Modified Baha Punch Technique: Least Invasive, Shortest Time and No Suturing

Hassan Alshehri¹ · Abdulrahman Alsanosi¹ · Osama Majdalawieh²

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Abstract To describe a new Baha surgical procedure (Modified Punch Technique) with a smaller punch hole, a minimal incision and the use of the hydroxyapatite-coated abutment (BIA400). Retrospective chart review. Patients were implanted between 2012 and 2013 at King Abdulaziz University Hospital (Kingdom of Saudi Arabia). Eligible for initial or replacement bone-anchored hearing system; includes six patients (four adults, two children). Baha surgery using the Punch Method is described. The mean surgical time was 12.33 min (range 6–30), without the single outlier, it was 8.8 min. Bleeding was significant but easily controlled in two patients only. Depending on the postauricular subcutaneous thickness, the sizes of abutment used were 6, 8, 10 or 12 mm. None of the patients experienced severe pain. The postoperative follow-up period was 7 months for one patient, 5 months for three patients, and 3 months for two patients. First report of combined Modified Punch Technique with the BIA400 abutment is minimally invasive, reduces surgical time and results in faster healing and reduced likelihood of postoperative numbness.

Keywords Baha · Surgical technique · Bone-anchored hearing aids · Osseointegration · Abutment

Introduction

Since its introduction in 1977, the CochlearTM Baha[®] Bone Conduction Implant has proven successful for thousands of patients throughout the world. In an ongoing effort to further improve the results and to shorten the time required for the surgery, the procedure for implantation has been modified by surgical teams, worldwide [1].

The most common surgical approaches practiced today are the Dermatome and the more recent Linear Incision techniques [2–5]. Both techniques require debulking of soft tissue around the implant; however, the current trend is to aim for minimal soft tissue trauma, reduction in surgery time, minimal skin overgrowth, and decrease pain and numbness around the implant site [1–3, 6, 7]. This trend was enhanced by the introduction of the Cochlear Baha BIA400 Abutment, which reduces the need for soft tissue reduction. The new abutment allows integration between the abutment surface and the surrounding tissue. The tight adherence between the dermis and the hydroxyapatite coated abutments causes significantly reduced pocket formation and epidermal down growth compared to conventional titanium abutments.

The aim of this study is to describe a new Baha surgical procedure, the Modified Punch Technique, which is minimally invasive, reduces surgery time, and results in faster healing and reduced likelihood of postoperative numbness. The technique described utilizes a smaller punch hole with a minimal incision and, for the first time, includes application of the hydroxyapatite-costed abutment (BIA400).

✉ Osama Majdalawieh
omajdala@dal.ca

¹ Prince Sultan Research Chair for Hearing Disability and Implantable Devices, ENT Department, College of Medicine, King Saud University, Riyadh, Saudi Arabia

² Cochlear AG, Peter Merian-Weg 4, 4052 Basel, Switzerland

Materials and Methods

A retrospective chart review was conducted for six patients (three males and three females) who underwent the Baha surgery using the Modified Punch Technique between 2012 and 2013 in our clinic. Two patients were children and four were adults with the youngest being 7 years of age and the oldest 60 years. One of the patients had atresia, one had single-sided sensorineural deafness (SSD), while the rest of patients presented with chronic supportive otitis media. See Table 1 for a full description of patient characteristics. This study was approved by the Institutional Review Board (IRB), King Saud University, College of Medicine, Riyadh. All subjects, or their legal guardian, had previously granted consent to the use of relevant data.

