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Review Article

The Early Development of Maxillofacial Prosthetics-A Historical Review

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Abstract

Facial deformities whether induced as part of punishment, accidents that happen during war or due to disease process have always intrigued fellow human beings. Those who were engaged in the profession of healing, in the ancient times have attempted surgical correction or created prostheses so that the humans could be rehabilitated both in appearance and in function. At times ingenious patients also have tried making prosthesis for themselves. The history of maxillofacial prosthetics has an abstract nature and it is developed through different periods of time. Initially maxillofacial prosthetics (MFP) was necessitated by humans who were not living but when the time transgressed from BC to AD, MFP was designed for living human beings.

Keywords: Maxillofacial Prosthetics; MFP; Tagliacozzi; Acharya Susruta; Gunner with Silver Mask

Introduction

Restoration of facial anomalies has a rich and profound past and is considered as one of the oldest attempts made on human body. Face provides identity to human beings and social acceptance [1]. In the ancient periods, archaeologists have found metallic inserts in the eye sockets, possibly inserted after death. Gold masks were found in Egyptian mummies; might have been fabricated as part of a ritual followed in those times (BC 3000-2500). It can be presumed that the ancient society has attributed great importance to the face even in the dead body [2]. Excavations done in graveyards of Peru found skulls with defects and matching gold and silver plates that indicate attempts of cranioplasties that has occurred in 3000BC [3].

History of Ramayana has been traced back to seven thousand years. Surpanakha, sister of King Ravana lost her nose at the hand of Lakshmana and it is presumed to have happened in Nasik in India. Name of the place arose from 'Nas' meaning nose and it is connected to this story. In the later years also, the practice of cutting the nose to shame a person prevailed in the Indian society.

Aacharya sushruta

Sushruta the ancient saint (6th century BC) ventured into surgical reconstruction of nose with a cutaneous flap obtained from the forehead. Amputation of nose and ear was executed as part of punishment for adultery in those times. No mention of prosthesis could be found with Sushruta literature [4].

A cartman and four Indian sepoys who were working for the British army were captured by Tipu Sultan's army and their noses were cut as a sign of infidelity to the mother land. They went to the house of a potter in Pune, the land of Marathas, where they got the noses repaired surgically following the technique of Sushruta. The name of the surgeon is mentioned as Maratha Vaidya Kumbhar. This was reported in the Madras Gazatte of August 1794. Two British doctors visiting India have noticed this and reproduced it in the Gentleman's magazine of London in October 1794. The Indian method of rhinoplasty was later popularised by British professionals. Sushruta and his technique of rhinoplasty was duly acknowledged in the world war museum and the royal Australasian college museum [5-7].

The practice and popularity of plastic surgery seems to have declined in the later years, probably because of the resistance of the religious leaders who thought that rhinoplasty is an attempt against God's will. The ancient society believed that disease is part of destiny and human beings cannot meddle with the God's domain. Many members of the healing profession too endorsed this

view and they did not recognise plastic surgery as part of the healing profession. During the time of Tagliacozzi (1546-1599) who is considered as one of the founding fathers of plastic surgery, rhinoplasty was reintroduced, after a long period of nearly a century. Because of the speciality, Tagliacozzi was denied a decent burial on his death in the consecrated ground. The faculty of medicine in Paris forbid plastic surgery performed on the face (1788) and the speciality has fallen into disrepute. Consequently, facial prosthetic devices have become popular and the responsibility of making them has fallen on to the shoulders of dental professionals. After 1860 many facial prosthetic attempts have been reported by dental professionals. Morton T G, the discoverer of ether anaesthesia has attempted obturators and nose prosthesis made in ceramic [8-12].

Hippocrates (440-360 BC) famed for the oath administered to physicians, has created voluminous medical literature but not all are retrieved. Maxillofacial defects do not find mentions in his literature. Cornelius Celsus (25 BC-AD 50) prepared an encyclopaedia of many subjects of which two belong to the subject of surgery. The long bone fractures and their treatment superseded other interests and the encyclopaedia did not refer to maxillofacial defects.

