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Original Article

Safety and Efficacy of Power Drills for Burr Hole Craniotomy in Small Resource Hospital

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BACKGROUND: Burr hole craniotomy is a surgical procedure used to access the brain by creating small openings in the skull, commonly employed in treating chronic subdural hematoma. While manual twist drills are traditional but slow tools for this purpose, power drills offer speed but require caution to avoid brain damage.

OBJECTIVE: To determine the safety and time efficiency of power electric drills in performing burr hole and craniostomy when they are available in low resource hospitals.

METHODS: This prospective cohort study involved 40 patients with a mean age of 35 years. The study included patients undergoing cranial surgeries requiring burr holes for craniotomy or craniectomy. A power electric drill with a perforator piece of a manual drill inserted in it was used. The drills were used to create the necessary burr holes for the surgery and to design specific craniectomy flaps, which were later cut using a Gigli saw and an introducer. The total number of burr holes in each case, the time taken for each burr hole, and the bone thickness in every case were recorded during the surgery.

RESULTS: We operated on 40 patients. The time of each burr hole ranges from 35 seconds to 60 seconds, with a mean of 45±11 seconds. During the usage of power drills, there were no detected complications.

CONCLUSION: Power electric drills are considered safe and time-efficient in performing burr hole and craniostomy when they are available in low-resource hospitals.

KEYWORDS: Burr Hole, Craniotomy, Power drill.

INTRODUCTION

Craniotomy involves the temporary removal of part of the skull by making a series of burr holes and performing a linear cut in the bone between them.[1,2] It is considered an ancient neurosurgical procedure originating in Egypt and is one of the oldest surgical procedures for treating cranial trauma.[3,4] In the past 20 years, burr hole craniotomy had been the most commonly performed procedure for relieving the compression of chronic subdural hematomas.[5] It is done by drilling one or several tiny holes in the skull to allow access to the brain and can be used to treat various medical conditions, including chronic subdural hematoma, acute extradural hematoma, brain tumors, vascular malformations, intracerebral hemorrhage, subdural empyema, hydatid cyst, and implantations of neurostimulators for diseases such as Parkinson's or epilepsy.[6]

The burr holes were historically carried out using drill-like instruments called terebra in the Hippocratic texts. The need for an easier, better, quicker, and safer instrument for performing burr holes persisted. Currently, the standard involves the use of different types of drills; Manual hand drills, which are the oldest type but considered the most unsafe due to uncontrollable drilling speed; electric drills, which provide stable force and minimize the physician's efforts; pneumatic drills, which operate based on compressed air; high-speed drills, designed to rapidly pass through the bone; and perforator drills, special tools used for drilling holes that switched off immediately after entering the needed space to prevent further bone perforation.[7]

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There are few potential complications associated with drilling burr holes. First, excessive pressure and inaccurate drilling may cause bone or skull fractures. Specifically, fractures of the skull surrounding the site of the burr hole that can result in additional trauma to the brain or blood vessels. Second, a dural tear can occur if the drill penetrates too deeply tearing the dura mater.[5,6,8] This can lead to cerebrospinal fluid leaks and increase the risk of meningitis or direct brain injury. This can result in bleeding, swelling, or direct trauma to brain tissue. Intracranial hemorrhage is a serious complication and can be life-threatening if not managed promptly.[8] Any surgical procedure that penetrates the skin can introduce bacteria, potentially leading to infections of the skin, bone, or brain. Infections such as osteomyelitis (bone infection) or abscess formation within the brain or skull can be severe. High-speed drills generate significant heat. Without adequate irrigation to cool the drill bit, this heat can damage the bone and adjacent brain tissue. Equipment failure or mechanical failure of the drill, such as abrupt stopping or malfunctioning safety features, can lead to incomplete procedures or unexpected surgical difficulties.[9,10] With the use of pneumatic drills, there is a small risk of air embolism where air gets into the bloodstream through exposed veins, which can be dangerous if it travels to the heart, lungs, or brain. Patients with a history of epilepsy or those undergoing surgery near seizure-prone areas of the brain may experience seizures following the procedure, especially if the brain tissue is irritated or damaged.[5,9]

