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Craniotomy with Ridges: A Time and Cost-Efficient Technique for Unwavering Fixation of Bone Flap

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ABSTRACT

After advent of the power driven tools, the ease of surgeons and pace of surgery has been enhanced. Nowadays, most of the neurosurgeons are tend to use the motorized drills for elevating a bone flap to make a craniotomy. The bone cutting by the craniotome is wide and nonbeveled, which mandates the fixation of bone flap at closure, either by wiring, miniplates, or other fixation techniques. This not only lengthens the duration of surgery but also adds extra cost of miniplates to the patient. Here we are presenting a novel technique of elevating a bone flap where fixation at the end of surgery is not obligatory, without any risk of sinking of bone flap into the craniotomy defect.

KEYWORDS: Ridges, Bone flap, Craniotomy

INTRODUCTION

Craniotomy is one of the oldest neurosurgical procedures, dating back to the Neolithic period in the form of making a hole in the calvaria (8000–5000 BC) (4). Although the procedure is ancient, the search for a better, easier, quicker, and safer method of performing a craniotomy continued. Currently, the standard involves the use of motorized electric or pneumatic drills to perform a craniotomy safely in a shorter period and with greater precision. Beveling is not possible, as bone cutting using a motorized craniotome is wider due to excessive bone loss and at right angle to the surface of the cranial vault (3). The bone flap when raised by a motorized craniotome mandates the use of miniplates, wiring, or other device to fixate the bone flap at closure, which is time consuming and expensive. This can be significant, especially in developing countries with limited resources. Other issues with the use of routine fixation devices include cosmetically objectionable imprinting, especially on the hairless part of the scalp; erosion of the overlying scalp; the loosening and migration of screws; and artifacts on imaging.

We describe the novel technique of elevating the bone flap and using a motorized drill and craniotome, where fixation of the bone flaps is not mandatory, as there is no fear that the bone flap will sink into the craniotomy defect. This saves the additional time of fixing the bone flap and, at the same time, reduces the cost of miniplates for patients.

Operative Tools and Technique

The operative armamentarium is the same as that used routinely. Additionally, two 4-mm chisels are used to elevate the bone flap. Preferably, we use an 11 mm perforator to prevent excessive bone loss.

Patient positioning, painting and draping, and the size and location of the craniotomy are determined according to the underlying pathology, as is standard protocol. After exposing the bone precisely, a burr hole is made using an 11 mm motorized high-speed perforator with an automatic disengaging gear, which stops automatically when it meets the dura to avoid injury to the dura and underlying parenchyma. Preferably, four burr holes are made to generate more contact points for the bone flap. The underlying dura is stripped off with the help of a small Penfield dissector to avoid tearing. A high-speed craniotome with Dura-Guard is then used to connect the adjacent burr holes. In our technique, cutting starts from one burr hole and stops just before reaching the midpoint of two adjacent burr holes; then, cutting starts from

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the other side, leaving a small bridge of bone (about 5–6 mm) between the two adjacent burr holes (Figure 1A). Thus, we generate four bridges of contacts if we make four burr holes. These bony bridges in this technique are not cut sharply but are broken by putting two 4-mm blunt chisels on either side of the bony bridges and applying gentle upward traction (Figure 1B). The edges of the chisel should not go deeper into the inner cortex to avoid injury to the underlying dura and brain parenchyma. Breaking bony bridges in this manner provides irregular beveled edges at this point with a chip of outer cortex with it (Figure 1C, D). When we reposition the bone flap, these beveled ridges prevent the bone flap from sinking into the craniotomy defect, and the chip of the outer cortex acts as a rest for the bone flap, further reinforcing stability. A gentle percussion on the bone flap at the level of these ridges causes the bone flap to fit snugly into the craniotomy defect (Figure 1E), thus obviating bone flap fixation.

