromes occurring without syndactyly is craniofacial dysostosis or Crouzon syndrome. It was first described in 1912 as one of the varieties of craniofacial dysostosis caused by premature obliteration and ossification of two or more sutures, most often coronal and sagittal.⁴⁻⁸ Facial deformity is observed at birth, followed with time by other features of the syndrome. The anteroposterior diameter of the head is smaller than transverse diameter.⁹ The forehead is high and wide. A wide face and hypoplastic maxilla producing pseudoprognathism are observed. Other common features include deviation of the nasal septum, narrowed or obliterated anterior nares, hypertelorism, divergent squint and antimongoloid eyelid slant. Impairment of hearing indicates disorders of the middle ear. Malocclusion, malposed teeth and dysphasia are noted.¹⁰

During the fabrication of an auricular prosthesis, spatial orientation of the trial prosthesis on the face and then simulation of the orientation over the working model is the most important and difficult part.¹¹ This case report presents three-dimensional (3D) precise orientation of bilateral auricular trial prosthesis for a young adult with Crouzon syndrome having bilateral rudimentary ears, using a facebow.

CASE PRESENTATION

A 20-year-old male patient presented with small and deformed ears since birth. He was diagnosed with a case of Crouzon syndrome. On extraoral examination, the patient had bilateral rudimentary ears and midfacial deficiency due to which he had a concave profile and mandibular pseudoprognathism (figures 1 and 2). On intraoral examination, the patient had normal functional occlusion with a full complement of teeth.

INVESTIGATIONS

Audiometry was advised and results showed normal hearing pattern. Radiographic examination was performed with orthopantomograph and lateral cephalogram. The radiographic and clinical evaluation confirmed the diagnosis as Crouzon syndrome. The patient's functions were normal and acceptable to the patient. The patient's prime

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Figure 1 Preoperative view of the left ear.

Figure 2 Preoperative view of the right ear.

concern was his appearance due to rudimentary ears. All the treatment options were discussed with the patient including surgical reconstruction, implant retained prosthesis and conventional silicone prosthesis. Fabrication of conventional silicone auricular prosthesis was planned due to time and financial constraints.

TREATMENT

Procedure for fabrication of auricular prosthesis

The patient was seated in a dental chair in supine position. His skin over the face and the hair adjoining the forehead were lubricated with petroleum jelly for easy impression retrieval. External auditory meatuses were blocked with gauze packs tied with thread. Impression compound (Pinnacle, DPI, India) was used to make beading for the confinement of the impression material around the area to be picked up in the impression. Two small endotracheal tubes were placed into the patient's nostrils to facilitate breathing during impression making. Thin mixed irreversible hydrocolloid impression material (Zelgan 2002, DENTSPLY, India) was poured over the face from hairline to chin, covering the postauricular part up to hairline on both sides. Gauze pieces and bell pins were placed in the impression

Figure 3 Frontal view of the patient's face.

material for retention of backing material. Dental plaster (Kaldent, KALABHAI, India) was used for backing to strengthen the set impression material. The completed impression was retrieved after the impression materials set. The impression was poured in dental stone (Kalstone, Kalabhai Karson Pvt Ltd, India) with adequate land area to make the facial moulage (figures 3 and 4). The auricular wax pattern was fabricated over the model using pattern wax. It was planned to use a facebow for the precise 3D orientation of trial prosthesis during fabrication between patient's face and working model.

Facebow transfer of trial prosthesis

Reference points were marked on the patient's face for the placement of the facebow. Two points were marked in front of both ears 13 mm from the superior aspect of tragus on a line from top of tragus to outer canthus of eye, to act as posterior points of reference (figures 5 and 6). The nasion was used as anterior point of reference. The ear pieces of the facebow were placed on the posterior points of reference and nasion indicator was placed on the nasion on the face of the patient (figure 7). Vinyl polysiloxane impression material in putty consistency (Express STD, 3M ESPE, USA) was wrapped around the ear-pieces to make an index for transfer of markings for precise orientation of the trial prosthesis over the face and the working model (figure 8). The wax pattern for prosthesis was modified and oriented on the patient's face using common anatomical landmarks including interpupillary plane, Frankfort horizontal plane and lower part lobule. Polyether medium body impression material (Impregum Soft, 3M ESPE, Germany) was used to attach the oriented and modified wax pattern to putty index attached with the earpiece of the facebow. Then this assembly was transferred to the model, and the wax pattern was completed over the model (figure 9).

Processing of auricular prosthesis

The orientation of the trial prosthesis on the patient's face was finalised and try-in was completed. The working model was

Figure 4 Facial model.

Figure 5 Ear piece of the facebow placed on left posterior point of reference.

indexed by creating four notches, three in the postauricular area and one in front of the tragus, for maintaining orientation of wax pattern over working die while flasking. Irreversible hydrocolloid impressions of the indexed model were made and poured in the dental stone to fabricate the working die. There was a deep undercut present behind the ears, so it was planned to utilise this undercut for mechanical retention of the prostheses. A custom-made framework was fabricated to support and retain the prosthesis. A 21-gauge stainless steel orthodontic wire was bent and adapted around the periphery of the ear with three prongs extending over the posterior surface of helix of the rudimentary ears and a hook was provided in front of the tragus to permit adjustment by tightening the wire (figure 10). The wire was etched and tray adhesive was applied over the wire to ensure bonding with silicone. Then the trial prosthesis adapted over the model was transferred to the indexed working die and completed wax pattern was flaked in the dental flask and dewaxing was performed.

