Challenges During Baha Surgery: Our Experience

Hetal Marfatia^{1,2} · Ratna Priya^{1,3} · Nilam U. Sathe^{1,4} · Shampa Mishra^{1,5}

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Abstract Baha has proven performance and advantages for patients with aural atresia or chronic ear drainage. Being a per cutaneous osseo integrated implant the skin around the fixture is in contact with a foreign body that leads to chronic inflammatory reaction and complications such as skin irritation and overgrowth occur frequently. Challenges that are faced during Baha surgery include those during candidate selection, work up, anesthesia related as well as intra-operative and post operative complications. Ours was a retrospective and observational study where case records of 10 patients who underwent Baha surgery in the Department of E.N.T during the time period from January 2010 to June 2013 were reviewed. Here, the candidates were advised Baha either for congenital external ear deformity or single sided deafness. Out of 10 patients, who underwent Baha implantation, 8 underwent single staged Baha implant and two patients had two staged implant owing to bone thickness <3 mm behind temporo-parietal suture line on HRCT Temporal bone. The complications observed were skin infection (Holgers grade 2) around the site of implant in two patients, skin overgrowth due to more thickness of scalp (Holgers grade 4) in

one of the patient. The patient had to undergo revision surgery to replace the abutment. And one of the patients underwent failure of osseointegration and was re-implanted later. Proper surgical technique and post operative wound care play an important role in avoiding complications.

Keywords Baha · Microtia · Challenges · Osseointegration · Complications · Skin infection · Skin overgrowth

Introduction

Bone anchored hearing aid (Baha) is considered a reliable and predictable adjunct for auditory rehabilitation in [1] patients with chronic ear infections, microtia and congenital external auditory canal atresia and single sided deafness that cannot benefit from conventional hearing aids. The system is surgically implanted and allows sound to be conducted through the bone by a process known as direct bone conduction [2]. The Baha system consists of three components: a titanium implant, an external abutment and an electronic sound processor. It is important to note that the Baha system requires surgical placement of the titanium implant followed by its integration into the bony architecture. The device works by transmitting sound through bone to the inner ear thus, bypassing both the external auditory canal and the middle ear [2].

In 1965, Branemark et al. [3], reported successful application of osseointegration in dental and craniofacial reconstructive surgery. Nine years later, Tjellstrom et al. [4], introduced the concept of direct bone conduction which could be achieved by using a skin-penetrating coupling from an osseointegrated titanium implant in the mastoid bone. Baha has proven performance and advantages for patients with aural atresia or chronic ear drainage

✉ Ratna Priya
ratnapriya01@gmail.com

¹ Department of E.N.T., Seth G.S. Medical College and K.E.M Hospital, Mumbai, Maharashtra, India

² 52, Mahant Road, Gr. Floor, Suraj Bhuvan, Vile Parle (E), Mumbai 57, Maharashtra, India

³ 95, Sahyog apartments, Mayur vihar, Phase-1, Delhi 110091, India

⁴ Patidar Complex, B/304, 3rd Floor, Kannamwar Nagar 2, Vikhroli, East Mumbai 400 083, Maharashtra, India

⁵ Plot no. 229, Dharampura, Raipur 492001, Chattisgarh, India

who cannot wear air-conduction hearing aids [5]. As it is a percutaneous osseointegrated implant the skin around the fixture is in contact with a foreign body that leads to chronic inflammatory reaction around the implant site and complications such as skin irritation and overgrowth occur frequently.

Challenges that are faced during Baha surgery include those during candidate selection, work up, anaesthesia related as well as intra-operative and post operative complications. The most important being the cost of the implant, since we are working at a tertiary care centre where we deal with patients of low socio-economic class. Here we describe our experience with 10 patients.

Methods

Ours was a retrospective and observational study where case records of patients who underwent Baha surgery in the Department of E.N.T during the time period from January 2010 to June 2013 were reviewed. Here, the candidates were advised Baha either for congenital external ear deformity (microtia) or single sided deafness. All patients with microtia underwent full work up to rule out the associated anomalies. The investigations included echocardiography to rule out cardiac anomalies, ultrasound of the abdomen to look for malformations of urinary system, paediatric evaluation to look for associated anomalies and ophthalmic consultation. Patients with single sided deafness underwent MRI Brain to rule out possibility of cerebropontine angle tumours. Hearing was assessed using pure tone audiometry (PTA) for adults and behavioural audiometry and BC BERA for infants and children. HRCT temporal bone was done to look for thickness of bone behind temporo-parietal suture line. Young children with bone thickness <3 mm on HRCT temporal bone were implanted via a two staged procedure.

