Outcomes of Bone Anchored Hearing Aid Implant at Universiti Kebangsaan Malaysia Medical Centre (UKMMC)

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Abstract The cross sectional study was conducted in Universiti Kebangsaan Malaysia Medical Center (UKMMC), Malaysia from August 2012 to December 2013. All patients implanted with in UKMMC from December 2001 until December 2012 was included. Glasgow Benefit Inventory (GBI) questionnaires and UKMMC questionnaires were used as part of the assessment tool. The GBI is a scoring which measures the change in health status produced by surgical interventions. UKMMC questionnaires was invented by our department to assess questions related to social and life style of patients and also the cosmetic perspective Baha implant and other daily related activities. The audiological assessment was assessed using hearing aid gain threshold. Complication with regards to skin reaction was graded using Holger Skin Classification. A total of 40 patients underwent Baha implant were recruited but only 35 patients fulfilled the criteria and included in this study for analysis. Age of patients ranged from 5 year old to 38 year old, with median of 13 years old. There were 22 patients (62.8%) were male and 13 patients (37.1%) were females. Almost all cases were canal atresia except one adult patient was a case of bilateral chronic discharging ear with chronic irritation with ear mould. Majority of patients 21 (60%) have hearing level of moderate to severe hearing loss (40–89 dB) and 14 patients (40%) have mild to moderate hearing loss

(20–39 dB). The level of hearing was retested post operatively. All of the patients have improvement in their aided hearing with the range of 10–25 dBL which is statistically significant at p value of <0.05 . The GBI was scored positively in all subscales. Majority of patients (91.4%) used BAHA more than 4 h per day and 88.6% agreed that BAHA is cosmetically acceptable. All patients experienced some form of skin irritation (Holger grade 1–2) however only 20% required surgical intervention. All our patients have range of 10–25 dB improvement of their aided hearing which is statistically significant at p value of <0.05 . BAHA has been proven to show significant benefit in audiological improvement and quality of life.

Keywords Baha implant · Bone conduction hearing aid · Conductive hearing loss · Quality of life

Introduction

Hearing loss is one of the commonest ear symptoms. It is divided into conductive, sensorineural and mixed types. Hearing aid usage has significant improvement in social, psychosocial and emotional. Bone anchored hearing aid is a bone conduction hearing aid which works by osteointegration of titanium implant into the temporal bone. It allows direct vibration transmission to the skull and inner ear by passing external auditory canal and middle ear. BAHA increase hearing in noisy environment and help to localise sounds. It improves speech understanding compared to conventional hearing aid [1] as well as quality of life of in many studies [2, 3]. This study aims to discuss the outcomes of BAHA implant at UKMMC based on the quality of life, hearing improvement and complications.

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Materials and Methods

This was a cross sectional study conducted in UKMMC. The study started from August 2012 to December 2013 with the duration of 17 months. It was a universal sampling in which all patients implanted with in UKMMC from December 2001 until December 2012 was included. Incomplete data and non-consented patients were excluded. Glasgow Benefit Inventory (GBI) questionnaires and UKMMC questionnaires were used as part of the assessment tool. UKMMC questionnaires was invented to assess questions related to social and life style of patients and also the cosmetic perspective Baha implant and other daily related activities.

The audiological assessment was assessed using hearing aid gain threshold. Pre-operative hearing level was taken from patient document and repeat hearing threshold performed post operatively within 3–6 months. Complication with regards to skin reaction was graded using Holger Skin Classification. The patient or parents verbally consented for this study was interviewed. The interview take placed in the clinic during their follow up. All patients' document was reviewed. The hearing level pre and post operation and skin complication was documented.

Results

From December 2001 until December 2012, total of 40 patients was implanted with Bone Anchored Hearing Aid in UKMMC. Five patients' record was incomplete. Therefore, only 35 patients participated in this study. During this study, the age of patients ranged from 5 to 38 years old. The youngest patient implanted with BAHA is 4 years old. Twenty-two patients (62.8%) are male and 13 patients (37.1%) are females. The demographic data summarized in Table 1.

The indication for BAHA in this study are bilateral congenital canal atresia (60%), unilateral microtia (37.1%) and bilateral chronic discharging ear (2.9%). Majority of patients 21 (60%) who underwent BAHA have hearing level of moderate to severe hearing loss (40–89 dB) and 14 patients (40%) have mild to moderate hearing loss (20–39 dB). The level of hearing was evaluated 3–6 months post operatively as the implant is more stable and patients are used with the implant. All of the patients have range of 10–25 dBL improvement of their aided hearing which is statistically significant at p value of <0.05 . Mean aided for is 20 dB. The improvement presented in the pure tone audiometry grafts (refer Figs. 1, 2).