Historians designate the period between 5th Century AD and 14th century AD as middle ages' or 'medieval period'. During this period, some surgical instruments were developed. Justinian II who reorganised the Byzantine Empire (668-711 AD) had his nose mutilated as part of a disciplining process and he wore a gold prosthesis to restore the social standing and there by the Kingdom [13] .

Figure 1: Rhinoplasty done according to Sushruta's principle.

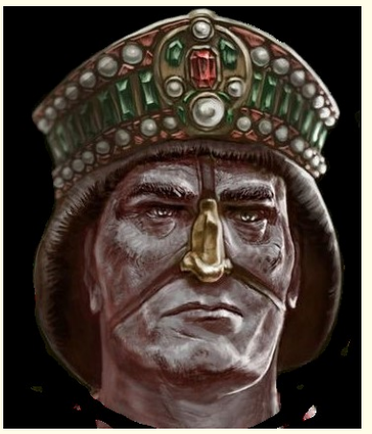

Figure 2: Justinian II, the nose which was cut off was restored with gold nose.

Abulcasis (936-1013) made great impact to the history of surgery. His monumental work is based on Greek and Roman school of medicine as well as the Arabic pharmacology. Abulcasis invented many surgical instruments; their design almost matching to their modern counterparts. His influence on eastern and western medical practice lasted for more than 600 years. It is believed that Abulcasis designed facial prosthesis in ivory [14].

Ambroise pare (1510-1590)

Ambroise pare has defined the important objectives of performing surgeries as follows:

- To remove what is superfluous
- To restore what has been dislocated (fractures)
- To separate what has grown together (which is not normal)
- To reunite what has been divided (severed in accidents)
- To redress the defects of nature (congenital abnormalities) [15].

Ambroise pare is given the status of a father figure of surgery by the modern counterparts. But during his time surgeons and barbers were given equal status in France. However, they were considered inferior to physicians. He received initial training as an apprentice under a barber surgeon and later got trained in a formal facility (Hotel Dieu Hospital) where on a later date he served as a surgeon. Pare was surgeon to the French royalty and French army. He served different Kings until his death. Pare's significant contribution is the introduction of ligature of arteries instead of cauterisation in the cases of amputation. This has avoided many deaths due to shock because of the crude methods used to stop bleeding [15]. During the lifetime, Pare did not receive due recognition. In 1943, a postage stamp was released depicting his photograph by the government; a belated recognition. (Figure 3).

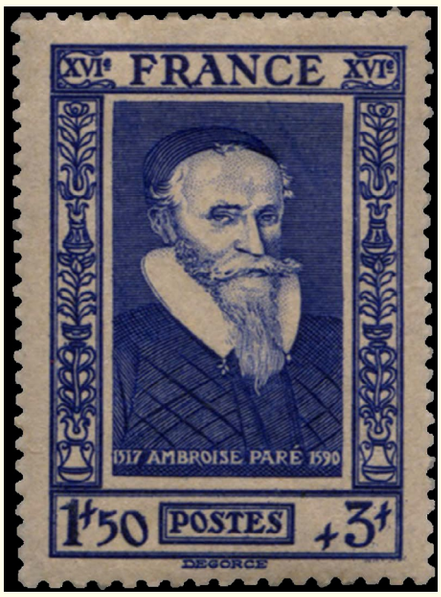

Figure 3: Postage stamp released in the name of Ambroise Pare postage in 1943.