Power drills have revolutionized the way of performing burr holes in neurosurgical procedures. Using power drills can significantly speed up the process of creating burr holes compared to manual drills, reducing surgery time and effort, which benefit both the patient and the surgeon. Power drills require less physical effort from the surgeon, which is particularly important during lengthy surgeries or when multiple burr holes are necessary.[8]

Our hypothesis is that power electric drills are highly useful and lead to significant progress compared to manual drilling in performing burr hole craniotomy when they are available in low-resource hospitals.

PATIENTS AND METHODS

This study was approved by the Institutional Review Boards (IRB) of Menoufia faculty of Medicine under IRB no. (3/2024 NEUS 19-2). This prospective cohort study involved 40 patients with cranial surgeries that needed burr holes for craniotomy or craniectomy in Menoufia University Hospitals and private practice. We used a power electric drill with the perforator piece of a manual drill inserted in it. **(Fig. 1).** Then, with controlled pressures, we used these drills to perform the required number of burr holes for the surgery and for designing a specific craniectomy flap. Later we used a Gigli saw and the introducer to cut the craniectomy flap.

We collected and analyzed data about the age and gender of the patients and also gathered information about the diagnosis of each case, associated comorbidities, and medications that each patient used. During the surgery, we calculated the total number of burr holes in each case and the time of each burr hole. We also measured the bone thickness in every case. Any complications that happened would be recorded. Statistical analysis was performed with the statistical package for social sciences (SPSS) version 11.0. **(Fig. 1)** illustrates drilling one of burr holes for craniotomy flap.

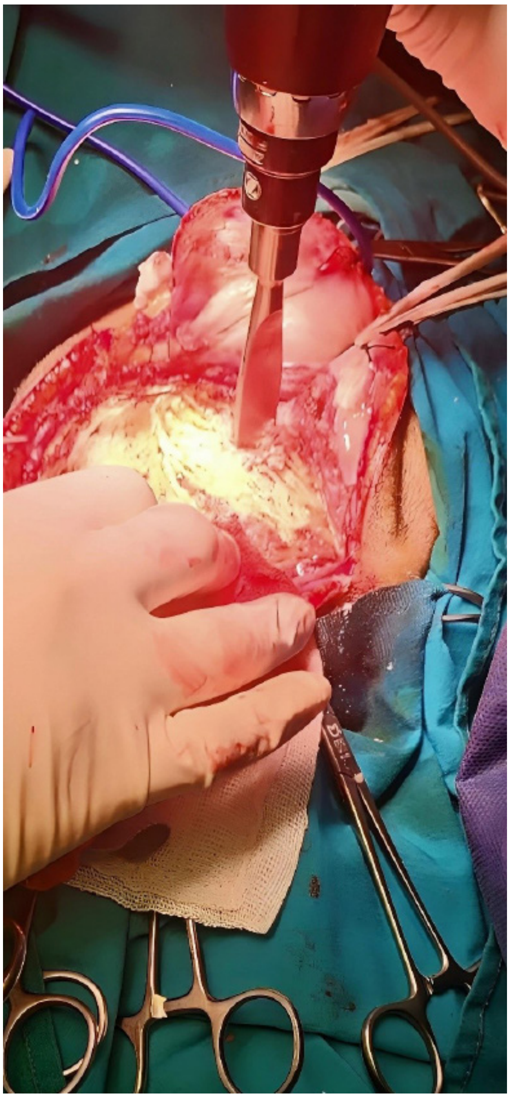

Fig 1: Drilling one of burr holes for craniotomy flap.

