ACCURACY OF C.T SCAN IN DETECTING SKULL BASE DEFECTS IN RECURRENT BACTERIAL MENINGITIS

By

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ABSTRACT

Background: Recurrent bacterial meningitis (R.B.M) is an uncommon but life-threatening condition. R.B.M may be the result of developmental and traumatic defects which provide portals of bacterial invasion to cerebrospinal fluid (C.S.F). An undiagnosed immunologic deficiency may allow the host to be susceptible to potential pathogens of meningitis. Early diagnosis is crucial to prevent any further episodes and serious sequelae.

Aim of work: The aim of the present work was to evaluate the accuracy of C.T scan in detection of skull base defect in R.B.M.

Method: Eight patients with R.B.M were included in this study. After resolution of the last attack, all patients were subjected to full history taking, full neurological and E.N.T examinations, laboratory investigations for immunological evaluation and abdominal ultrasound. All patients were subjected to C.T scan for brain and skull base. The helical C.T scanners used in this study, single, 4, 64 slices and C.T metrizamide (C.T.M).

Results: There were 5 male and 3 female patients. Their ages ranged from 9 to 17 years. All cases had 2 attacks except 2 cases with 3 attacks. There were traumatic group included 3 cases (2 cases with C.S.F leak and one occult case), and congenital group included 5 cases (2 cases with C.S.F leak and occult 3 cases). The four cases with C.S.F leak were sub classified into two groups equal in number, traumatic and spontaneous groups. The 64 slice scanner detected the defects in 6 cases, while C.T.M detected the defects in all cases.

Conclusion: In R.B.M with absence of history of trauma, C.S.F leak and immunodeficiency conditions did not exclude the presence of anatomic defects. The 64 slice scanner was sensitive to small cranial dural defects, while C.T.M was sensitive and specific for defect localization.

Keywords: Recurrent bacterial meningitis, C.T evaluation.

INTRODUCTION

Acute bacterial meningitis is a potentially life-threatening infection of the cranial and spinal leptomeninges that can lead to significant mortality and morbidity (Kendirli et al. 2006).

R.B.M is defined as any reappearance of clinical and laboratory signs and symptoms of bacterial meningitis after adequate and successful treatment of a preceding meningitis (Lieb et al., 1996 and Tebruegge and Curtis, 2008).

A second episode of meningitis was considered as a recurrence if it was due to a different organism from the first organism or if it was due to the same organism but occurred more than 3 weeks
after the completion of therapy for initial episode (Tebruegge and Curtis., 2008).

Developmental or traumatic defect may be responsible for R.B.M via access of bacteria into the subarachnoid space. An undiagnosed immunologic deficiency may allow the host to be susceptible to potential bacterial pathogens of meningitis (Tuygun et al., 2010).

A single episode of bacterial meningitis is often blood borne. In recurrent episodes of meningitis, the other possible routes of bacterial invasion to the cerebro spinal fluid(C.S.F) should also be considered (Kendirli et al., 2006).

It is not easy to detect the underlying etiologies for patients with high risk of recurrence when the bacterial meningitis occurs for the first time unless there is a history of skull base injury or the presence of C.S.F leakage (Westmore and Whittam., 1982).

**AIM OF THE WORK**

Detection of the cause of R.B.M need extensive diagnostic procedures and the occult skull and dural defects are hard to diagnose even with modern imaging studies, So, the aim of this study is to assess the accuracy of C.T. scan in localization of skull and dural defects in R.B.M.

**PATIENTS AND METHODS**

This study included eight patients with R.B.M managed in Al Hehma hospital, Mansoura city, through the last three years. After adequate and successful treatment of the last attack, all patients were subjected to complete history taking, full neurological and E.N.T examinations, laboratory investigation for immunological evaluation including complete blood picture, quantitative serum immunoglobulin, complement 3 and 4 levels, isohemagglutinin levels, human immune deficiency virus antibody test, and abdominal ultrasound for detection of splenic lesions or aplasia. All patients accepted and wrote consent about the diagnostic measures and surgical procedures.