The quality of life was assessed by Glasgow Benefit Inventory (GBI) questionnaire. The response is based on five point scale ranging from large deterioration of quality of life (scale 1) to a large improvement in quality of life (scale 5). The

Table 1 The demographic data of BAHA patients in Universiti Kebangsaan Malaysia Medical Center

Variable	No (%)
Age; median	13 (9.17)
Age category	
1–10 years old	12 (34.2)
11–20 years old	14 (40.0)
21–30 years old	4 (11.4)
31–40 years old	4 (11.4)
Side of operation	
Right	27 (77.1)
Left	8 (22.9)
Gender	
Male	22 (62.9)
Female	13 (37.1)
Race	
Malay	26 (74.3)
Chinese	8 (22.9)
Others	1 (2.9)

Cronbach alpha value for GBI is 0.68. In clinical practice, the acceptable level for internal consistency for Cronbach alpha is >0.5 . There are 3 subscales and the Cronbach alpha for all 3 subscales is 0.833 for general subscale, 0.708 for social support subscale and 0.14 for physical health subscale. All these scores range from -100 to $+100$. The GBI was scored positively in all subscales in this study. Total mean for general subscale is 46.31 (SD 20.25), social subscale is 58.57 (SD 26.3) and physical health subscale is 41.43 (SD 26.00). Total subscale score is 47.51 (SD 18.59).

The quality of life is also measured by questions invented by residents' otorhinolaryngology in Universiti Kebangsaan Malaysia Medical Center. There are eight items with responses in the form of agree, do not agree and undecided. In this study, 32 patients (91.4%) used BAHA more than 4 h per day and another 3 patients (8.6%) used BAHA less than 4 h. Three patients felt uncomfortable to sleep on the operation site as they experienced rashes over the site due to pressure. 20 patients experienced the sound processor detached from abutment. The other variables summarized in Table 2.

All patients had experienced some degree of skin irritation and inflammation post operatively with Holger class 1–2. It resolved by antibiotic and local steroid applications. Seven (20%) patient required removal of redundant skin over the abutment throughout their used of BAHA.

Discussion

The first BAHA implant operation in Malaysia was in 2001. Since 2001 until 2012, our hospital was the pioneer for BAHA program in Malaysia has implanted more than

Fig. 1 Pure tone audiometry of right ear: aided and non-aided hearing level

Fig. 2 Pure tone audiometry of left ear: aided and non-aided hearing level

40 patients. The indications for BAHA included congenital canal atresia with microbial, unilateral microbial, bilateral chronic discharging ear, acicular discontinuity and single sided deafness. The majority of patient in this study have bilateral congenital canal atresia with microbial, followed by unilateral microbial. One patient indicated for bilateral chronic discharging ears. BAHA benefit for this group as their ear canal is not occluded by ear-mole [4]. Liu et al. [5] in his study also showed commonest indication for BAHA is congenital atresia. The other indication of BAHA is mixed hearing loss [6].

The median age of this study is 13 years old. The youngest patient implanted with BAHA in this study is 4 year old. The Majority of patients implanted with BAHA are from pediatric age group [7].

Improvement of hearing means a combination of improvement in audibility and quality of sound such as warble tone threshold, speech reception threshold, and discrimination in noise [8].

Håkansson et al. [9], in his 10 years study, reported the audiometric results in 147 patients with BAHA. He divided the patients into three groups based on their pure-tone average (PTA) bone thresholds; 0–45, 46–60, and >60 dB. He concluded that there was a strong relationship between PTA bone conduction thresholds and successful rehabilitation. In the group with the best cochlear reserve (PTA < 45 dB), 89% felt their hearing was subjectively improved after BAHA. Conversely, in the groups with progressively less cochlear function (46–60 and >60 dB), 61 and 22% respectively of patients reported subjective hearing improvement. In our study, majority of patients 21 (60%) have mild to moderate hearing loss with bone conduction threshold is 20–70 dBL. 14 patients (40%) have moderate to severe hearing loss with threshold 40–90 dBL. In our study all patients had 5–25 dBL hearing improvement at 500, 1000, 2000 and 4000 Hz with BAHA. The mean threshold improvement is 20 dBL.

Glasgow Benefit Inventory is used in many studies and has document a significant improvement in patients' wellbeing and state of health [3]. Arunachalan et al. [10] showed that significant score in all subscales; general score was +40, social benefit was +27 and physical score was +10. In our study, GBI result showed significant positive score in all sub-scores. The general score was +46.31, social score was +58.5 and physical score was +41.43. Another study by Gillett et al. [11] also reported that, BAHA had significantly improved quality of life by enhancing the patients' wellbeing; improve the social and health status.

