ORIGINAL ARTICLE

‘Plunging’ during burr hole craniostomy: a persistent problem amongst neurosurgeons in Britain and Ireland

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Abstract
The inadvertent ‘plunging’ of an instrument into the cranial cavity is a feared complication of drilling a burr hole and while anecdotes abound, little is known about the extent or the consequences of this problem. A survey by anonymous postal questionnaire of 304 neurosurgeons in Britain and Ireland was conducted to analyse the extent of this complication. Of respondents, 66.2% had experienced ‘plunging’, 22.3% having ‘plunged’ at least twice, indicating a high prevalence of this complication. The Cushing perforator was implicated by most. ‘Plunging’ carried a 12% risk of death or permanent neurological morbidity. The authors analyse the prevalence and significance of this preventable complication, and discuss various options available to minimize its occurrence.

Key words: Burr hole, complication, Cushing perforator, plunging.

Introduction
The drilling of cranial burr-holes is an integral part of many neurosurgical procedures. Various implements have been employed for this purpose with the Hudson brace being the most widely used manual instrument. Powered instruments including a variety of ‘clutchless’ perforators and high-speed drills are also employed. Penetrating injuries of the brain can occur by inadvertent ‘plunging’ into the cranial cavity during use or misuse of instruments.1

The advent of an automatic (‘clutchless’) drill for fashioning cranial burr-holes was reported over half a century ago with a view to reducing the likelihood of a ‘plunge’, as the drill stops automatically once the inner table of the skull is perforated.2 However, it is still considered somewhat extravagant to use this instrument where only one or two burr-holes are needed, as in shunt surgery or drainage of chronic subdural haematoma, because of the re-sterilization costs and the replacement cost of a single-use perforator. Many neurosurgical units retain the use of the Hudson brace and reusable Cushing perforator and it is still said that most neurosurgeons will ‘plunge’ at some stage in their career.

Whilst there are reports of isolated mishaps with various instruments on record,3,4 data on the frequency of this complication has been scarce, probably owing to the understandable reluctance to admit such an event. We, therefore, undertook to survey neurosurgeons in Britain and Ireland by anonymous postal questionnaire to analyse the extent of the problem, with a view to addressing some of the issues regarding this potentially preventable complication.

Materials and methods
An anonymous, postal questionnaire (Fig. 1) survey of 304 members of the Society of British Neurological Surgeons (170 consultants, 134 trainees) based at 38 Neurosurgical units throughout Britain and Ireland was conducted in 2002.

Results
Of the 304 neurosurgeons surveyed, 198 (65.1%) responded. Of the respondents, 130 (65.6%) had experienced a ‘plunge’ event; 29 (22.3%) had more than one ‘plunge’ experience. The Hudson brace with Cushing perforator attachment (Fig. 2a) was the
instrument implicated by 123 (94.6%) respondents, with the other seven reporting 'plunges' with various instruments, including powered drills with 'clutched' perforators and, in one case, a periosteal elevator. One-hundred-and-three (79.2%) of the respondents reported breaching the dura during the 'plunge'. The respondents who 'plunged' are characterized by grade of seniority (Table I).

The procedures during which a 'plunge' event was reported are recorded (Table II). Interestingly, the 'plunge' reported during the functional neurosurgical procedure caused the operation to be abandoned, only for the surgeon to discover the patient not only unharmed, but the intractable tremor cured! Others were less fortunate, with 37 hemorrhagic complications of 'plunge' events recorded (Table III) resulting in 10 cases of neurological morbidity and seven deaths; 10 patients underwent emergency craniotomy to evacuate an iatrogenic intracranial hematoma (Fig. 3).
Discussion

The inadvertent ‘plunging’ of an instrument into the cranial cavity is a feared complication of drilling a burr-hole. Whilst anecdotes abound, little is known about the extent or consequences of this problem. Although our results represent data from recent times dating back some 30 years, there is little doubt that ‘plunging’ during burr hole craniostomy still remains an issue in modern neurosurgical practice. Furthermore, it seems to be primarily related to the use of the Cushing perforator, a pointed instrument not unlike the ‘pointed trepan’ (Fig. 4c) condemned as dangerous by no less than Sir Percival Pott nearly 250 years ago (Fig. 2c), who instead favoured trephining (Fig. 4b) a disc of bone to avoid this complication.²

Sir Percival’s views were brought to the attention of the south-western Branch of the British Medical Association in July 1877 in a paper read by no less than Robert S. Hudson, inventor of the instrument which bears his name (Fig. 2a).

It may be that the Cushing perforator is so heavily represented in ‘plunging’ incidents because it has

![Fig. 3. Fatal intracerebral and intraventricular haemorrhage from a ‘plunge’ during routine shunt surgery.](image)

![Fig. 4. (a) Modern Hudson brace; (b) nineteenth century brace and trephine; (c) brace with pointed and disc trephine attachments (Tabulae instrumentarii chirurgici. F Leo, Berlin, 1824).](image)
been more widely available than other types of manual perforators, although air-powered drills are being used more frequently for burr hole craniotomy, even for single burr-hole procedures. Some procedures (e.g. ICP probe insertion, ventriculostomy) are now usually performed by twist drill craniotomy with a reported iatrogenic intracranial haemorrhage rate of 0.38%. 5

Whilst any rigid surgical instrument applied to the cranium has the capacity to ‘plunge’, causing intracranial injury (particularly where the skull is diseased or fractured), only very few respondents reported mishaps with ‘clutched’ or automatic perforators (Fig. 2b), which can be used with powered instruments or simply as an attachment to a Hudson brace (Fig. 4a), and have been available since 1949. 2 This instrument has subsequently been modified to include a variable-depth stop to prevent ‘plunging’ in the unlikely event of the drill not disengaging. 6

The over-representation of trainees in the ‘plunger’ group strongly suggests that the surgeon’s experience or the level of trainee supervision has a bearing on the risk of a ‘plunge’ event occurring. It is imperative that adequate training and supervision is provided for beginners undertaking burr-hole procedures. Surely the era in neurosurgical development where ‘every neurosurgeon will probably ‘plunge’ at some stage’ has passed with the widespread availability of safer options (Fig. 2b–d). The Cushing perforator should be reserved for exceptional circumstances only, remembering that a ‘plunge’ carries roughly a 12% risk of permanent neurological disability or death.

Acknowledgements

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References