Surgical Procedure: Modified Punch Technique Described

1. Similar to previous surgical techniques, the indicator for Baha is used to carefully mark the location of the planned implant site, generally 50–55 mm from the ear canal and with the indicator in line with the top of the pinna (Fig. 1a, b).
2. The incision is marked 20–30 mm long, posterior to the pinna following the direction of the hairline. Then, the soft tissue thickness is measured using a thin hypodermic needle (22 or 24 gauge, yellow or blue), a clamp, and a ruler. The needle is held firmly and perpendicular to the skin surface and pushed gently until reaching the bone without depressing the tissue (Fig. 2a, b). The appropriate abutment length is selected by adding 3 mm to the measured tissue thickness. Local anesthesia is administered at the site of the abutment and gentle pressure is applied (Fig. 2c).
3. A size 6 mm punch instrument (Robbins Instruments, Catham, US) is held perpendicular to the skin at the marked implant site. A gradual pressure is applied against the bone while twisting the punch until it reaches

the bone. It is important to keep it perpendicular to avoid tethering of the skin on one side and a pocket on the other side when the abutment is placed. Usually, the punched tissue will come out in one piece that includes the periosteum. It should be noted that the thicker the subcutaneous tissue, the more redundant tissue will be seen in the punch site. This tissue can be handled either with a thin tip retractor or by removing the tissue with a pair of scissors, which will allow for a better visualization of the bone on the bottom of the punched space. Any bleeding from this area can be controlled by direct pressure or bipolar diathermy or both. After this step, the surgeon will be able to see the bone. The margins of the periosteum can be dissected away from the site of implant using a sharp dissector. (Fig. 3a–c).

Fig. 1 Site preparation: **a** measurement, **b** marking implant site

Table 1 Patient characteristics

Patient ID	Age (years)	Gender	Bone conduction threshold (dB HL) ^a	Type of loss	Previous Baha surgery (yes/no), L or R ear
S1	32	M	15	Conductive	Yes (L)
S2	41	F	18	Conductive	No
S3	60	M	15	Conductive	Yes (L)
S4	7	F	10	Conductive	No
S5	43	F	20**	SSD	No
S6	14	M	15	Conductive	No

** The bone conduction level in the better ear for the SSD patient

^a Pure tone average (500, 1000, 2000) for side of implant

Fig. 2 Soft tissue thickness measurement. **a** Soft tissue estimation by thin needle, **b** measuring thickness using ruler, **c** local anesthesia infiltration

4. An irrigation channel can be created using an intravenous cannula size 14 or 16 gauge (orange or gray) by inserting it from the upper limb of punch site until the tip of cannula is seen at the base of the punched site. Once this is accomplished, the cannula needle can be withdrawn and the cannula can be fixed by a clip on the drape towel. The irrigation tube, which is connected to the drilling machine, can be connected to the cannula and the suction tip can be placed on the lower part of the incision (Fig. 4a). Begin drilling the bone using the guide drill with 3 mm spacer. While drilling, move the burr up and down and slightly enlarge the hole to ensure visual inspection and that coolant reaches the tip of the drill (Fig. 4b). Check the bottom of the hole repeatedly for bone, both visually and with the dissector. If there is adequate bone thickness, remove the white spacer on the guide drill

Fig. 3 **a** A 6 mm punch is used and directed perpendicular to skin and bone level, **b** punched site before removal of tissue, **c** punched site after removal of tissue

- and continue drilling to a depth of 4 mm. During this step, the surgeon may face bleeding from the emissary vein, which can be controlled by applying direct pressure using ribbon gauze or using bone pate to occlude the bleeding lumen. The hole is widened using a 4 mm widening drill by up and down movements taking care not to press too hard, especially in soft bone, to avoid excessive countersinking. The irrigation should be continuous during this stage (Fig. 4c).
5. The abutment is picked up from its ampoule using the abutment inserter and placed in the hole without irrigation until the first threads of the implant are well within the bone (two rotations). Once the implant is in the bone, continue implant placement with irrigation (Fig. 5).
6. The final step is to carefully ease the skin over the abutment ensuring that the skin edges do not create an

Fig. 4 **a** Irrigation channel using a large pore cannula (gray color), **b** drilling the implant site using the guide drill, **c** widening the hole using a 4 mm widening drill with countersink

Fig. 5 The BIA400 abutment fully seated

Fig. 6 **a** A thin, low-adherent dressing is applied without any pressure, **b** the healing cup is attached to the abutment

unwanted pocket formation (Fig. 5). Apply dressing and healing cup without pressure. No suturing is required (Fig. 6a, b).

