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Implants for Auricular Prosthesis - A Systematic Review

*Dr.K.Ramkumar, **Dr.C.Sabarigirinathan, **Dr.K..Vinayagavel
*Dr.C.Gunasekar ***Dr.M.Dhanraj
PhD Research scholar Department Of Prosthodontics TNGDC&H ,Chennai , Professor , Department Of Prosthodontics TNGDC&H Chennai, *** Professor , Department Of Prosthodontics, Saveetha Dental College & Hospital , Corresponding author: Dr.K.Ramkumar*

Abstract
***Aim of the systematic review** : The aim of the study is to systematically review the implants in auricular prosthesis.*
***Objectives :** 1.To find out the number of people with ear defects and its cause., 2. Total number of cases rehabilated with implant supported prosthesis, 3.Over all success rate and success rate in non radiated bone and radiated bone. 4. Type of attachment system used for auricular prosthesis.*
***Methodology:** Studies considered for inclusion were searched in MEDLINE (PubMed) and relevant journals were hand-searched. The search was restricted to studies published in English from ,1 January 1987 to 1 January 2017.The key words are - Implants for ear prosthesis , Auricular prosthesis , Follow up studies on implant supported ear prosthesis , Attachment in auricular prosthesis.*
***Results :** Total of 13 articles were taken for the review. The following aspects were reviewed in the shortlisted journals - 1.To find out the number of people with ear defects and its cause., 2. Total number of cases rehabilated with implant supported prosthesis, 3.Over all success rate and success rate in non radiated bone and radiated bone. 4. Type of attachment system used for auricular prosthesis. Total of 794 patients have been reported for ear loss, 1463 implants was placed in the mastoid bone for the fabrication of implant retained auricular prosthesis .The overall success rate is 97.3% . Total number of 46 magnets, 250 bars and clip were used as attachment for the fabrication of auricular prosthesis.*
***Conclusion :** The implant in the mastoid bone is the more reliable treatment option in the rehabilitation of patient with auricular defects .*
***Keywords :** Auricular defects ,implant in maxillofacial prosthesis ,implant supported auricular prosthesis*

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I. Introduction

The loss of facial structure like eye, nose, ear in an individual influence psychology to a greater level .The cause for the loss of facial structure is due to severe congenital anomalies, accidental trauma, surgical intervention of destructive tumour or malignancies .The rehabilitation of maxillofacial defect can be done by two ways such as autogenous and prosthetic reconstruction. Implants provide retention of auricular prosthesis by bar and clip method & magnets. In 1977 implants was placed in the mastoid bone to attach Bone anchored hearing aids (BAHA)[1] . In 1979 implants was placed in the mastoid bone to retain an ear prosthesis ,this pioneering work was done in Goteborg university Sweden .From late 1970 to 1990 lot of group from Sweden ,United states of America & Canada were working on implant supported facial prosthesis. In 1980 Tjellstrom published a report on BAHA , 1981 Tjellstrom described two papers of which one specifically described about implants to retain ear prosthesis, Tjellstrom after 11 years of his first report in 1980 ,presented 10 years follow up and discussed about the Success rate of implants in auricular prosthesis. Pioneers like Parel , Roumanas etal , Tolman and Taylor widely reported the follow up on implants in auricular prosthesis. Implants is proven to be an alternative treatment options in retention of auricular prosthesis, hence systematic review on implants in auricular prosthesis is planned.

II. Aims & Objectives

The aim of the study is to systematically review the implants in auricular prosthesis. The Objectives are – 1.To find out the number of people with ear defects and its cause.2. Total number of cases rehabilated with implant supported prosthesis, 3.Over all success rate and success rate in non radiated bone and radiated bone. 4. Type of attachment system used for auricular prosthesis.

Inclusion criteria for considering studies for this review:

Prospective and retrospective cohort studies assessing implant as treatment option in rehabilitation of ear defects were selected .Article assessing the follow up on type of attachments used in auricular prosthesis were included for the review . Case series discussing on five and more patients about the implant as treatment option included in the review.

Exclusion criteria for considering studies for this review: Case report on ear prosthesis excluded Case report and Follow up on Bone Anchored Hearing Aid (BAHA) were excluded.

Search strategy for identification of studies: The methodology followed for selecting the article concerned to the topic is summarized in(Fig 1) . MEDLINE (PubMed) search were done with the following (MeSH) and free text terms:

1. Implants for ear prosthesis
2. Auricular prosthesis
3. Follow up studies on implant supported ear prosthesis
4. Attachment in auricular prosthesis.