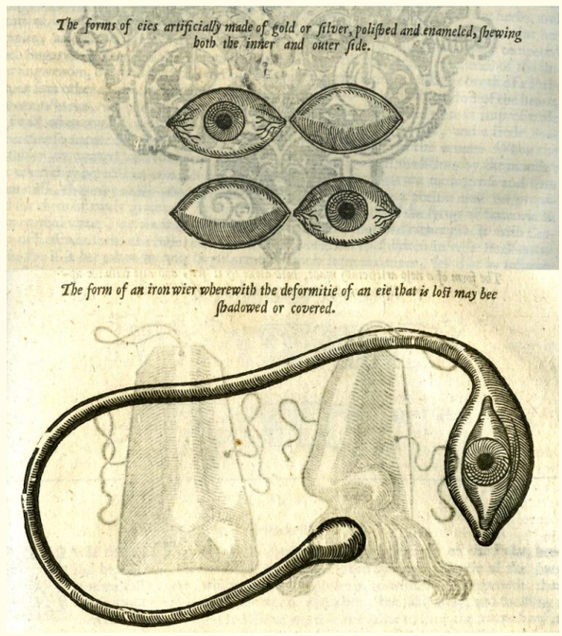

Figure 4: Illustrations of prosthesis from the book of Pare.

Technically maxillofacial prosthetics got initiated by Ambroise Pare because of the pressing need he faced in the military. He made facial prostheses (Epitheses) using gold, silver, paper and linen which were either held in position by laces or glued to the tissue surface. Ocular shells and orbital prostheses were also made by Pare. Another significant contribution of Pare is the preparation of Obturator. He used the word "Obturateurs" which is derived from the Latin word 'obturo' meaning 'stop up'. Palatal defects were common with gun shot injuries and venereal disease. Pare's obturator consisted of Gold or silver plates with clip like extensions towards the defective area. The clip could engage sponge like materials which would swell because of the secretions and provided reasonable seal. In a second design, the extension towards the defect could be rotated to engage the nasal cavity undercuts (Figure). The description of obturator is included in a book published by Pare in 1541 [15,16]. Pare has dedicated the book to the King of France (Figure 4-6).

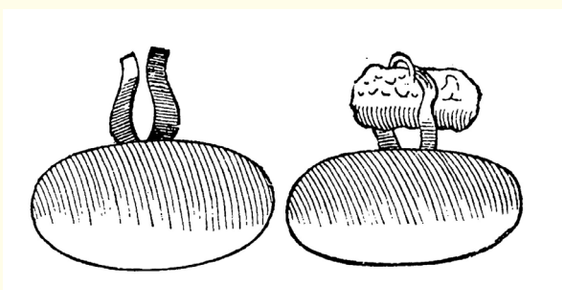

Figure 5: Obturator design -1 of Pare.

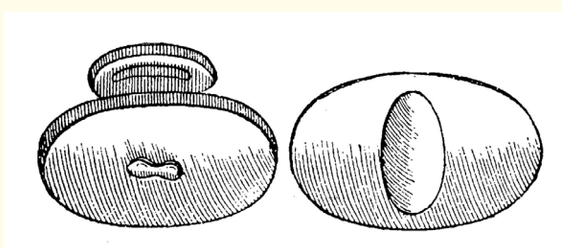

Figure 6: Obturator design-2 of Pare.

Demosthenes was an ancient Greek orator and philosopher who lived between 384-323 BC had cleft lip and palate. It is postulated that he used to keep pebbles or seashells inside the mouth and practised speeches in an underground room and in the seashore. He has overcome his speech deficiency by this practice. It cannot be considered as a historic precursor to obturator because it was only a personal practice, though an interesting observation [17].

Tycho Brahe (1546-1601)

Tycho Brahe an established Danish astronomer and Alchemist had his education in the universities of Copenhagen and Leipzig. In 1566, 20-year-old Brahe fought with a fellow student, Manderup Parsberg, his third cousin, in a duel over a matter of who was the better mathematician. As a result, Tycho lost a large chunk of his nose. It resulted in a least desirable duelling scar. A duelling scar is considered as a mark of aristocratic courage, but it should be a little line on the cheek or a little scratch on the forehead. Tycho wore a prosthetic nose made of brass with matching oil paint applied on throughout his life [18,19]. Tycho used a putty like material which served as an adhesive to attach the prosthesis to the face and always carried the putty in a small pot. Historians claim that on a later date, both Tycho Brahe and Parsberg became good friends (Figure 7).