DISCUSSION

In the nascent period of neurosurgery, the skull used to be opened with the help of a trephine and enlarged with a chisel and hammer. The pivotal development in elevating the bone flap was the invention of the Gigli saw, which was a flexible, fine barbed wire that could make a sharp cut in the skull bone (1,2). The Gigli wire was used worldwide to elevate bone flaps, and it is still being used in many neurosurgery institutes to perform craniotomy. The Gigli wire cuts the bone at an angle, producing beveled edges with lesser bone loss, which prevents the bone flap from sinking into the craniotomy defect; thus obviating the use of miniplates and wires to fix the bone flap. Because of the narrow cut between the bones, the cosmetic results are quitegood with the Gigli saw.

With the advent of the powerful motorized drill system, the popularity and use of the Gigli wire gradually declined because it was more time consuming (1). In addition, stripping of the dura by the guide can cause cumbersome epidural oozing, especially in the region of the dural sinuses, and to-and-fro movement while cutting the bone can dislocate the patient's head from the head holder's pin. The motorized drill overcame all these problems. The drill system is simple, fast, precise, and relatively safer for patients, as well as for surgeons. Additionally, with the help of a craniotome, we can perform a craniotomy by making a single burr hole, which saves time and is aesthetically superior. One odd aspect of the drill