5.1 AND 2
6.1AND 3 OR 2 AND 3
7.1 AND 4 OR 2 AND 4

Hand search were done pertaining to the topic and journals included shown in (Fig 1). Manual search also included the bibliographies of all articles selected for full-text screening as well as previously published reviews relevant for the present systematic review. Finally, the 'related article' feature of PubMed was used for all articles selected for full-text screening. The search was restricted to human studies published in English from 1 January 1987 to 1 January 2017.Twelve articles were selected for systematic review.

III. Results:

The articles shortlisted for the review were analysed for the following data ,total number of patients affected by ear loss, cause of ear loss, number of implants placed, and success rate .The extracted data from the selected journals were listed in Table 1.The details of ear loss and its cause were listed in Table 2. Overall success rate of implants for auricular prosthesis and implants in non radiated and radiated bone were listed in Table 3.The details of attachments used for retention in auricular prosthesis listed in Table 4.

Table 2 shows total of 794 patients have been reported for ear loss, of which the cause is due to congenital defect, carcinoma and trauma were 51, 29, 16 (total 96) respectively. All the journal does not discuss about the cause for the ear loss, this is the reason for the disparity of total number 794 with 96 for whom the cause have been highlighted. Total number of 1463 implants was placed in the mastoid bone for the fabrication of implant retained auricular prosthesis. Total 1389 implants have osseointegrated successfully. The number of implants placed in non radiated and radiated bone are 1365 and 24 respectively. Total number of implants failed, buried, and not loaded which comes to 74 out of 1463 .Overall mean success rate is 97.3% for the implants placed in the mastoid bone .The success rate of implants placed in non radiated bone is 95.5%. The success rate of implants placed in radiated bone is 100 %. The data discussed is shown in Table 3. Table 4 shows total number of 46 magnets, 250 bars and clip were used as attachment for the fabrication of auricular prosthesis. Combination of two different attachments was done for 3 cases and other method retention in 1 case.

IV. Discussion

The cause for the ear defects is due to the congenital defects, carcinoma and trauma of which, the congenital defect is the major cause of the ear loss. Total of 51 case ,out of 794 was reported due to congenital reason is observed in this systematic review . Number of cases reported in this systematic review with ear loss due to carcinoma and trauma were 29 ,16 respectively . The syndrome associated with congenital ear loss are Goldenhar syndrome and Frnceschetti syndrome . Thalidomide harm also reported as one of the cause for congenital ear loss. The cause for majority of case in congenital ear loss is not known .Carcinoma which required ear resection were Epiteiloma , Malignant melanomas, Haemangioma. Inflammatory condition which requires ear resection is Chondrodermatits (S.no 10 Table 1) . Implants is the more reliable and successful treatment options in rehabilitation of auricular defects .Implants placed in the mastoid bone for the retention of auricular prosthesis is classified in to solitary implant and collective implant .The solitary implant have a flange on the top with the remaining feature similar to the root form implant, while the implants used in intraoral condition will not have a flange .Collective implant known as epiplates looks like the mini plates used in the treatment of maxillofacial fractures[15]. Total of 1463 implants have been placed in the mastoid bone of which

1365 implants in non radiated bone and 24 in radiated bone were reported in this systematic review. Implants used in intraoral situations were also placed in the mastoid bone. The type of implant used has not been specified by most of the authors, total of 133 Branenmark system ,23 EO(extra oral) system ,and 1 Epitec (epiplates) system of implants have been placed in the mastoid bone for the fabrication implant supported auricular prosthesis ((S.no 10 Table 1).

Overall success rate of implant placed in the mastoid bone is 97.3% and the success rate in the non radiated and radiated bone is 95.5% and 100% respectively , have been reported in this systematic review. Osteoradionecrosis should be taken in to consideration while placing implants in radiated bone ,the risk of osteo radionecrosis is almost zero [5].The dose employed were below 6,500 cGy ,which in oral cavity has precipitated very few necrosis [5] . The success rate in non radiated bone is 100% as only lesser number of implant have been placed in the non radiated bone .A total of 24 implants have been placed in radiated bone, which have been reported in this systematic review .Another issue is the time interval between radiation and implant placement ,progressive radiation cause occlusion and obliteration of fine vasculature, some investigators have observed improvement in bone regenerative after 1 year from the period of radiation administration [5] .The criteria such as dose of radiation and time period between the administration of radiation and placement should be taken in to consideration while placing the implant. Magnetic retention , bar–and–clip method are the widely used method of retention[15] .Magnetic retention is more easy for the patient to maintain as they can clean the issue around the implant .In contrast it is difficult to maintain the hygiene around the bar – and – clip method [10]. Type of attachment used has not been mentioned by most of the authors in this systematic review, only three authors mentioned about the type of attachment used .Total of 46 magnets , 250 bar – and – clip have been used in this systematic review.