Patient Evaluation

Pain is a difficult complication to evaluate because different people have different thresholds for pain. It is for this reason that a special scale for pain severity was used in which the pain was classified according to its severity and the demand for analgesia. It was administered 1 week after surgery and patients were placed into four pain categories: Type 1: no pain; Type 2: mild pain without the need for analgesia; Type 3: moderate pain with the need for analgesia (one dosage); Type 4: pain associated with regular use of analgesia (severe).

Results

The surgery time (minutes) was calculated from the time of incision to the time the implant was secured in place. The shortest time achieved was 6 min and the longest time was

Table 2 Operative details

ID	Surgical time (min)	Bleeding	Abutment length (mm)	Discomfort and skin reaction	Classification	Other	Follow-up (months)
1	6	Minimal	10	Holgers Grade 2	Type 2	None	3
2	10	Minimal	12	Holgers Grade 1	Type 2	None	3
3	8	Minimal	12	Holgers Grade 1	Type 1	None	5
4	8	Minimal	6	Holgers Grade 2	Type 3	Dura exposed	5
5	30	Significant	12	Holgers Grade 1	Type 2	Dura exposed	7
6	12	Significant	8	Holgers Grade 1	Type 1	Emissary vein bleeding	5

30 min (mean = 12.33 min) with a standard deviation of 8.12.

Bleeding was significant (between 40 and 120 cc) in two patients, and required immediate management, intraoperatively: one (S6) had significant bleeding from the bone tissue (emissary vein) and the other (S5) had bleeding from both bone and soft tissue. The remaining four patients had minimal bleeding. In two patients (S4 and S6), the dura was exposed after using a 4 mm burr. According to the postauricular subcutaneous thickness, the BIA400 abutments used were 6, 8, 10, or 12 mm. The 12 mm abutment was used in three patients (S2, S3, S4), all adults (see Table 2).

The subjective pain scale showed that two patients (S3, S6) reported no pain (Type 1), three patients (S1, S2, S5) showed mild pain (Type 2), and only one patient (S4) reported moderate pain (Type 3). None of the patients experienced severe pain using this approach. One patient (S5) had minor numbness while all of the patients had mild skin reaction around the abutment (four patients with Holgers Grade 1 and two patients (S1 and S4) with Holgers Grade 2). The postoperative follow-up period was 3–7 months (see Table 1).

Discussion

Various techniques have been described for bone anchored hearing system placement since the Baha introduction in 1977. In the early 1990s, a simplified surgical technique using a linear incision instead of a semi-circular incision was developed at the Radboud University Nijmegen Medical Centre. The linear incision technique aimed at simplifying the surgical procedure, lowering complications, and reducing the surgery time. Evaluation of this technique and long-term results have been published in several studies [3, 8–11].

The biopsy punch has been used in the Baha surgery for many years. The punch is used to create a hole in the skin exactly over the abutment making it possible to carefully

ease the skin flap down over the abutment. The Punch Method was previously described by Goldman et al., where patients underwent the procedure for placement of a 4-mm implant with a longer 9-mm abutment [12]. The initial incision was performed using a 12-mm punch biopsy with variations to the standard procedure. This large size punch required suturing to close the wound after implantation. The authors concluded that this method decreased major postoperative infections, reduced incision length, improved cosmetics, and decreased operative time (<15 min).

The method described in this paper demonstrates a further reduction in both the incision and invasiveness of the Baha surgical procedure compared to that previously reported [12]. Our technique utilizes the most minimal incision and is the least invasive procedure described to date for Baha surgery. The hydroxyapatite-coated abutment (BIA400) was used with this method. A recent study used the Linear Incision Technique with the abutment [4]. To our knowledge, this current study is the first to report initial findings on a small group of patients in whom the use of both a Modified Punch Technique and the newly designed hydroxyapatite-coated abutment was applied. The abutment is designed to allow for minimally invasive surgery and soft tissue preservation. It allows integration between the soft tissue and the abutment to minimize pocket formation that acts as tract for bacterial entrance deeper to the bone.