C.T. scan was done for all patients. Three General Electric (G.E) scanners were used, C.T Hi speed Adv. (single slice), C.T. light speed plus (4 slices) and C.T volume "C.T.V" (64 slices). Non enhanced cranial C.T. was done for all patients. It included the anterior and middle skull base looking for a possible single or multiple defects. Images were reconstructed into direct/ oblique sagittal and coronal planes. C.T.M was done for all cases to accurately localize the site of defect.

Surgical procedures included in this study were repair of the defect in the cribiform plate by E.N.T surgeon and the defect in the posterior wall of frontal sinus by neurosurgeon.

In cases with defect in the cribiform plate the patients under went endoscopic endonasal surgical repair under general anesthesia. The anterior one third of the middle turbinate was resected and prepared for a graft. The graft was modified into an appropriate size and plugged into the defect.

In cases with defect in the posterior wall of frontal sinus, the operation was done under general anesthesia through a bicrural scalp flap with small craniotomy across the frontal sinus. The frontal sinus mucosa was stripped and the sinus with its duct plugged with fat or muscle.
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RESULTS

There were 5 male and 3 female patients. Their ages ranged from 9 to 17 years. All cases had 2 attacks of meningitis except 2 cases with 3 attacks.

There were 3 cases with history of trauma (one case with fall down and 2 cases with functional endoscopic sinus surgery (F.E.S.S.), and 5 cases without history of trauma.

There were 4 cases with history of C.S.F. leak and 4 cases without C.S.F. leak. The 4 cases with C.S.F leak included 2 cases with history of trauma and 2 cases without history of trauma.

C.T. scan detected the defect in 6 cases, while C.T.M detected the defect in all cases. The defect was corrected extra cranially through endonasal surgical repair by E.N.T surgeon in 6 cases, while in the other two cases were corrected by the neurosurgeon intracranially.

The patient features were summarized in table (1).

Figures 1, 2, 3 and 4 showed some cases in this study.

Table (1): Features of the patient with R.B.M.

<table>
<thead>
<tr>
<th>No.</th>
<th>Age in years</th>
<th>Sex</th>
<th>No. of episodes</th>
<th>History of trauma</th>
<th>History of C.S.F. leak</th>
<th>CT</th>
<th>CTM</th>
<th>Surgical repair</th>
<th>Figures</th>
</tr>
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<tbody>
<tr>
<td>1</td>
<td>17</td>
<td>♂</td>
<td>2</td>
<td>No</td>
<td>No</td>
<td></td>
<td>Defect in the cribriform plate</td>
<td>Contrast leak through the defect</td>
<td>Extra cranially</td>
</tr>
<tr>
<td>2</td>
<td>10</td>
<td>♂</td>
<td>2</td>
<td>Present</td>
<td>present</td>
<td></td>
<td>Defect in the cribriform plate</td>
<td>Contrast leak through the defect</td>
<td>Extra cranially</td>
</tr>
<tr>
<td>3</td>
<td>15</td>
<td>♀</td>
<td>3</td>
<td>Present</td>
<td>present</td>
<td></td>
<td>Defect in the cribriform plate</td>
<td>Contrast leak through the defect</td>
<td>Extra cranially</td>
</tr>
<tr>
<td>4</td>
<td>16</td>
<td>♂</td>
<td>2</td>
<td>No</td>
<td>No</td>
<td></td>
<td>-</td>
<td>Contrast leak through the defect</td>
<td>Extra cranially</td>
</tr>
<tr>
<td>5</td>
<td>13</td>
<td>♀</td>
<td>2</td>
<td>No</td>
<td>present</td>
<td></td>
<td>Defect in the posterior wall of frontal sinus</td>
<td>Contrast leak through the defect</td>
<td>Intracranial</td>
</tr>
<tr>
<td>6</td>
<td>14</td>
<td>♂</td>
<td>2</td>
<td>No</td>
<td>No</td>
<td></td>
<td>Defect in the cribriform plate</td>
<td>Contrast leak through the defect</td>
<td>Extra cranially</td>
</tr>
<tr>
<td>7</td>
<td>14</td>
<td>♂</td>
<td>3</td>
<td>No</td>
<td>Present</td>
<td></td>
<td>-</td>
<td>Contrast leak through the defect</td>
<td>Extra cranially</td>
</tr>
<tr>
<td>8</td>
<td>9</td>
<td>♂</td>
<td>2</td>
<td>Present</td>
<td>No</td>
<td></td>
<td>Defect in the posterior wall of frontal sinus</td>
<td>Contrast leak through the defect</td>
<td>Intracranial</td>
</tr>
</tbody>
</table>
17 years old male patient with no history of trauma or C.S.F leak. Coronal C.T.M shows small defect in right cribiform plate with contrast leakage into Right nasal cavity < arrow >.