RESULTS

We operated on 40 patients with an age range between 12-72 years, with a mean age of 35 years. Ages below 12 years were excluded due to small bone thickness and for safety and avoidance of bone fracture and brain injuries. Twenty-eight cases (70%) were males and 12 cases (30%) were females. Twelve cases (30%) were diagnosed with chronic subdural hematomas, 11 cases (27.5%) were diagnosed with acute subdural hematomas, 7 cases (17.5%) were diagnosed with extradural hematomas, 6 cases (15%) were diagnosed with brain tumors and 4 cases (10%) with hydrocephalus. The number of burr holes in each case depended on the diagnosis that ranged from 1 burr hole in cases of hydrocephalus and 2 burr holes in cases of chronic subdural hematomas. In cases of craniectomy flap the number of burr holes ranged from 4 to 6 burr holes according to the size of the flap. The time of each burr holes ranged from 35 seconds to 60 seconds, with a mean time of 45±11 seconds. The calvaria thickness ranged from 5 to7 millimeters. It was directly proportional to the age. There were some exceptions in the temporal bone, which is normally thinner and its thickness ranged from 2 to 5 millimeters and in some cases of brain tumors in which the bone thickness reached up to 11 millimeters. During usage of power drills there were no detected complications such as dural tears or brain injuries, which may be attributed to the previous experience for usage of manual drills.

DISCUSSION

Imhotep, around 2900 BC, was the first to describe the approach of craniotomy.[11] The therapeutic use of craniotomy for managing fractures began in the 5th century BC with Hippocrates.[12,13] The use of a trephine to remove sections of the skull was believed to alleviate headaches, mental illness, epilepsy, and hematomas.[14,15] Burr holes are performed either as a stand-alone treatment or as part of a larger craniotomy procedure, with the potential for procedural complications. Dulling of the drill bit can lead to cortical over-penetration or plunge due to the increased axial pressure required to advance the drill bit.[5] Common surgical complications while using the manual drill include dura mater perforation, hemorrhage, contusion, and cerebral tissue damage. Neurological issues may include seizures, aphasia, follow-up surgeries, and an extended hospital stay.[16]

The Hudson brace, like other manual drills, can potentially cause hemorrhagic complications if drilling is not precisely controlled or if accidental penetration occurs. This can result in conditions such as acute epidural hematoma, which poses a serious risk during any craniostomy procedure.[17] The use of a power drill could potentially enhance the safety profile, reduce the risks of complications, and improve the overall efficiency of common life-saving neurosurgical procedures performed urgently.[18]

In our study, power drills typically offer faster drilling speeds and easier handling, reducing the time required to achieve intracranial access compared to manual drills. This is in contrast to other studies that found the Hubly electronic drilling had a slightly longer drilling time compared to manual drills.[8] Power drills have significantly improved the way burr holes are performed in surgical procedures, by speeding up the process of creating burr holes. This increased efficiency reduces overall surgery time, benefiting both the patient and the surgical team.

It was reported that the penetration rate was higher for electrical drilling, with an average of 90% compared to manual drilling with an average of 80%. They also reported microscopic analyses of 40 burr holes showing that electric drills lead to more precise holes with smaller diameters, rounder shapes, and fewer irregularities in their margins compared to manual drills.[8]

Power drills require less physical effort from the surgeon, which reduces fatigue. This is particularly important during lengthy surgeries or when multiple burr holes are necessary. The usage of manual drills causes fatigue in the surgical team before the actual planned surgery and increases the time of surgery. The usage of power drills can decrease the time of surgery and save the energy of the surgical team during the surgery. Therefore, in small resource hospitals, we try to use available low-speed power drills to perform burr holes and assess their safety and efficacy.[4] The power drill facilitated safe and accurate burr holes at the bedside with a reported acceptable safety profile. Our study had the same results, as we experienced no complications.

CONCLUSION

Power electric drills are considered safe and time efficient in performing burr hole and craniostomy when they are available in low resources hospitals. They reduce the required physical efforts and time to perform single or multiple burr holes with safe results and reasonable efficiency.

List of Abbreviations

IRB: Institutional Review Board.
SPSS: Statistical package for social sciences.

Disclosure

The authors report no conflict of interest in the materials or methods used in this study or the findings specified in this manuscript.

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