V. Conclusion

The major cause of ear defects is the congenital reasons ,followed by carcinoma and trauma .Implants serve as the wonderful treatment option in the rehabilitation of auricular defects with overall success rate of 97.3%.The success depend on the proper treatment planning of surgical and prosthodontic protocol.

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Table 1 – Data Extracted From The Journal
Note – R denote Radiated site , NR – denote radiated site

S.No	Author	Aim of the study	Method of study	Total number of Patients studied	Total number of patients treated for ear defects	Cause for ear loss	Number of implants placed in temporal bone	Outcome
1.	K.M.Holgers [1] 1987	To evaluate Soft tissue reactions around percutaneous implants on skin –penetrating titanium implants used for bone anchored auricular prostheses	Study was conducted at ENT – Department Sahlgren' hospital ,Goteborg ,Sweden Follow up Period from Oct 1997-May 1985		32 Out of which 4 patients have bilateral defects	Ten patients lost ear due to tumor surgery (out of which 2 were treated for radiotherapy)	136 28 x 4 =112 4 x (3+3) = 24 4 implants placed per patient	4 implants have been removed
2.	Stephen M .Parel [2] 1991	To find out the success rate of osseointegration and facial prosthesis of various centres located in USA and Sweden	13 centres in USA and Sweden participated in the survey.	USA 84(R) / + 11(NR)= 95 SWEDEN 130(NR)+ 16 (R) = 146	USA 49(NR) + 1 (R) = 50 SWEDEN 107(NR) + 2 (R) = 109	_	USA (NR) 162 NR sites 159 integrated NR sites USA (R) 4 NR sites 4 integrated NR sites SWEDEN (NR) 354 NR sites 348 integrated SWEDEN (R) 6 in R sites 6 integrated	Lost 3 implants in NR sites Overall success rate 98.1% in NR sites in USA Overall success rate 100 % in R sites in USA Lost 6 implants in NR sites Overall success rate 98.3 % in NR sites in Sweden Overall success rate 100 % in R sites in Sweden

S.No	Author	Aim of the study	Method of study	Total number of Patients studied	Total number of patients treated for ear defects	Cause for ear loss	Number of implants placed in temporal bone	Outcome
3.	Magnus Jacobsson [3] 1992	To evaluate osseointegration of titanium implants used for anchoring facial prosthesis over 5 year period follow up	Retrospective study of Hospital record of ENT department , Sahlgren's Hospital ,University of Goteborg ,Sweden	87	70 Of which 9 patients have bilateral defects	Not specified	234	98.72% over all < 3 years 97.44% 3-5 years 100% >5years 100
4.	John .F.Wolfaardt [4] 1993	Craniofacial osseointegration :The Canadian experience	All the centres in Canada involved in osseointegration were involved in the study . 8 –centres were contacted out of which six responded	48 (operative sites)	29 (operative sites) Nonradiated patients	Not specified	(29 x 3 = 87 3 implants per site) 87 in Non radiated patients integrated 86 Implants lost early less than one year 1	98.9 % No experience on radiated patients
5.	Eleni Roumanas [5] 1994	Six year follow up report on the success rates of carniofacial implant at UCLA	Prospective study	30 Includes nasal ,ear and orbital	10 Out of 10 in one case implant placed in radiated bone	Congenital -6 Trauma -2 Tumor -2	40 (3 buried)	1.92.5% success rate overall success rate . 2.success rate in Non radiated sites auricular prosthesis – 91.9% 3. success rate in radiated sites auricular prosthesis – 100 %

S.No	Author	Aim of the study	Method of study	Total number of Patients studied	Total number of patients treated for ear defects	Cause for ear loss	Number of implants placed in temporal bone	Outcome
6.	Christina A.Gitto [6] 1994	Evaluation of the Peri – implant epithelial tissue of percutaneous implant abutment supporting maxillofacial prosthesis	The study was conducted at the department of dentistry and maxillofacial prosthetics Roswell park cancer institute in Buffalo ,New York	7 **5- ear defects** 1- hair prosthesis 1- orbital prosthesis	5	**Congenital - 2** **Carcinoma – 2** **Trauma - 1** **Patient 1** – 32 / female mild hemifacial microstomia with congenitally absent of left ear **Patient 2 –** 75/ male squamous cell carcinoma of right ear **Patient 3 –** 67/ male malignant melanoma of left ear **Patient 4** – 36 / female traumatic loss of scalp and left ear **Patient 5** - 49/male hemifacial microstomia with congenitally absent of left ear	17 implants for ear defects (titanium craniofacial implant BUD industries ,East Aurora NY) **All of them retained by magnets**	Majority of patients were asymptomatic and have excellent result .The most important factor in terms of skin reaction is the accumulation of sebaceous material resulting from poor hygiene .
7.	Rubenstein [7] 1995	Attachments used for implant – supported facial prostheses : A survey of United states ,Canadian ,and Swedish centres	1. one Swedish, 3 Canadian ,24 United states centres . 2.method of study by questionnaire 3. 1992 survey conducted	Total number of patients 357 150 – USA 165- Sweden 42 – Canada	USA-101, CANADA-28, SWEDEN - 120	Cause of ear loss not specified, details of attachments used is given in Table 1		