Baha surgery was done under general anaesthesia. The Linear Incision technique was used [2–6]. The implant site was positioned 6–6.5 cm from the ear canal. A 3 cm vertical incision was made down through the periosteum at the hair-line to expose the planned implant site. Approximately 1 cm of the periosteum is elevated around the site. A 3 mm deep guide hole was drilled at the planned implant site (at 2000 rpm); Drill indicator was used to keep the insertion strictly 90° to the bone. The burr was moved up and down and the hole was enlarged slowly, carefully inspecting the bone. Continuous irrigation was provided so that water reaches the tip of burr and the osteoclasts do not undergo thermal injury. If the hole's floor was solid, the hole was extended to 4 mm depth. The guide hole was used to align a countersink burr, which widened the guide hole and created a shallow countersink in the adjacent bone surface. A self tapping titanium bone screw with attached abutment (the percutaneous part to

which a processor would be affixed 2–3 months postoperatively) was carefully picked up with an abutment inserter and then advanced to full depth at a slow revolution rate and controlled insertion torque of 40–50 N cm. First turn of the implant was placed without irrigation and later continuous irrigation which works as a coolant for rest of the turns was used. Around the incision, the soft tissue was manually reduced in the area of 1–2 cm by tenting with skin hooks. As a counter pressure, a finger felt for sufficient thinning and care was taken to avoid button holing. Skin wound edges were sutured to underlying periosteum to coapt dead space; the skin flap was sutured back in its original position.

Healing cap was placed and compression dressing with umbilical tape was given for 7 days. Suture removal was done after 7 days and. Patients was kept on regular two weekly follow up. After waiting for 3–6 months (depending on bone quality) for osseointegration the Baha processor was snapped on to the abutment and the hearing improvement was documented using pure tone audiometry and plotted as Baha aided audiogram.

Results

In our study, indication of Baha implantation consisted of bilateral congenital external ear malformation in eight patients, unilateral microtia with congenital fixity of stapes in other ear in one patient and single sided deafness in one of the patient. Goldenhar syndrome with unilateral renal agenesis was present in one of our patients. Also, atrial septal defect with undescended testis was found to be associated in one child with bilateral microtia. Out of 10 patients who underwent Baha implantation, 8 underwent single stage Baha implant and two patients had two staged implant owing to bone thickness <3 mm behind temporo-parietal suture line on HRCT Temporal bone.

The complications observed were skin infection (Holgers grade 2) around the site of implant in two patients (Table 1; Figs. 1, 2). This settled following 2 weeks of oral antibiotic and meticulous wound care and cleaning. One of the patients developed skin overgrowth due to more thickness of scalp (Holgers grade 4) (Fig. 3) and also the abutment height was inadequate. The patient had to undergo revision surgery to replace the abutment. And one of the patients underwent failure of osseointegration and was reimplanted later.

Discussion

The Baha is a surgically implantable system for treatment of hearing loss that works through direct bone conduction. Baha is used to help people with chronic ear infections,

Table 1 Complications of Baha surgery

	Complications of Baha	Number of patients	Percentage (n = 10)
1	Skin infection	2	20
2	Skin overgrowth	1	10
3	Loss of osseointegration	1	10
4	No complication	6	60

Fig. 1 Holger's grade 2 skin inflammation

congenital external auditory canal atresia and single sided deafness that cannot benefit from conventional hearing aids. It is based on the concept of osseointegration defined by Branemark as a direct structural and functional connection between living bone and the surface of a load-carrying implant. Osseointegration in the Baha system, is certainly achieved using commercially pure titanium (99.75 %) covered with a highly biocompatible thin oxide layer. It is an active process that develops gradually over 6–12 weeks following fixture implantation. Many factors influence successful osseointegration, including the material, the macrostructure and microstructure of the implant, the quality of bone at the site of implantation, and surgical factors [7]. The implant must remain completely stable during the initial period of osseointegration, this is crucial; otherwise osseointegration will fail with the

Fig. 2 Holger's grade 2 inflammation in another patient

formation of a fibrous capsule around the implant instead of new bone formation. The initial immobility of the implant is automatically brought about by the use of peculiar screw-shape of the implant that is affixed to the bone with definite torque parameters.

Patient selection and work up stands out as a challenge in itself as most candidates had congenital microtia and such patients are reported to have high incidence of associated congenital renal and cardiac anomalies. These have to be dealt with pre operatively so as to avoid inadvertent general anaesthesia complications. All our patients underwent full screening to look for these anomalies where we did ultrasound of abdomen and 2-D ECHO. One of our patients had unilateral renal agenesis, one had horse-shoe shaped kidney and one of them had ectopic kidney for which we had to take pre operative paediatric nephrology fitness. Also, presence of congenital heart disease in our patients made us to take paediatric cardiology reference and fitness for general anaesthesia. Also, one of the patients underwent surgery for undescended testis.

One of our patients had Goldenhar syndrome which is oculo-auriculo-vertebral dysplasia (OAVD) and is associated with multiple ocular, auricular, facial, cranial, vertebral and cardiac abnormalities. The presence of mandibular hypoplasia and hemivertebra lead to limitation of neck movement causing difficulty in airway management and

Fig. 3 Skin overgrowth in one of the patients

intubation and thus was a challenge to our anesthesiologists. They did fiberoptic bronchoscopy assisted intubation under general anesthesia and controlled ventilation. This was anticipated as patients with Goldenhar syndrome do have difficult airway owing to restricted neck movement and calls for a thorough pre operative evaluation and intraoperative airway management and the need for stand by tracheostomy [8, 9].