Figure 7: Tychobrahe with the metallic nose.

Figure 8: Pierre Fauchard.

Pierre Fauchard (1679-1761)

The origins of Pierre Fauchard are not known with full details and most of the descriptions provided by different authors can be considered as imaginary. Fauchard's family was situated in Brittany (France). Initially he practised around his place and once gained confidence, the practice was shifted to Paris. He had authored a work named 'Le Chirurgien Dentiste' (The Surgeon Dentist or Treatise on the Teeth) which accredited him with the title "Father of Modern Denistry." It was a two-volume work written in 1723 and first published in 1728. Fauchard has stated that most of the information contained in the book was not new but known to his predecessors but never revealed in publications. Professionals of his time might have kept the knowledge of dental treatment as a guarded secret or monopoly; probably to maintain a successful practice [17].

In the second part of his book, he has described a few innovative designs of obturators. The design mainly consisted of two wings which could be opened and closed with the aid of a screw like key. In the collapsed state the obturator could be inserted into the defect area and after that the wings could be opened using the key. On expansion, the wings engaged the undercuts in the nasal cavity. Fauchard has used metal, bone and ivory in the construction of obturators. His obturators had a covering with sponge to ensure retention. Fauchard had a hobby of 'watch making' and perhaps that might have influenced in the design of the obturators. The teeth incorporated in the obturators were not looking natural but it does not reduce the importance of his invention (Figure 8,9).

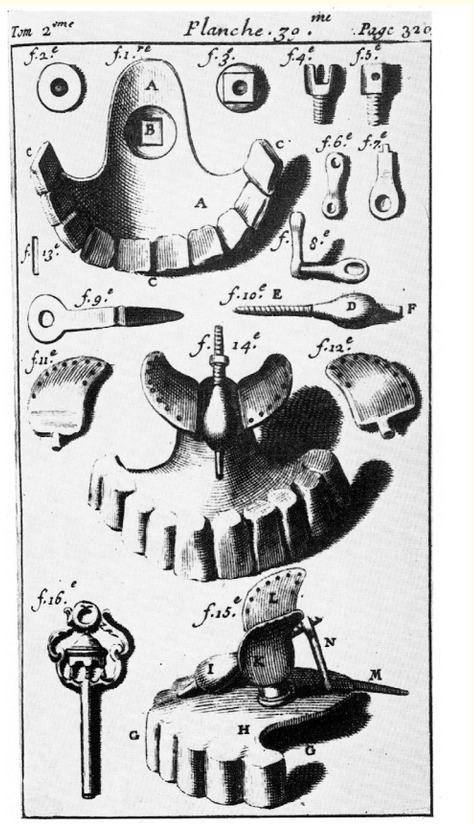

Figure 9: Obturator designed by Fauchard.

Evolution of obturators

Etienne Bourdet, a French dentist in 1756 expressed his idea, quite a deviation from that of Fauchard. He believed that in due course of time all the palatal defects would shrink and hence obturators need not extend far into the defects but need only be covered with a plate. The plates could be tied around the teeth with ligatures made of silk or gold threads. From that time onwards, the idea of metal plates that cover the palate has come to practice.

In 1820 Christopher Francois Delabarre improved on the design of Bourdet by replacing the ligatures with metallic clasps, probably the first attempt to use clasps in the history of dentistry. He has also tried obturators which have extended not only over the hard palate but over the soft palate defects also. The soft palate extension was made of soft 'caoutchouc' (rubber/India rubber) which was flexible. This was the first time a moving soft palate was incorporated in an obturator.