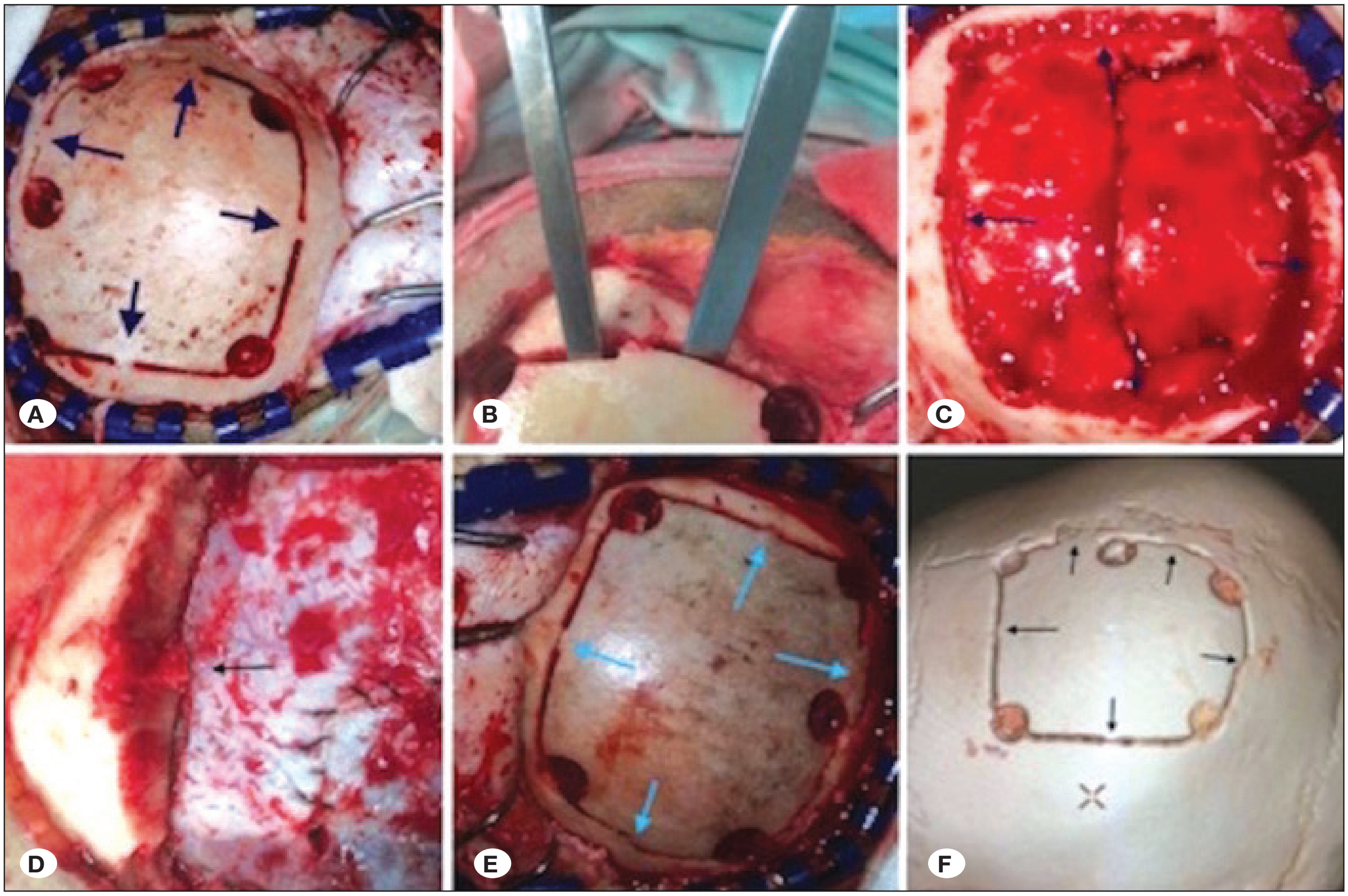

Figure 1: A) Showing the method of connecting the adjacent burr holes leaving a small bridge in between the two burr holes. **B)** Method of elevating bone flap using gentle upward traction with the help of two small (4 or 5 mm) chisel [**(C)** and **(D)**] the beveled ridge of bones at the level of bridge. **E)** The position of bone flap after the surgery. **F)** CT head with 3D reconstruction after four weeks of surgery showing snuggly fit bone flap into the craniotomy defect.

system is its wider cut between the bones and non-beveled edges, which mandates fixation of the bone flap to prevent it from sinking into the craniotomy defect. In our setup, we have been using an electric drill with a craniotome for the last seven years to perform craniotomies. Earlier, we used to elevate the bone flap in a conventional way, but there was an obligatory need to fixate the bone flap, as well as the additional burden of the cost of miniplates to the patients and complications related to fixation in a few cases, providing us impetus to innovate this technique.

We have been using this technique for the last year in our department, and we have performed more than 100 craniotomies using this technique, without additional complications. This technique is highly safe and friendly to surgeon, because the instruments used do not differ from those used for the conventional method. The risk of dural injury is lesser, because we connect the adjacent burr holes from both sides, contrary to the conventional method. Aesthetic results are also quite good, without any need for fixation by miniplates. The aesthetic results are even better in some conditions, like unilateral frontal or bifrontal craniotomy, where fixation by miniplates or wire could cause a gruesome impression of the miniplates on the forehead. This technique provides stable fixation in a lesser operative time, even without securing sutures, and it produces good results in all types of craniotomies, except in pterional and posterior fossa craniotomies, which require generous bony nibbling.

Like other technical advancements, this technique is also fraught with limitations, as it cannot be applied if we are planning to elevate the bone flap with a single burr hole. A greater number of burr holes provide more stability, and the standard requirement is at least three burr holes for adequate stability.

CONCLUSION

Our technique of raising the bone flap is technically feasible and highly effective in performing craniotomies in a simple