15 years old female patient with history of surgical trauma after F.E.S.S and C.S.F leak. Coronal C.T.M shows defect in right cribiform plate with contrast leakage into right nasal cavity < arrow >.

13 years old female patient with history of C.S.F leak and no history of trauma. Sagittal reformatted image shows small defect in the posterior wall of frontal sinus < arrow >.

9 years old male patient with history of trauma and absence of C.S.F leak. Coronal reformatted image shows small defect in the posterior wall of frontal sinus < arrow >.

**DISCUSSION**

Because the skull and dural mater are important cerebral barriers, any native or acquired defect in them may result in intracranial infection (Chen and Jiangl, 2011).

Developmental and traumatic anatomical defects are fundamental underlying cause of R.B.M. These conditions are mostly due to the presence of a communication of the subarachnoid space with the paranasal sinuses, nasopharynx, middle ear cavity or skin.

Fractures of the paranasal sinuses, cribiform plate and petrous bone can lead to communications with paranasal sinuses, nasopharynx and middle ear cavity respectively. In these patients, meningitis may be recurrent and due to the possible direct contact of bacteria to these cavities (Menkes and Till, 1990 and Yoge, 2003).

A dural lesion is assumed to be of congenital origin if there is no other satisfactory explanation, such as history of trauma or possible iatrogenic damage, an
inflammatory or neoplastic process, elevated intracranial pressure, or other relevant intra-operative findings (Haugenauer et al., 1979).

Cerebrospinal fluid rhinorrhea is often categorized as traumatic,iatrogenic, or spontaneous (Wise and Schlosser, 2007). Spontaneous C.S.F rhinorrhea is an uncommon form of C.S.F leakage that is attributable to multiple causative factors (Abubara, 2007). Central to all causes is a fistula between the subarachnoid space and the sinonasal cavity, through which the fluid leaks. In 2007, Wise and Schlosser further subdivided spontaneous C.S.F rhinorrhea to distinguish leaks without any identifiable origin. They call these leaks spontaneous idiopathic C.S.F rhinorrhea, attributing them to increased intracranial pressure or empty sella syndrome. Spontaneous C.S.F rhinorrhea with an identifiable cause is the result of compromise of the local anatomy, either because of a local disruptive growth or because of anatomical anomalies in the area (Gaffey et al., 2012).

The defect in the skull and dural matter was considered occult if there is absence of C.S.F leak. In our study we have 4 cases considered occult. It is difficult to decide whether an occult dural lesion is traumatic or congenital. Traumatic dural lesions can remain asymptomatic for decades and the patients frequently fail to recall significant minor or old injuries (Okada et al., 1991).

Our results can be classified roughly according to history into, traumatic group include 3 cases (2 cases with C.S.F leak and occult case) and congenital group include 5 cases (2 cases with C.S.F leak and occult 3 cases ). The 4 cases with C.S.F leak sub classified into 2 groups equal in number, traumatic and spontaneous groups.

High resolution C.T scan has a sensitivity of more than 90% in detecting C.S.F leak sites (Connor 2010). Computed tomography delivers super bony detail of the skull base and is well suited for detection of skull base defect. Axial images are best for evaluation the frontal and lateral sphenoid sinus walls, while coronal images in bone window algorithm are used to examine the roof of the ethmoid and sphenoid sinuses as well as the lateral sphenoid sinus walls. C.T cisterogram can be useful in reaffirming the exact location of a leak (Gaffey et al., 2012).