In 1841, Stearn, a medical graduate who had a congenital cleft tried to treat himself with an appliance. He was aware of Goodyear's experiments in combining sulfur with rubber to improve the properties. He tried to close the cleft and gave a pharyngeal extension to get perfect articulation of speech. He carved a wooden mould and made a velum in vulcanised rubber. Cleft palate treatment evolved into a distinct speciality with Stearn publishing about the appliance

in the reputed journal, Lancet. His appliance can be considered as a fore runner of speech bulb [17-20]. Different designs of fixed and movable speech aid prostheses followed possibly with limited success. PMMA was used in obturators by 1947 [23].

Gunner with silver mask

Alphone Louis, a native of St. Lau-rent, Pas de Calais, Paris, was member of the 2nd Regiment of Artillery of the French army which was engaged in the Belgium war (1832). Unfortunately, a shell which was burst above the battery and a splinter passed through the left side of his face and took away considerable portions of the jaw bones and the soft tissues. The surgeon tried to close the defect with the soft tissues. The soldier lost one arm partially along with the facial defects. The surgeons dressed the wound but gave little hope for his survival. Later from the war field, he was transferred to a hospital where he got good care. Food was given in the form of soup, lemonades and wine which were poured directly to the pharynx with a modified spoon. Deglutition and sense of taste improved slowly and the infection was controlled. Once cast could be made, Dr. Forjet executed a silver mask, enclosing the full extent of the defect. The edges were masked by the moustache and whiskers. Skin colour was incorporated with oil paints. The mask had a trap door, inside of which the jaw element with teeth and reservoir for saliva were accommodated. There is no record of the follow up of the patient for a long time. This cast and the mask are exhibited in the anatomical museum of the University of Edinburgh and reported in the 'London Medical Gazette of 1832' and in the 'Outlines of Military surgery of 1844' [21,22]. Two more cases of war victims were reported - Franco Prussian war and Battle of Missionary ridge. However, they were documented with realistic drawings and not photographs. (Figure 11-13).

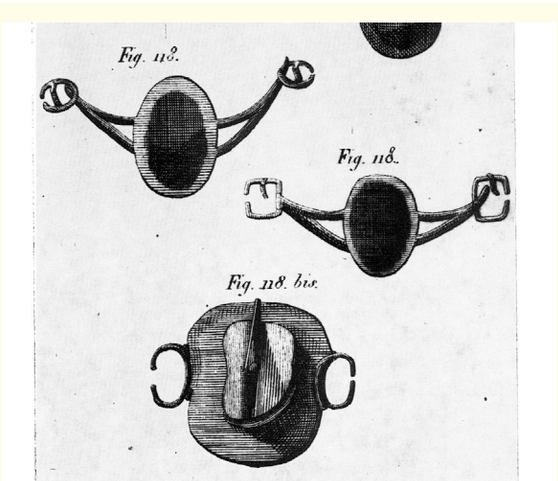

Figure 10: Clasps used by Delabarre.

Figure 11: Gunner who lost part of the face.

Figure 12: Gunner with silver mask.

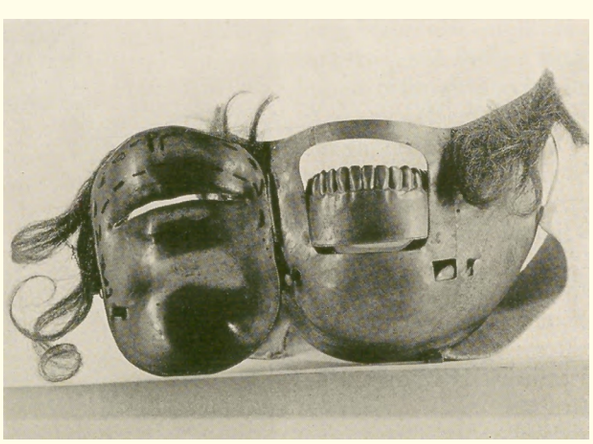

Figure 13: The jaw and door portion of the mask.