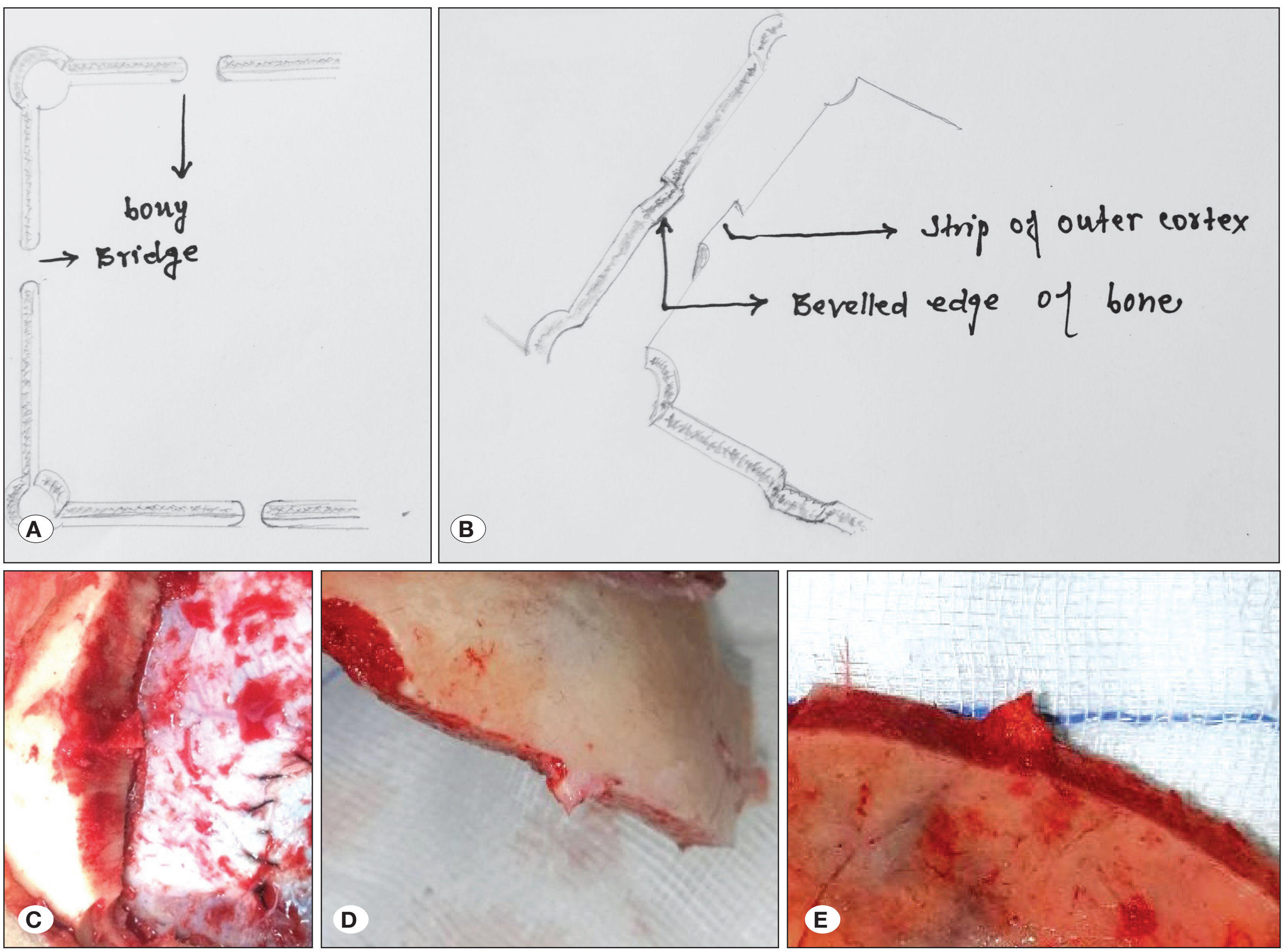

Figure 2: A) Drawing illustrating bony bridge between two burr holes. **B)** Drawing showing beveled bony ridge along with strip of outer cortex in bone flap. **C)** Tangential view of bone showing irregular bony ridge, which prevent bone flap from sinking into the craniotomy defect. **D, E)** shows strip of outer cortex which is produced when bony bridges are broken by gentle upward traction with the help of chisels.

way. It uses power-driven tools, which saves time, and it does not require wiring or plating, which saves additional time and costs related to the surgery. The aesthetic results are comparable to conventional methods without additional costs.

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