The Use of the Twist Drill to Evaluate Head Trauma

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The twist drill technique was originally developed at the Montreal Neurological Institute by Dr. William V. Cone and his associates over twenty years ago as a substitute for burr holes in many circumstances. Although well-known to those who received training at the Montreal Neurological Institute, the technique was not published because Dr. Cone was concerned that its great advantages of simplicity and safety in trained hands were qualities which might lead the uninitiated to utilize the technique with dangerous abandon.

Our experience at the University of Washington during the past 17 years indicates that the twist drill technique can be both safe and useful. Not only is it readily used for ventriculography and tumor biopsy, but the safety, ease and rapidity with which this procedure can be performed make it a valuable tool in the diagnosis and treatment of traumatic intracranial hemorrhage. The mere simplicity of the technique prompts rapid and definitive diagnosis and decreases the time between injury and treatment.

There are 3 objectives that have prompted us to publish our experience with this technique as it has been applied in a variety of conditions associated with head trauma.

1. To describe the technique in detail so that interested neurosurgeons can perform and evaluate the procedure.
2. To illustrate with clinical material the rapidity and ease with which the procedure can be performed, using a minimum of equipment and technical assistance.
3. To demonstrate the low mortality and morbidity associated with the procedure.

Technique

The diagnostic and therapeutic problem is to gain access into the subdural and epidural spaces.

This is readily accomplished in the emergency room, on a stretcher or in an operating room by drilling a small hole through the skull using the equipment illustrated in Fig. 1. Through this hole a blunt needle can be inserted into the epidural or subdural space.

The patient is placed in a supine position with the head of the bed, stretcher or operating table elevated 15 to 20° or to an angle that is comfortable and convenient for the operator and patient. The scalp is then shaved, including the temporal areas, and prepared with a suitable solution. Surgical caps and masks are worn by the operating personnel and the hands of the operator are washed and gloved. A sterile towel is then placed under the head of the patient. The location of each proposed hole is marked by a gloved fingernail or a sterile needle. In cases of trauma, as illustrated in Figs. 2 and 3, the anterior holes are placed just in front of the coronal suture and 4 to 5 cm. from the midline. The posterior or parietal holes are placed over the parietal boss 7 to 8 cm. from the midline. A \( \frac{1}{2} \) inch circle of skin and subcutaneous tissues at these sites are infiltrated with 1% xylocaine containing 1:100,000 epinephrine. If a large wheal is raised with the local anesthetic it tends to distort the relationship between the scalp incision and the underlying twist drill hole. This is more of a problem with re-exploration of the hole than with the initial exploration.

Using a \#15 Bard-Parker blade or its equivalent, a small stab wound is made through the scalp and periosteum. Occasionally a bothersome scalp bleeder is encountered at this point and can usually be controlled by further injection of local anesthesia or by pressure. A 7/64 inch, regular angle carbon bit driven by a Smedberg hand drill is used to perforate the skull. It is inserted through the scalp incision perpendicular to the skull. Care must be taken as the hole is started not to allow the drill point to "walk," otherwise the underlying bony opening will be difficult to identify. With care, the twist drill first binds at the diploe and again as the inner surface of the skull is reached. In cases where ventriculography or brain biopsy is being performed, it is necessary to funnel-out (bevel) the outer rim of the twist drill hole. This can be best accomplished by angling the drill around the circumference of the hole periodically after the drill has penetrated the outer table of the skull and before the inner table has been reached. Too much angulation of the drill after the hole has been started may break the drill point. After the
inner table has been perforated, the drill is removed and the bone dust is cleaned from the area and from the drill point.

The dura is then palpated by means of a #16 or #18 Cone ventricular needle. Occasionally fresh blood from the diploe will be obtained but this should cause no concern if, by palpation, the dura is found to be tightly adherent to the inner table. If the dura cannot be palpated and if proper care has been taken not to perforate it, then one is dealing with an epidural hematoma. If, on the other hand, the dura is adherent to the inner table, then the next step is carefully to shred (perforate) the dura by replacing the drill and making partial revolutions of the drill handle. Care must be taken at this point not to plunge the drill point into the subjacent cerebral tissue. It is recommended that only slightly more than the estimated amount of drill point needed to go through the scalp and bone be exposed beyond

Fig. 1. Twist drill tray.

