Measurement of Bone Thickness in Baha: How we do it?

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Abstract- Bone anchored hearing aid is used for hearing rehabilitation in those patients with conductive or mixed hearing loss who cannot be benefitted with a traditional air conduction hearing aid. The success of the implant depends on its osseointegration with the scalp bone which in turns depend on quality and thickness of the bone,that has to be more than 2.5 mm. Here, we suggest an innovative technique to measure bone thickness both pre- operatively and intra-operatively. High resolution computerized tomography was performed with button cell in place. Scans were reviewed to measure the bone thickness behind temporoparietal suture line .The site of artefact produced by the button cell was also noted. The bone thickness corresponding to the site of artefact was noted and considered during the surgery for the implant. To further increase the accuracy, we used a measuring rod as a tool to assist in intraoperative measurement. The measuring rod is in different sizes of 2mm, 2.5mm, 3mm, 3.25mm, 3.5mm and 3.75mm. This too helped us to find the optimum thickness before fixture placement at the site and avoid complications. Meticulous placement of the implant at the correct site avoids extrusion of the implant. Hence, we recommend measurement of bone thickness pre operatively and intra-operatively. Use of button cell artefact in high resolution computerised tomography of temporal bone is a simple and effective technique to choose the site of implant placement pre-operatively and use of depth gauge intra-operatively. In our series, it has helped us avoiding multiple drill holes.

Index Terms- Baha, Bone thickness, HRCT tempral bone, button cell, measuring rods

I. Background

Bone anchored hearing aid is used for hearing rehabilitation in those patients with conductive or mixed hearing loss who cannot be benefitted with a traditional air conduction hearing aid. Occasionally patients with single sided deafness also opt for Baha. It was first introduced in 1977 by Tjellstorm, now more than 15 000 patients have been fitted with Baha implant all over the world.[1,2]

The success of the implant depends on its osseointegration with the scalp bone which in turns depend on quality and thickness of the bone. The important prerequisite being thickness more than 2.5 mm. High resolution computerised tomography of the temporal bone is performed during the pre operative work up of the patient to determine bone thickness. It is measured behind the temporoparietal suture line.

In this article we suggest an innovative technique to measure bone thickness both pre- operatively and intra-operatively.

II. Procedure

We describe a novel way to measure skull bone thickness pre operatively in patients with congenital external ear deformity to locate the most appropriate site for Baha implantation.

Our patients with bilateral congenital microtia with bilateral moderately severe conductive hearing loss along were posted for Right sided Baha implantation surgery. Head was shaved pre operatively four finger breadths above and behind the malformed ear. Orbitomeatal line was extrapolated to approximately 6.5 mm behind the pinna thereby leaving space for pinna reconstruction in the future and site was marked and button cell was put over it. (Figure 1)This was kept in place using transpore. High resolution computerized tomography was performed with this in place. Axial and coronal cuts of the scan were reviewed to measure the bone thickness behind temporoparietal suture line .The site of artefact produced by the button cell was also noted. (Figure 2)The bone thickness corresponding to the site of artefact was noted and considered during the surgery for the implant.

At the time of surgery, while drilling hole for implant with the guide drill, we used measuring rods of different sizes 2mm, 2.5mm, 3mm, 3.25mm,3.5mm and 3.75mm to assess the bone thickness intra-operatively. These are custom made by us to measure the depth of the hole intra-op, thereby indirectly measuring the bone thickness. (Figure 3)

Whenever we found the bone thickness was more than 3mm the spacer was removed and 4 mm drilling was done.

III. Discussion

Baha is a percutaneous implantable hearing aid and depends on the concept of both osseointegration and bone conduction hearing. It consists of implant which is known as fixture, transcutanous abutment and sound processor. The fixture usually comes in two sizes of 3mm and 4mm and the selection by the surgeons is dependent on the bone thickness and quality of the bone at the site of implantation.