The patient's skin colour was observed and staining of silicone was carried out for optimal colour matching of the prosthesis with adjoining skin. The silicone material mixed with stains was packed into dewaxed flasks and curing of the material was performed at room temperature for 24 h as the silicone used was room temperature vulcanising silicone.

The cured prostheses were removed from the dental flasks and extra material was trimmed off with fine scissors (figure 11). The finished and polished prostheses were delivered to the patient and the wire was tightened for appropriate retention (figure 12). Postinsertion instructions regarding use of prostheses, maintenance and cleaning were given.

Figure 6 Ear piece of the facebow placed on right posterior point of reference.

Figure 7 Front view of the facebow orientation.

OUTCOME AND FOLLOW-UP

The patient was educated about the use and precautions during the use of the prosthesis. He was highly satisfied with the treatment outcome, which was apparent from his instant acceptance of the prosthesis and from his facial expressions. No complication was observed during treatment and follow-up.

DISCUSSION

External ear deformities are caused by congenital anomalies including microtia associated with craniosynostosis, hemifacial microsomia and other syndromes. Other aetiological factors are traumatic injuries due to accidents, animal attacks, burns or human bites and cutaneous malignancies. Biological replacement of the missing or deformed ear is the ideal therapy. However, autogenous reconstruction of the deformed or missing ear is one of the most technically challenging plastic surgical procedures.^{12 13} Auricular prosthesis made from alloplastic material is an alternative to autogenous reconstruction. Since the days of the first auricular prosthesis described by Ambrose Pare,¹⁴ the retention of an artificial auricle has relied on some form of either mechanical or adhesive retention. Mechanical methods of

Figure 8 The facebow attached to trial prosthesis with putty index.

Figure 9 Orientation of trial prosthesis on the model using a facebow.

retention include engaging natural or surgically created anatomic undercuts, or attachment with temple piece of eyeglasses, hearing aids or double-sided adhesive tapes. Medical adhesives are widely used methods of retention for facial prosthesis but they are difficult to apply by the patient, may lead to tissue irritation and prosthesis degradation. Mechanical means engaging tissue undercuts or osseointegrated implant with attachments are substitutes for adhesives. Postauricular undercut was engaged in the presented case using a custom-made, adjustable wire framework design incorporated in the prosthesis.

Inappropriate orientation of an auricular prosthesis on the face can undermine the rehabilitation by even the most aesthetic prosthesis. Surface markings have been commonly used as references for the determination of location of ear prosthesis. Cephalometry and computer modelling have also been used for the same purpose.

The facebow is a caliper-like device, generally meant for recording jaw relations for intraoral prosthesis. It is used to orient the maxillary arch in relation to the base of the skull. In the current case, the facebow has been used to orient extraoral

Figure 10 Wire framework for retention and support adapted on the working model.

Figure 11 Left and right silicone auricular prostheses.

trial prosthesis. A novel technique for precise spatial orientation of the auricular trial prosthesis by transfer of record from try-in on the patient's face to the model for fabrication has been presented for a young patient with Crouzon syndrome.

Prostheses made by computer-aided-designing and computer-assisted-manufacturing (CAD/CAM) techniques are better than those fabricated by conventional methods. But unfortunately, taking into account the complexity and the high cost of the equipment needed, these techniques can only be applied in well-developed establishments or academic institutions, which makes us rely on more conventional techniques for the fabrication of extraoral maxillofacial prosthesis.

Advantages of CAD/CAM fabricated prosthesis include:

1. With a proper digital library, various shapes of the auricular structure could be superimposed on the digital model and the required one opted for in a matter of a few hours.
2. For paired structures (eg, eyes, ears), duplication to the exact dimension and mirroring can be done.
3. Using rapid prototyping, complex internal forms such as those present in the external ear can be reproduced with precision.
4. Eliminates the need for an impression procedure.
5. The digital model and the plastic prototype can be preserved. This is important as replacement of the prosthesis is

Figure 12 Postoperative frontal view.

required once every few years following discolouration, change in fit, tearing, aging and general wear.

6. The plastic prototype also allows multiple pouring for shade matching purposes.
7. They do not require a skilled anaplastologist for sculpting the clay model of the defect area (especially the ears).
8. The possibility of 3D visualisation and easy virtual changes (type of nose, dimensions, position on face) ensure optimisation of the whole process prior to manufacturing.
9. In addition, it allows the feedback of the patient to be incorporated.

The disadvantages of CAD/CAM are:

1. Cost factor: it is the primary and major disadvantage for poor patients in developing and underdeveloped countries.
2. Radiation dose: several articles have reported various techniques to reduce the radiation dose.
3. Requires equipment and computational skills of the CAD/CAM methods.

More innovations in this method include the use of digital technological advancements in the form of rapid prototyping, stereolithography and computer numerical control milling.

The accuracy of the results when facebow is used, is dependent on precise orientation of the pattern on the face and preserving the orientation relationship while transferring it to the

working model. However, the precision is influenced by subjectivity in this manual technique.

The biggest advantage of this innovative technique is that it is a simple, quick, effective and economical technique as it does not require elaborate and costly equipment and makes use of a facebow, which is a routinely used device in the dental operatory.

Competing interests None.

Patient consent Obtained.

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Learning points

- The wire framework embedded inside the silicone prosthesis can be used for adequate mechanical retention without affecting the aesthetics.
- Postauricular anatomic undercut engaged with custom-made wire framework provides adjustable retention to the prosthesis.
- The facebow, generally meant to orient intraoral landmarks, may be used for spatial orientation of extraoral landmarks on the face.
- The facebow can be used for simple, quick and precise three-dimensional orientation of the ear trial prosthesis in a single step.

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