Norman Kingsley who is well known as the 'father of modern orthodontics' made facial prosthesis (Figure). He has stabilised the position of dentist in the treatment of facial defects. He has stated "the province of dentist is unquestionably enlarging and his admitted domain is increasing every year". "He claims for his profession, the right to treat, medically, surgically or mechanically all the diseases or deformities of the buccal cavity and is extending his operations to the nasal cavity" [10].

Numerous materials were tried in the fabrication of facial prostheses viz. wax, cardboard, leather, parchment, wood, gold, silver, hard rubber, soft rubber, collodion and celluloid. Acrylic plastic and silicones have entered the scene much later.

Tin noses shop

During the First World War many wounded soldiers returned from the battlefield with horrible facial injuries and for them 'Tin noses shop' gave comfort. British sculptor Francis Derwent Wood was touched by the suffering of these soldiers and offered his services at the 3rd London General Hospital in 1915 and started the 'Masks for Facial Disfigurement Department' or popularly known as the tin noses shop. Wood and his co-workers created light weight copper masks and made them look natural with paints. The masks would rest on the face by spectacles.

Compared to body injuries, facial injuries were more because their bodies were shielded inside the trenches but their heads were exposed to the attack of heavy artillery and machine guns. In an article published in The Lancet (June 1917) Wood made the classic statement which has categorized the role of surgeon and the prosthetic specialist - "My work begins where the work of the surgeon is completed". He added further 'when the surgeon restores function, I endeavor to make a man's face as near as possible to what it looked like before he was wounded'. Wood stated that the prosthesis would restore self-respect by restoring the appearance (Figure 14) [24].

Figure 14: Nose restored by Wood.

Ocular prosthesis

The most ancient artificial eye was found in an excavation done in Iran. It belonged to a woman approximately aged between 28 to 32 years. It was supposed to be made in bitumen with some gold element. The prosthesis is estimated to be made between 2900-2800 BC. It had an iris from which radiating lines were engraved (Figure 15-17). In those days people believed that seeing is because of the light emanating from the eye and the radiating lines probably indicate this. In 500 BC, Egyptian and Roman priests made prosthetic eyes in clay to be worn on mummies. Romans have used artificial eyes in living human beings also which is evidenced by usages like 'faber ocularis' (artificial eye maker).

Figure 15: The ancient eye excavated in Iran.

Figure 16: Eye shell found in the excavated body.

Figure 17: Excavated skull and the eye shell.

Next in the history is the contribution of Ambroise Pare (1510-1590), the French surgeon who is considered as the father of ocular prosthesis. The classic figures of eye prosthesis appeared in his book which was published after his life time (1614). He has

designed prosthetic eyes to be worn outside the eye socket and inside the socket. The sixteenth century prosthetic eyes were mainly made in gold or silver with enamel coatings.

The era of glass eyes started in the late 16th century by Venetian glass blowers. In the 17th century skilled glass blowers of Germany also made glass eyes. Britain and France also had glass eye makers. In the 19th century Ludwig Muller Uri who is a famous dolls eye maker ventured into prosthetic eyes in his glass factory. Muller was working with a Netherland based ophthalmologist Herman Snellen. Glass eyes were heavy and on dropping got fractured easily. In an attempt to make it light Snellen developed hollow eye prosthesis by connecting two shells with space in between. Snellen developed a chart which is still in use for vision testing (Figure 18). Till the second world war, glass eye maintained its supremacy. Though not very popular, even now in some parts of the world glass shells are being used.