The Baha surgical procedure has witnessed a huge reduction in surgery time, dropping from a couple of hours to a few minutes over the past years, especially for the linear incision technique with soft tissue preservation. Some authors reported decreases in duration down to 20 min [13, 14] and, most recently, as short as 9 min [4]. A comparison between the Punch and Linear Techniques was conducted by Gordon and colleagues where it is concluded that the Punch Technique provides more favorable outcomes [5]. In our described method, using a Modified Punch Technique, the surgery duration ranged from 6 to 12 min; with one patient at 30 min. The surgical time for that subject, patient 5, was considerably longer due to

cautery and pressure required to control the excessive bleeding from both the subcutaneous tissue and bone. In patients with 8 and 10 min duration, the removal of fat from the subcutaneous tissue that entered the surgical field (fat inverted toward the punched area) was required. Thick subcutaneous tissue was observed in those patients and reduction in time could be achieved using special types of retractors. One patient (S6) required 12 min. for the surgery because of bleeding that was controlled by direct pressure.

We faced three types of bleeding during the course of the surgical procedure: one originated from the subcutaneous tissue; the second from bone (emissary vein); and the third, from both sites. If the bleeding from the subcutaneous tissue is minimal, it can easily be controlled by applying small pressure. If, however, the bleeding is significant, it may be necessary first to apply a small pressure for some minutes while locating the source of bleeding and then apply bipolar cautery. The bleeding originating from bone can be controlled by applying a small pressure for few minutes and, if necessary, applying bone wax to the site of bleeding. Bleeding from bone and tissue can be controlled using a combination of pressure, bipolar cautery and bone wax, as needed.

Bleeding during the Modified Punch Technique represents the most difficult part of this simple procedure and managing it consumes the most time. Controlling and treating bleeding during Baha surgery has not been discussed extensively in the literature; only one case report mentioned postoperative epidural hematoma that was treated by craniotomy and evacuation [12]. In addition to the bleeding, dura can be exposed during Baha surgery depending on bone thickness. We faced this issue in our earlier Baha patients without any significant complications. Two patients, previously implanted with the Baha using the Dermatome technique (S1, S3), described their experience following the Modified Punch Technique as simple, painless, less skin reaction, and without any numbness. One of these patients had flap necrosis following his previous surgery, which was treated by skin grafting. The one patient who had mild numbness due to the use of cautery to control the bleeding from the subcutaneous tissue was not seen as a significant complication from this Modified Punch Technique.

It is important to highlight that following the Modified Punch Technique, all patients in this study reported no pain at 1 week, postoperatively. Previous studies have reported that around 5 % of patients have persistent pain and around 17 % have intermittent pain, postoperatively [15]. Although the current study included a small sample of patients with a follow-up period of maximum 7 months, we expect that patients implanted using the Modified Punch Technique will experience less pain immediately after surgery, decreasing to no pain with time compared to other

techniques. The positive outcomes and patient feedback from the Modified Punch Technique has encouraged us to continue using it as the main surgical method at our center.

Conclusion

The Modified Punch Technique described in this study supports integration between the soft tissue and the abutment and results in minimizing a pocket formation that may act as a tract for bacterial entrance deeper to the bone. The new technique is less invasive, decreases surgical time, decreases postoperative infections and numbness, requires no suturing, and improves the post-surgery site cosmetics. The limitations of this study are the short follow-up time and the small sample of patients. Larger studies are needed to confirm the safety and efficacy of this modified technique.

Compliance with Ethical Standards

Conflict of interest Hassan Alshehri, Abdulrahman Alsanosi, and Osama Majdalawieh declare that they have no conflict of interest.

Ethical Approval This study was approved by the Institutional Review Board (IRB), King Saud University, College of Medicine, Riyadh.

Informed Consent All subjects, or their legal guardian, had previously granted consent to the use of relevant data.

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