The intraoperative risks associated with Baha surgery include insufficient thickness of temporal squama, emissary vein bleeding, injury to the dura leading to csf leak and subdural hematoma. At times there is a bleeding from

the diploic bone which can be easily controlled using adrenalin soaked gelfoam, bone wax or surgical. In our series, since we had nine out of ten patients with congenital external ear deformity and the bone quality in such patients is compromised, we had to drill multiple holes in order to look for the appropriate site of implant placement. But we did not have any another major complication such as dural injury, csf leak or bleeding intraoperatively.

Post operative wound infection was graded according to classification by Holgers et al. [10] into grade 0 for no irritation, grade 1 for slight redness, grade 2 for red and moist, no granulation tissue, grade 3 for red and moist with granulation tissue and grade 4 for revision of skin penetration necessary. In our series the post operative complications observed were skin infection around the site of implant in two patients which developed 2 weeks following the surgery and occurred as a result of low socio-economic state of the patient, poor hygiene and humid climate. These were mostly minor and self limiting and resolved after judicious local wound care and antibiotics. One of the patients developed skin overgrowth 6 months following surgery due to more thickness of scalp and also the abutment height was inadequate. The patient had to undergo revision surgery and the abutment height was increased. Commonest complication encountered was inflammation around the site of implant. It varied from mild redness to redness with moist skin. In one of the patients there were granulations also. While one of the patients with good scalp thickness had skin overgrowing the implant and completely covering it. And in one of the patients there was failure of osseointegration. This can be prevented by ensuring that the angle of inserting Baha is right angle to the bone, which is ensured using drill indicator and the assistant guiding the surgeon so that it is 90° all the time and by proper irrigation during surgery so that cooling results in preserving osteoclasts.

The following table depicts the complications presented in the international literature. The results in our series mostly matched the above (Table 2).

Table 2 Depicting complications of Baha surgery in literature

Study	Wound infection	Skin overgrowth	Implant extrusion	Failure of osseointegration	Recurrent antibiotic treatment
Mazita et al. [11] N = 16	3	2		1	
Fuchsmann et al. [12] N = 16	4	2	1		
Asma et al. [13] N = 33	3	4			3
Kraai T et al. [14] N = 31	24	5	10	3	8
Hobson et al. [15]				Complication rate = 23.9 %	

The low incidence of soft tissue complications in these western countries is due to absence of humid climate and patients also belong to higher socio-economic stature. Hence, we observed that though Baha is a great option of hearing rehabilitation in patients with microtia—antia but since it is a percutaneous osseointegrated implant the skin around the fixture is in contact with a foreign body. This leads to chronic inflammatory reaction around the implant site and complications such as skin irritation and overgrowth occur frequently.

Some precautions that can be kept in mind to prevent skin overgrowing the abutment site include undermining of the wound edges, removal of all subcutaneous tissue down to thin periosteal layer, keeping the healing cap in place for at least 1 week, frequently cleaning around the abutment and treating local infections in a timely fashion.

Some important steps to prevent implant extrusion include using copious irrigation when drilling. The bone must not be heated above 42 °C. To avoid overheating, drilling should be carried out in short bursts to allow time for cooling as one is drilling the guide hole. When using the countersink, removal of accumulated bone chips from the cutting flutes should be done. As the Baha implant relies on osseointegration with the skull, living bone close to the implant is a prerequisite for a successful outcome. Also to allow 3 months osseointegration time after surgery before fitting the speech processor.

Local wound infections can be avoided by explaining proper care to the patients which includes frequently cleaning around abutment with soft brush provided with Baha, reporting to the doctor immediately in case of any erythema or inflammation around implant site and treating local infections in a timely fashion.

The recently introduced Baha attract eliminates the local soft tissue reactions associated with the abutment as it consists of titanium implant inserted in the bone behind the ear with an implant magnet placed beneath the skin and the sound processor is then attached to an external magnet and attracts the internal magnet [7].

Conclusion

Hence, we conclude that though Baha is a great option of hearing rehabilitation in patients with microtia—antia but since it is a percutaneous osseointegrated implant the skin around the fixture is in contact with a foreign body. This leads to chronic inflammatory reaction around the implant site and complications such as skin irritation and overgrowth occur frequently. Proper surgical technique and post operative wound care play an important role in avoiding complications.

Compliance with Ethical Standards

Conflict of interest None of the authors have any conflict of interest.

Ethical Approval All procedures performed were in accordance with the ethical standards of the institutional and/or national research committee and with the 1964 Helsinki declaration and its later amendments or comparable ethical standards.

Human and Animal Rights This article does not contain any studies with animals performed by any of the authors.

Informed Consent Informed consent was obtained from the patient included in this study.

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