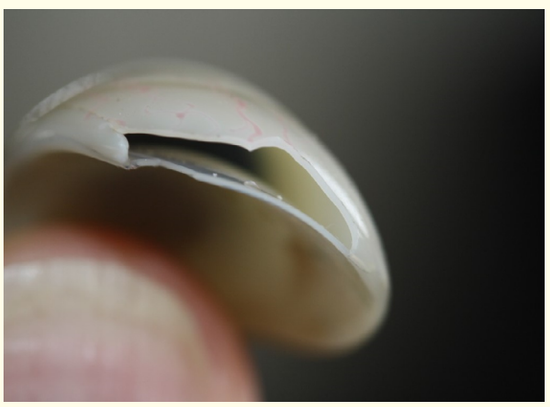

Figure 18: Snellen's eye shell.

In the 1930s Poly Methyl Methacrylate (PMMA) was introduced to Dentistry replacing the vulcanite in the making of denture bases. It is a historic coincidence that the World War II started in 1939 and Germany has stopped supplying glass eyes and the raw materials to US and UK. Technicians in both the countries started making ocular prosthesis in PMMA. Rest is modern history of ocular prosthesis. The making of eye shells was no more the monopoly of ocularists since dental technicians had better expertise with PMMA. Acrylic shells are the first choice for eye shells especially the custom made ones because of the versatility of the material (Figure 19-22). [25-28].

MFP in India

In the 1970s and early 80s, maxillofacial prosthetic services were offered at the Safdar Jung Hospital, Delhi. A few dentists and technicians were trained at that centre and they provided MFP service in different parts of the country. At present there is no record of activities happened in India during those times. Some individual attempts of maxillofacial rehabilitation were reported from the

Figure 19: Child with defective left eye.

Figure 20: Left eye with acrylic eye shell.

Figure 21: Surgical removal of nose due to cancer.

Figure 22: Prosthetic nose made in acrylic.

Government Dental College, Trivandrm by way of presentations and publications on maxillofacial prosthetics. PMMA was the material used for making the prosthesis (Figure). The first author was associated with the efforts of the Government Dental College.

A few dental professionals of India on their own initiative got trained in MFP from King's college, London, UCLA School of Dentistry, USA, and Mahidol University, Thailand. In India, training facilities are available at Tata Memorial Hospital, Mumbai, Amrita School of Dentistry, Cochin, Rangoonwala College of Dental Science, Pune and Dudani Education Centre, Pune. In spite of all these institutions, the maxillofacial prosthetic service does not match with the requirements of the country. When more government institutions come forward, the treatment can become affordable.

Conclusions

The role of maxillofacial prosthetics in complementing the surgical treatment continues to provide good quality service to many patients with disfigurements. The initial phase of development and research ended with the materials used for the maxillofacial prosthesis. Acrylic and silicone stabilised the speciality of MFP. The recent phase of research started with the introduction of implants, CAD/CAM based fabrication of prosthesis and bio technologic processes. In future, body parts like nose and ear will be fabricated with printed polymers and those will be integrated to the body by tissue engineering.

Author Contributions

Conceptualization -K. Chandrasekharan Nair, Pradeep Dathan; Review of articles - K. Chandrasekharan Nair, Viswanath Gurumurthy; Initial draft preparation - K. Chandrasekharan Nair; Review and editing - K. Chandrasekharan Nair, Pradeep Dathan, Viswanath Gurumurthy; Supervision - K. Chandrasekharan Nair.

All authors have read and agreed to the published version of the manuscript.

Conflict of Interest

The authors have no conflict of interest to declare.

Figure credits

Fig 1. https://medium.com/@mitra/sushruta-samhita-part1-cow-asjee-d5c02fe2be52

Fig 2. https://europeanroyalhistory.wordpress.com/2022/02/15/circa-february-15-706-byzantine-emperor-justinian-ii-executes-his-predecessors/

Fig 3. https://broughttolight.ucsf.edu/2015/04/24/1751/

Fig 4-6. Aramany MA. History of Prosthetic Management of Cleft Palate: Paré to Suersen, J Cleft Palate, 1971, 8:415-30

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