Fig. 2. Location of stab incisions and needle placement through twist drill hole.
the chuck jaws. This will act as a safeguard in case the drill should plunge for some unexpected reason. If a high pressure chronic subdural hematoma is present, the fluid will squirt out of the scalp incision as the dura is perforated.

The blunt needle is once again gently inserted along the wall of the bony hole and past the "ledge" of dura which can be felt as a light snap. Gentle insertion of the needle should continue until the resistance of the pia-arachnoid is encountered. The distance from the inner table or "dural snap" to the pia is noted, defining the extent of the subdural space. If a chronic subdural hematoma is encountered it can be removed easily by needle aspiration. If an acute or subacute hematoma is encountered, further surgical intervention may be warranted.

In addition to the four usual twist drill holes, holes should always be made in the temporal fossae when the diagnosis of epidural hematoma is being considered and when exploration through the quadrantic holes is negative. The temporal holes are placed 2.5 cm. above the zygoma and 2.5 cm. in front of the ear. The superficial temporal artery is avoided by palpating its location. Branches of the middle meningeal artery can be avoided by prior inspection of the skull x-rays.

After the procedure has been completed the twist drill sites are cleaned with a moistened sponge and Band-Aids are applied.

Clinical Uses

The twist drill technique has been employed at the University of Washington since the spring of 1948. In that time the technique has been applied in 1,426 instances for exploratory purposes and in 408 for tumor biopsy. These figures do not document the total experience since they represent only those instances where the twist drill procedure was identified in the hospital statistics and do not include those cases where the technique was utilized for ventriculography. Since 1948 there have been 2 deaths which can be attributed to the twist drill procedure. One was a consequence of needle biopsy of a large glioma in which an acute subdural hematoma was induced by laceration of a sial artery. The second death resulted from additional bleeding into a subacute subdural hematoma secondary to laceration of an aberrant middle meningeal artery by the drill point. Other complications that have resulted from the procedure are listed in Table 1.

Of the complications listed, 3 resulted simply from passage of a needle through the brain and might just as well have occurred through a burr hole or craniotomy.

We have evaluated our experience with 2,000 head injuries admitted to the service over a 7½ year period from January, 1954, to July, 1961, in order to illustrate the way in which this technique is used. During this time, 106 subdural hematomas and 35 epidural hematomas were diagnosed and treated, an incidence of 5.3 per cent and 1.8 per cent respectively in the total series.

Subdural Hematoma. In the more seriously injured or elderly patients, the need for early, accurate diagnosis and treatment can readily be achieved with the twist drill technique. The method was utilized in 98 of 106 patients with subdural hematomas, both for the purpose of exploring the subdural and epidural spaces and for treatment of the chronic subdural hematomas by needle aspiration. In the group of 49 patients with chronic subdural hematomas, 9 had burr holes and 6 had craniotomies in addition to
twist drill needle aspiration. However, in these 15 patients, neither the findings at operation nor the subsequent clinical course of the patients indicated that the additional surgical procedures were of benefit. Fifty deaths were recorded in this group of 106 subdural cases, a mortality of 47.2 per cent. In the group of patients aged 50 or older, the mortality was 50.7 per cent, and in those under 50 the mortality was 41.0 per cent (Fig. 4).

In 64 of the 106 patients with subdural hematomas, sufficient information was available to document the time interval between injury and treatment. For those in this group that died (33 patients) the average time from injury to treatment was 3.9 days. In the remaining group of 31 survivors the average time was 21.7 days. Some indication of the confusing clinical picture is illustrated by the diversity of presenting signs and symptoms in these 106 cases. In 65 cases (52 per cent) we were able to document the presence or absence of a lucid interval. However, as noted below in the epidural hematoma group, only 37 per cent had a lucid interval. Thus, in this series, a lucid interval is more characteristic of subdural than epidural hematomas. Of the total group, 51 patients had unilateral pupillary dilatation. In 38 cases the large pupil was ipsilateral to the hematoma; in 8 it was on the contralateral side; and in the remaining 5 there was unilateral pupillary dilatation with bilateral hematomas.