In our study, C.T scan performed with 64 slices C.T.V showed high sensitivity to detect very small skull base defects. Sagittal and coronal reformatted images were helpful in detection of defects and to compensate for the incomplete neck extension during image acquisition. C.T.M was considered the most accurate modality in localize dural defects.

Conclusion

Absence of C.S.F leak is not an indication for intact cranium, so patients with bacterial meningitis from the first attack disallowed to discharge from the hospital without a series of studies to detect the possible routes of migration of bacteria to the C.S.F space especially if precise localization of the dural lesions is a prerequisite for surgical repair and a water-tight closure of the defect is the only method for prevention of recurrence of bacterial meningitis. C.T offers a relatively easy, reliable and non-invasive method for detection the anatomical
defects in R.B.M. Multislice C.T scan with reformatted images are sensitive in
detection of dural defects while C.T.M is
sensitive and specific.

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ACCURACY OF C.T SCAN IN DETECTING SKULL BASE DEFECTS IN RECURRENT BACTERIAL MENINGITIS

Title:

Tقييم دقة الأشعة المقطعة بالكمبيوتر في تشخيص تثبيت قاع الجمجمة في حالات الالتهاب البكتيري السحائي المتدفّق.

Author:

Al-Azhar Med. J.

<table>
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<th>No.</th>
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<th>Participants</th>
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<td>1</td>
<td>Dr. Yasser Hossam</td>
<td>Conducting the surgical procedures related to the cranial base in the recurrent bacterial meningitis</td>
<td>Assistant Professor of Anatomy, Department of Anatomy and Surgery, Faculty of Medicine, Cairo University</td>
</tr>
<tr>
<td>2</td>
<td>Ahmed Hossam</td>
<td>Participating in the research work</td>
<td>Assistant Professor of Radiology, Faculty of Medicine, Cairo University</td>
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Chairman of the Committee: Dr. Yasser Hossam

Chairman of the Department: Dr. Yasser Hossam

Approved: [Signature]

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الملخص العربي:

يعتبر الالتهاب السحاقي المتكرر مع قلة حدوثه ذو خطورة بالغة على حياة المريض. ويعد الثقب الناتج عن إصابة الرأس أو النقص الخلقي لقاع الجمجمة هو الممر الرئيسي للبكتيريا لإصابة السائل النخاعي بالمخ خاصة بمرضي نقص الجهاز المناعي. كما يساعد التشخيص المبكر للإصابة في منع تكرار العدوى وتوجب المضاعفات الخطيرة. ولدراسة مدى دقة الأشعة المقطعة في تشخيص الثقب بقاع الجمجمة في حالات الالتهاب السحاقي المتكرر أعدت هذه الدراسة على ثمانية مرضى. وبعد علاج آخر نوبة التهاب تم فحص المرضى إكلينيكيا وإجراء الفحوص العملية وعمل أشعة مقطعة على المخ وقاع الجمجمة بالجهاز الأحادي، والرياحي ومتدود المقطع، 44 مقطع والمقطعة بالصيغة. وقد أسفر البحث المتضمن 5 جماجم و3 نساء عن تقارب سن المرضى بين 9-17 سنة وركرار الإصابة مرتين عدا باثنين منهم أصيبوا ثلاث مرات. وذكرت الإصابة بعد حدث تصادم في ثلاث حالات ومع نقص خلقي بقاع الجمجمة في خمسة حالات. كما حدث نسيب للسائل النخاعي في أربعة حالات اثنان بعد إصابة بالرأس واثنين مع نقص خلقي بقاع الجمجمة. وتم تشخيص 6 حالات بجهاز الأشعة المقطعة متعدد المقطعات 64 بدون صبغة مع تشخيص كل الحالات باستخدام الصبغة. ولذلك؛ فإنه في حالات الالتهاب السحاقي المتكرر مع عدم سابقة إصابة بالرأس وعدم تسرب سائل النخاعي وكفاءة الجهاز المناعي، فإنه لا يوجد وجود نقص بقاع الجمجمة يكون ممر للبكتيريا وهنا تتضح قدرة جهاز الأشعة المقطعة متعدد المقطعات 64 والصيغة في التشخيص.