Bone quality in children differs from the adult in many ways. Children usually have a soft bone due to low mineral content and high water content. U.S food and drug administration recommends Baha in children more than 5 years of age as minimum bone thickness of 2.5 mm is necessary for fixture placement. Younger children are provided with Baha soft band which is attached to the processor which allows for early stimulation of the cochlea and further speech and language development.

The skull thickness in children with congenital external ear deformity can be a considerable factor hindering proper placement of Baha implant.[3] As we know that skull thickness of at least 2.5 mm is needed if a 3mm long fixture is to be placed.[4] If the bone thickness is more than 2.5 mm then fixture placement, abutment insetion and soft tissue reduction is done in the same setting called as Baha FAST. Otherwise, surgeons go ahead with a two staged Baha surgery where in the first stage only the implant and with cover screw are is placed and abutment is placed in the second stage after removing the cover screw. The thickness of the bone not only decides the size of the fixture but also whether the surgery can be done at one go or needs staged procedure.

In one of the studies by Tjellstorm in 2004, they measured the skull bone at the site of Baha implant and variations in the bone thickness were observed in children as well as in adolescence. The average thickness at the 5 years of age came out to be just 2 mm. Also they observed that during surgery, the dura of the middle cranial fossa was exposed at the floor of drilled guide hole in more than 25 % of cases, which means we have to be extremely careful during the surgery in order to avoid devastating complications such as dural tears, subdural haematoma, cerebrospinal fluid leaks and damage to sigmoid sinus.[5] Thus, pre operative measurement of bone thickness using HRCT temporal bone helps us to avoid unforeseen complications and proper planning during surgery. Also, since bone thickness more than 2.5mm is mandatory before going ahead with surgery, knowing it pre operatively is important and in case it is anything less than 2.5mm, we may have to abandon surgery and wait till the child achieves adequate bone thickness.

It is important to know it pre-operatively because of variations in bone thickness of the skull in children especially with congenital malformations, surgeons may have to drill multiple holes before a site with appropriate skull thickness is achieved.[6] This increases operative time as well as the complications which may arise as result of making multiple “test holes” and it further emphasises that knowing bone thickness pre operatively may help to avoid both. Dr. Hockmann has described a similar technique using Computerized Axial Tomography (CAT) wherein he measured the thickness of the skull in 4 cases of bilateral aural atresia in children aged between 3 and 4 years before fixture placement and this proved to be very correct in figuring out the skull thickness at the chosen site.[7]

To further increase the accuracy of implanting at the site of appropriate bone thickness, we used a measuring rod as a tool to assist in intraoperative measurement. The measuring rod is in different sizes of 2mm, 2.5mm, 3mm, 3.25mm, 3.5mm and 3.75mm. This too helped us to find the optimum thickness before fixture placement at the site and avoid complications.

IV. Conclusion

The key point in success of Baha is good osseointegration which in turn depends on the thickness and quality of bone at the site of implant. So it is imperative to choose the site of implant correctly. There by avoiding complications such as dural tears, cerebrospinal fluid leak, bleeding from sigmoid sinus. Meticulous placement of the implant at the correct site avoids extrusion of the implant. Hence, we recommend measurement of bone thickness pre operatively and intra-operatively. Use of button cell artefact in high resolution computerised tomography of temporal bone is a simple and effective technique to choose the site of implant placement pre-operatively and use of depth gauge intra-operatively. In our series, it has helped us avoiding multiple drill holes.

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Figure legends
Figure 1: Showing button cell placement at the possible site of implant before HRCT temporal bone
Figure 2: Axial cuts of HRCT temporal bone showing site of artefact produced by the button cell
Figure 3: measuring rods of different sizes 2mm, 2.5mm, 3mm, 3.25mm,3.5mm and 3.75mm to assess the bone thickness intra-operatively. These are custom made by us to measure the depth of the hole intra-op, thereby indirectly measuring the bone thickness.

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