S.No	Author	Aim of the study	Method of study	Total number of Patients studied	Total number of patients treated for ear defects	Cause for ear loss	Number of implants placed in temporal bone	Outcome
8.	Eleni Roumanas [8] 1994	Implant - retained prosthesis for facial defects : An up to 14 year follow up report on the survival rates of implant at UCLA	1).Total number of patient 72 2).peroid 1987-2001 3).maxillofcaial clinic at UCLA & City Hope Medical Centres 4) . Hospital record analysed	Total patients - 72 Auricular prosthesis -37 Orbital Prosthesis -20 Nasal prosthesis 15	37 35 – R 2 - NR	Tumour -13 Congenital -13 Trauma -11	Total implant placed 117 111 –NR Of which buried -8 Failed -5 6 – R sites Failed -0	Overall survival rate 95% 94% success in NR sites 100% success in R sites
9.	Hooper SM [9] 2005	Implant – supported facial prosthesis provided by a maxillofacial unit in U.K regional hospital :longevity and patient opinions	A 23 question postal survey was conducted on 75 patients treated with implant supported facial prosthesis.	Auricular -62 Nose – 6 Eye – 5 Combination 2	62			26% of replacement prosthesis were provided due to color fading .

S.No	Author	Aim of the study	Method of study	Total number of Patients studied	Total number of patients treated for ear defects	Cause for ear loss	Number of implants placed in temporal bone	Outcome
10.	Gao Guo [10] 2008	A retrospective study of implant retained auricular prosthesis at clinical navigation and robotics of charite university hospital –Berlin ,Germany	Period of study 1992 -2004 1.All the patients who received implant were recalled for evaluation . 2. Two clinical parameters skin probing depth and sulcus fluid flow rate (SSFR) were examined		46	**Congenital defect – 30** Goldenhar syndrome – 8 Frnceschetti syndrome -3 Thalidomide harm - 1 Reason unknown -18 **Tumor resection – 12** Epiteiloma -5 Malignant melanomas -1 Basaloma -4 Hemangioma -2 **Inflammation 1** Chondrodermatits 1 **Trauma 1** **Burn injury**	Total – 157 implants placed Branenmark system 133 EO system 23 Epitec system 1 **Retention device used** **Magnets – 31** **Bar & clip -15**	Implant survival rate was 100 %
11.	Robert F [11] 2008	The aim of the study is to report on the survival rate of 16 patients treated for ear defects	Period of study 1987 – 2003. Patients who received implants for ear defects were followed up retrospectively		16		39	Survival rate 100 %

S.No	Author	Aim of the study	Method of study	Total number of Patients studied	Total number of patients treated for ear defects	Cause for ear loss	Number of implants placed in temporal bone	Outcome
12.	Karakoca S [12] 2010	Retrospective study of treatment outcomes with implant –retained Extra oral prosthesis : Survival rate and prosthetic complication	72 patients were treated with implant retained extraoral prosthesis .Each patient was examined with respect to the prosthesis appearance and abutment and attachment component complications at 6 month interval over a period of 10- 46 months	Auricular -32 Orbital – 25 Nasal - 13				Two prosthesis were made with in period of 46 months . Survival rate of first auricular prosthesis -14.1 months Survival rate of second auricular prosthesis -14.4 months
13.	Mevio .E [13] 2015	Osseointegrated Implants in patients with auricular defects : a case series study .	Case series	Auricular – 15	15			Survival rate 100%
14.	Mevio[14] 2016	` Bone - Ancored titanium implants in patients with auricular defects :three years and 27 patients experience	27 patients with ear defects were followed up by recalling the patient for follow up .	Auricular defect - 27				Over all 100%