UKMMC BAHA questions are related with patients' daily activity. More than half of patients agreed that with BAHA, they felt easier to travel (57.2%), they spend more time outing (54.3%), felt more comfortable in noisy environment (60%) as well as during sleep (71.4%). From these questions we conclude that BAHA give satisfaction in life. Studies also showed high degree of satisfaction in relation to speech perception in quiet conditions, during conversation with one person in noisy environment and conversation at home [12]. These studies also noted satisfaction in relation to sound amplification and listening to radio, television or music. In this study, 91.4% patients used BAHA more than 4 h per day. This showed that BAHA implant is comfortable and easy to handle. The other 8.6% used BAHA less than 4 h. They described that they feel uncomfortable using the device. In this study too, 88.6% claimed that BAHA is cosmetically acceptable. The device is going to be more appealing by time as technology improves.

Table 2 Patients satisfaction towards common daily activities

No.	Questions	N (%)		
		Agree	Do not agree	Undecided
1.	Does BAHA implant cosmetically acceptable	31 (88.6)	1 (2.9)	3 (8.6)
2.	After BAHA implant, you feel easier to travel	20 (57.2)	2 (5.8)	13 (37.1)
3.	After BAHA implant, you are feeling more comfortable in noisy environment	21 (60)	3 (8.6)	11 (31.4)
4.	After BAHA implant, you spend more time outing or doing outdoor activity	19 (54.3)	1 (2.9)	15 (42.9)
5.	After BAHA implant, you are able to participate in water related activity	13 (37.1)	2 (5.8)	20 (57.1)
6.	After BAHA implant, you are feeling more comfortable during sleeping	25 (71.4)	3 (8.6)	7 (20.0)

Complication of BAHA implant is divided into intra-operative and post-operatively. Intraoperative, difficulty and failure osteointegration, dura tear causing cerebrospinal fluid, sigmoid sinus injury and bleeding. Post-operative complication is local infection and inflammation at the implant sites. Gillett et al. [11] showed that 33% have temporary minor skin infection, 17% have thickening of skin around the implant which require soft tissue reduction and 2% failed osteointegration. Faber et al. [13] in his study showed that the skin reaction occur in 18.5% and implant failed to osteointegrated in 1.3%. Asma et al. [14] in her 10 years experience of surgical outcomes of BAHA, documented that 21.1% patient have tissue reaction and one patient had failure of osteointegration. Generally, only 2 cases reported to have cerebral abscess following BAHA implant [15]. In this study, all patients had experienced grade 1–2 post operation which resolved with antibiotic and local steroid applications. Seven (20%) patient required removal of redundant skin over the abutment throughout their used of BAHA.

The new technology of non-skin penetrating Baha Attract systems with partially implantable bone conduction hearing aids offer better hearing aided level as well as less skin reaction. This system uses magnetic coupling to hold the sound processor externally. The implantable magnet is anchored to the skull via a single osseointegrated fixture. This allows maximum energy sound transfer. Kurz et al. [16] concluded that Baha Attract system is beneficial and useful as it has additional attenuation, ranging from 5 dB at 1000 Hz and 20–25 dB above 6000 Hz.

Conclusion

All patients have improvement in their aided hearing with the range of 10–25 dBL which is statistically significant at p value of <0.05 . The GBI was scored positively in all subscales. General subscale score was 46.31, social subscale score was 58.57, physical health subscale score was 41.43 and total subscale scores was 47.51. The UKMMC questionnaire showed that BAHA improved their daily

activities of travelling, sleeping, outing and noisy environment activity. Majority of patients (91.4%) used BAHA more than 4 h per day and 88.6% agreed that BAHA is cosmetically acceptable. However, in this study, all patients experienced some form of skin irritation (Holger grade 1–2) but only 20% required surgical intervention. We concluded that BAHA has proved significant benefit in from audiological improvement and quality of life. The complications are rare and relatively low and can be minimized by meticulous surgery as well as good cleaning and care of the operation site.

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Compliance with Ethical Standard

Conflict of interest All the authors stated above declare that they have no conflict of interest.

Ethical Approval All procedures performed in this study were in accordance with the ethical standards of Research Ethic Committee Universiti Kebangsaan Malaysia (RECUKM) and with the 1964 Helsinki declaration and its later amendments or comparable ethical standards. Formal consent obtained from each of the individuals in this study.

Informed Consent Informed consent together with formal consent were obtained from all individual participants for whom indentifying information is included in this article.

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