An improved subarachnoid screw for intracranial pressure monitoring

Technical note

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A new subarachnoid screw for monitoring intracranial pressure has been developed incorporating a lock-nut and multiple subarachnoid ports in a low-profile design. This device offers enhanced stability and flexibility.

KEY WORDS - subarachnoid screw - subarachnoid space - intracranial pressure monitoring

Intracranial pressure (ICP) monitoring by means of a hollow subarachnoid screw was first reported by Vries, et al. In employing this technique at our institution, frequent difficulties have been encountered related to loosening of the screw and occlusion of the screw lumen by clot or dura mater. The Richmond screw has a relatively short stretch of thread; when the outer extent of the thread is screwed deep to the outer table, the thread no longer has a solid seat in the bone. Manipulation of the stopcock or other connector that is attached to the Luer lock end of the screw tends to move the screw in its twist-drill hole. The combination of the outer end of the Richmond screw with the monitoring line connector produces a large moment arm that disturbs the base of support in the skull as the outer end is jostled during routine care of the patient. The device is frequently dislodged, with loss of ICP waveform. Another subarachnoid device, the Philly bolt, has a low profile and a stop flange that rests against the skull and enhances stability; however, this flange is not adjustable to accommodate different skull thicknesses. The Leeds screw inserts into a standard burr hole and has multiple intracranial side ports recessed behind an end-plate. This device was initially used in the epidural space; later reports describe its use in the subdural space. The Leeds screw has the disadvantage of requiring a relatively large trephination, and difficulties with insertion have been reported.

This report describes a new subarachnoid screw with enhanced mechanical stability and flexibility. Recent reports have discussed the possibility of a discrepancy between convexity subarachnoid and intraventricular pressure measurement; that issue was not addressed in the present study.

Screw Design

The new subarachnoid screw is shown in Fig. 1 in two sizes: a small size for infants and small children and a larger one for adults. The major modification in this screw is the incorporation of a lock-nut that screws down against the outer table of the skull. This nut prevents rotation of the screw and provides a broad base of support. A long stretch of thread coupled with the adjustable lock-nut allows insertion into a wide range of skull thicknesses. In order to maintain a low profile, the outside connector of the screw is small and accommodates a standard intravenous male T-connector. Elimination of the stopcock with its extra ports should lessen the risk of infection. The subarachnoid end of the bolt extends inside the skull a distance of 3 mm in the adult size and 2 mm in the pediatric version, and includes two side ports intersecting the central lumen. The side ports are intended to decrease the frequency of occlusion. The adult screw is 37 mm long; the pediatric screw is 25 mm long. The overall length with the connector attached is 55 mm for the adult version and 45 mm for the pediatric version as compared with an overall length of 74 mm for the combination of the Richmond screw with a stopcock. A special wrench interlocks with the connector of the screw for insertion; both screw and wrench are made entirely of stainless steel and are reusable.
Improved subarachnoid screw

**FIG. 1.** Subarachnoid screw with knurled lock-nut and T-connector in adult (left) and pediatric (right) sizes.

**Placement Technique**

The frontal scalp area is shaved and prepared with povidone-iodine solution. The screw is usually inserted on the right side; in any given case, the side of insertion is chosen by the surgeon with regard to cerebral dominance and intracranial pathology. A point 2 to 3 cm anterior to the coronal suture and 3 to 4 cm from the midline is infiltrated with local anesthetic, and an incision 18 mm long for the adult screw or 10 mm long for the pediatric screw is made down to the skull. The periosteum is elevated using the blunt end of the scalpel handle, and a twist-drill hole is made through the skull (~6-in. in diameter for the adult screw, ~in. for the pediatric screw).

The distance from the dura to the outer surface of the scalp is measured with a blunt probe; if the dura was perforated by the drill, the inner margin of the inner table may be felt by the probe. This distance is subtracted from 34 mm for the adult screw or 23 mm for the pediatric screw; the resulting difference is the length of the screw that will protrude above the scalp surface when the device is fitted into proper position. This position will leave the tip protruding below the dura. After measurement is made, the dura and arachnoid are perforated using a ~-in. drill bit. The lock-nut is screwed into its outermost position against the connector and the device is tightened into position in the twist-drill hole using the wrench. The distance between the scalp surface and the outer edge of the screw is checked against the previously calculated measurement. The lock-nut is then screwed down against the skull, taking care that the scalp edges slide up alongside the nut and that these edges are not compressed against the skull. A piece of gauze wrapped around the knurled lock-nut assures a good grip on the nut as it is screwed down finger-tight against the skull.

After placement, a No. 21 hypodermic needle is inserted into the screw lumen to a distance less than the length of the screw, and the lumen is flushed with normal saline to remove any blood clot or bone dust. The lumen is then filled with saline, and a T-connector is inserted which is then attached to sterile tubing and a conventional pressure transducer. If an adequate ICP tracing is not obtained due to occlusion by blood clot or bone dust, the lumen may again be flushed as described above. Alternative methods for cleaning the lumen include probing the lumen with a No. 20 spinal needle or irrigation with 0.2 cc of saline from a syringe mated to the connector. A single suture usually suffices to close the end of the incision and appose the wound edges to the side of the lock-nut. A purse-string suture around the lock-nut may be necessary to stop oozing from the scalp. Povidone-iodine ointment is applied to the wound margins, and a sterile dressing is applied. The T-connector and monitoring tubing are changed daily. The screw is easily removed with the wrench at the end of the monitoring period, and the wound is sutured using sterile technique.

**Comment**

This subarachnoid screw has been used to monitor ICP in 14 patients ranging in age from 15 months to 53 years. Duration of monitoring varied from 1 to 7 days. Stability of the screw has been excellent; the device has never been dislodged and has been noted to withstand significant mechanical stress. The lock-nut has not required periodic tightening. Occlusion and loss of the ICP tracing have been rare, and no infections have occurred. Figure 2 shows an ICP tracing obtained using the new screw in a head-injured patient.

**Summary**

A new subarachnoid screw has been developed featuring enhanced mechanical stability and flexibility. The major modification is the incorporation of a locknut; also, considerable attention was paid to the details of the design to assure a stable reliable device. The screw has been used successfully in 14 patients, and there have been no complications.
References


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