Table 2 - Details of ear loss and cause

S.No	Author	Number of patients with ear defects	Cause		
			Congenital	**Carcinoma**	**Trauma**
1.	K.M.Holgers [1] 1987	32 (of which 4 patients have bilateral defects)	–	–	–
2.	Stephen M .Parel [2]1991	159 (USA – 50 + Sweden – 109)	–	–	–
3.	Magnus Jacobsson [3]1992	70 (of which 4 patients have bilateral defects)	–	–	–
4.	John .F.Wolfaardt [4]1993	29	–	–	–
5.	Eleni Roumanas [5]1994	10	6	2	2
6.	Christina A.Gitto [6]1994	5	2	2	1
7.	Rubenstein J [7] 1995	249 USA 101 +CANADA 28+ SWEDEN 120)	–	–	–
8.	Roumanas [8] 2002	37	13	13	11
9.	Hooper SM J [9] 2005	62	–	–	–
10.	Gao Guo [10] 2008	46	30	12	2 Inflammation 1 Burn injury 1
11.	Robert F .wright [11] 2008	16	–	–	–

12.	Karakoca S [12] 2010	32	–	–	–
13.	Mevio .E [13] 2015	15	–	–	–
14.	Mevio.E [14] 2016	32	–	–	–
	TOTAL	794	51	29	16

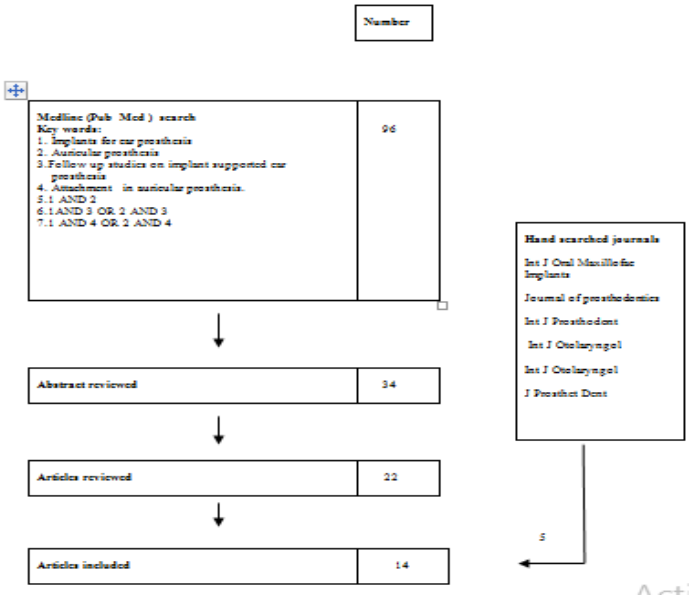
Table 3 - Success rate of implants for auricular prosthesis

S.No	Author	Total number of implants placed in mastoid	Implants in Non radiated bone	Implants in radiated bone	Overall success rate	Success rate in Non radiated bone	Success rate in radiated bone
1.	K.M.Holgers [1] 1987	136	136	–	97.05%	–	–
2.	Stephen M .Parel [2] 1991	426 USA 166 SWEDEN 360	162 354	4 6	98.1% 98.3%	98.14% 98.3%	USA 100% SWEDEN 100%
3.	Magnus Jacobsson [3] 1992	234	234	–	98.72%	–	–
4.	John .F.Wolfaardt [4] 1993	87	87	–	98.9%	–	–
5.	Eleni Roumanas [5] 1994	40	32	8	92.5%	91.9%	100%
6.	Christina A.Gitto [6] 1994	17	–	–	100%	–	–
7.	Rubenstein J [7] 1995	249 USA-101, CANADA-28, SWEDEN - 120	249	–	–	–	–
8.	Roumanas [8] 2002	117	111	6	95%	94%	100%
9.	Gao Guo[10] 2008	157	–	–	–	–	100%
	TOTAL	1463	1,365	24	Mean 97.3%	Mean 95.5%	Mean 100%

Table 4 – Data on attachments in auricular prosthesis

S.No	Author	Number of patients with ear defects	Attachment type			
			Magnets	Bar & clip	Combo	Others
1.	Christina A.Gitto [6] 1994	5	5	_	_	_
2.	Rubenstein J [7] 1995	**249** (USA 101 +CANADA 28+ SWEDEN 120)	**10** USA 8 CANADA - 0 SWEDEN 2	**235** USA 89 CANADA 28 SWEDEN 118	**3** USA 3 CANADA 0 SWEDEN 0	**1** USA 1 CANADA 0 SWEDEN 0
3.	Gao Guo [10] 2008	46	31	15	_	_
	Total		46	250	3	1

Fig 1 -Search strategy for identification of studies



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