It is in situations such as these where the history and findings do not coincide with the classical situation that the technique described becomes an invaluable aid. So often one is inclined, in the confusing case, to watch and wait before performing burr holes or angiography because of the additional operating room preparation and personnel required. When a space occupying lesion is even remotely suspected, the twist drill technique can be used to obtain the answer within minutes, and incidentally, alleviate the anxiety experienced by both the family and the physician.

Subdural hematomas begin to liquify at about 7 to 10 days, and at this time it becomes possible to evacuate them by means of needle aspiration through the twist drill sites. If there are many fragments of clot aspirated and only an insignificant amount of liquefied hematoma removed, then either burr holes or a craniotomy will be necessary. Once the clot has fully liquified it can be "dried-up" with about 4 to 6 needle aspirations at daily intervals.

**Epidural Hematoma.** There is probably no situation in neurosurgery that demands more rapid diagnosis and treatment than the acute

### Table 1

**Complications and deaths attributable to the twist drill procedure**

<table>
<thead>
<tr>
<th>No. of Cases</th>
<th>Causes</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Complications</td>
<td>Penetration of sagittal sinus</td>
</tr>
<tr>
<td>2</td>
<td>Broken twist drill point in skull</td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>Subdural empyema</td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>Superficial intracerebral hematoma mistaken for subdural hematoma</td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>False positive</td>
<td></td>
</tr>
<tr>
<td>5</td>
<td>False negative (3 subdural hematomas, 2 epidural hematomas)</td>
<td></td>
</tr>
<tr>
<td>1</td>
<td>Deaths</td>
<td>Rupture of pial artery during tumor biopsy, with resulting acute subdural hematoma</td>
</tr>
<tr>
<td>1</td>
<td>Laceration of afferent middle meningeal artery. Additional bleeding into a subacute subdural hematoma</td>
<td></td>
</tr>
</tbody>
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**Fig. 4. Distribution of patients with subdural hematoma by age.**
epidural hematoma. It is in those cases where the clinical picture is not "classic" that the twist drill technique becomes a valuable aid in reducing the critical period from injury to treatment. In the group of 35 epidural hematomas, twist drill holes were performed in 30 cases. Of the 5 that did not have this procedure, 2 had carotid angiography and 1 had ventriculography. Two of the 5 patients did not have a preoperative diagnostic procedure. In the group diagnosed by twist drill and treated by craniotomy, the mortality was 48.5 per cent. The average age was 44.3 years, and the peak incidence occurred during the 4th and 5th decades (Fig. 5). If this group is also broken down into those under and over 50 years of age, a difference in mortality of 25.7 per cent is noted. This striking difference, as in the subdural hematoma series, is an indication that the older group tolerates traumatic insults less well than the younger group. Early, accurate treatment is obviously desirable and we feel this can be best accomplished by the use of the technique described.

Although the complications of angiography are less in this age range than in the subdural series, the morbidity from that technique still remains higher than that with the twist drill procedure regardless of the age or groups involved. Furthermore, the twist drill procedure can be accomplished in a shorter period of time.

In this series of epidural hematomas the clinical picture was not stereotyped as has often been suggested. The presence of a lucid interval in this group (37.0 per cent) and in other series\(^2,3\) is, as stated by McLaurin and Ford,\(^3\) "the exception rather than the rule." Therefore, there is nothing unique about the association of the lucid interval with an epidural hematoma. It is merely a measure of the severity of the trauma to the central nervous system.

In 5 of the 35 patients (14.3 per cent) a fracture was not demonstrated either radiologically or at the time of operation. These findings are similar to those findings reported by Mealey\(^4\) and McLaurin and Ford.\(^3\) Fourteen (40 per cent) of the patients in this series did not have unilateral pupillary dilatation. Of the 21 (60 per cent) patients who had unilateral pupillary dilatation, 4 (14 per cent) were contralateral to the hematoma. In cases of this sort where the diagnosis is uncertain, the twist drill technique provides a rapid means of establishing the presence or absence of a hematoma.

The usefulness of the technique in acute epidural hematomas as well as in acute and subacute subdural hematomas is limited almost exclusively to diagnosis. On occasion, however, enough fresh blood or clot can be removed to serve as a temporizing maneuver until a definitive operation can be accomplished.

**Discussion**

The major advantages of the twist drill technique are the ease, speed and safety with which it can be performed. The indications for its diagnostic use include signs and symptoms suggesting epidural or subdural hematoma, or the need for a definitive diagnosis by biopsy of expanding intracerebral lesions (neoplasm, abscess, intracerebral hematoma, etc.). It is also useful for ventriculography. The technique provides the definitive therapy for chronic subdural hematomas and may be used for the drainage of intracerebral hematomas and abscesses as well as neoplastic cysts. Particularly in the latter circumstance, the speed with which this technique can be performed may be lifesaving.

Obviously many of these diagnostic goals can be met by conventional burr holes. Although it is possible to see epidural or subdural hematomas through burr holes, equal diagnostic security can be achieved by the...
twist drill technique in experienced hands. Furthermore, the ease with which the twist drill technique can be employed obviates the long delays inherent in mobilizing personnel and equipment for a surgical procedure in the operating room. Moreover, since the twist drill hole is a miniature burr hole, it is obvious that, if the dura is opened, the chance of subsequent cortical damage will be less.

Many of the diagnostic goals can also be met by angiography. Again the twist drill procedure can be accomplished more easily and more quickly. The complications associated with the twist drill technique have proved to be appreciably lower than those reported for angiography. Furthermore, many of the patients in this series were in the older age groups where the angiographic risks are known to be highest. Finally, the twist drill technique provides the means for specific therapy and a precise pathological diagnosis. Although angiography helps to localize the lesion it provides only deductive pathological evidence.

In our experience with the twist drill technique, complications were encountered in only 15 cases of the 1,834 procedures surveyed. This represents a morbidity of 0.81 per cent. Of the complications listed in Table 1, 3 were of minimal consequence and were due to faulty technique. The drill point was broken off within the skull in 2 instances as a consequence of over-vigorous attempts to bevel the hole. The single penetration of the sagittal sinus was the obvious result of faulty location of the hole and was fortunately of no clinical consequence since prompt hemostasis was achieved with a fragment of Gelfoam. The twist drill exploration of the epidural or subdural space was judged to be normal in 5 instances when a hematoma was, in fact, present. In each instance, the twist drill hole had been placed at the margin of the hematoma and the diagnosis was therefore not established until other techniques were utilized. The only major morbidity in this series of 1,834 twist drill procedures were the 2 cases of subdural empyema (0.1 per cent).

In addition to confirming a diagnosis which is strongly suspected, the twist drill technique has proved to be of even greater value when clinical conditions are confusing as in trauma or in the elderly patient, with cerebro-vascular disease. In the presence of many confusing neurological signs, the possibility of a chronic subdural hematoma may appear so unlikely that the risks of angiography or burr holes do not seem justified. In such circumstances where the probability of a negative exploration is high, the clinical issue may be expeditiously resolved by twist drill exploration. It has been our experience that some patients have been saved by this approach under circumstances where the diagnosis would otherwise not have been made.

In addition to the value of this technique in diagnosis, it also provides the definitive therapy for chronic subdural hematomas already described.

Summary

The twist drill technique is a rapid and relatively simple method for perforating the skull, in order to gain access to the epidural and subdural spaces and the brain. We have reviewed our experience with 1,834 twist drill procedures in 2,000 cases of head trauma. The technique has proved to be useful in establishing the diagnosis of epidural and subdural hematoma as well as in the definitive therapy of chronic subdural hematoma.

We wish to emphasize that although the procedure may seem easy to do, it can be dangerous in unskilled or inexperienced hands. Moreover, the neurosurgeon must be capable of wisely interpreting and utilizing the information this method may provide.

References