Orbital Computed Tomography of Blast Injury

(Detection and Localization of Metallic Foreign Body)

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Introduction

Computed tomography (CT) is useful for the evaluation of orbital trauma because it can visualize most of the soft tissue, foreign bodies, and bony details.\(^1\text{-}^3\)

Especially with CT, it is possible to find out the metallic foreign bodies in the orbit and their location accurately.

Refinements of the instrument design over the past decade have greatly increased in its resolution so that small foreign bodies, and those of low radiographic density can now be localized within the globe accurately. Besides advantages of the CT over the traditional techniques as painlessness, non-invasiveness, non-metallic and multiple foreign bodies, as well as double perforations, can be clearly demonstrated without exerting pressure on the lacerated globe. The author reports experiences of CT scan in 10 cases of Blast injury, who had intraocular foreign bodies.

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Materials and Methods

Ten blast injured patients were referred to detect and localize the intraocular foreign bodies between December 1984 and August 1987 (Table 1). All of these patients had orbital CT scan and simple orbital views preoperatively.

The patients ranged from 19 to 32 years in age and all were male. CT scan was performed in all patients using technicare deltascan-2060. Two basic CT projections (orbital axial and sagittal—projections) were performed with 5 mm thickness and interval to evaluate the position of the foreign bodies.

Representative Case Reports

Case 1.

A 26-year-old man was struck in the left eye when a blasting cap exploded accidentally. Routine skull and orbital radiographs were taken. Physical examination revealed the anterior entry site through the cornea.

Table 1. Case Records of 10 Blast Injured Patients

<table>
<thead>
<tr>
<th>Case</th>
<th>Age/Sex</th>
<th>Location of IOFB(number)</th>
<th>Size(mm)</th>
<th>Procedure</th>
<th>Others</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>26/M</td>
<td>Lateral rectus muscle(1)</td>
<td>3.5x3.5x3.0</td>
<td>Enucleation</td>
<td>Double perforation</td>
</tr>
<tr>
<td>2</td>
<td>22/M</td>
<td>Vitreous proper (4)</td>
<td>1.0x1.0x1.0</td>
<td>Vitrectomy with IOFB removal</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Posterior scleral wall(1)</td>
<td>1.5x1.5x1.5</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Medial canthus area(1)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>25/M</td>
<td>Vitreous proper (1)</td>
<td>2.5x2.5x2.0</td>
<td>Enucleation</td>
<td>Double perforation</td>
</tr>
<tr>
<td>4</td>
<td>29/M</td>
<td>Proximal optic nerve(1)</td>
<td>1.0x1.0x1.5</td>
<td>Enucleation with IOFB removal</td>
<td></td>
</tr>
<tr>
<td>5</td>
<td>19/M</td>
<td>Vitreous proper (1)</td>
<td>1.5x1.5x1.5</td>
<td>Enucleation</td>
<td></td>
</tr>
<tr>
<td>6</td>
<td>32/M</td>
<td>Vitreous proper (1)</td>
<td>2.0x2.0x2.5</td>
<td>Enucleation</td>
<td></td>
</tr>
<tr>
<td>7</td>
<td>24/M</td>
<td>Vitreous proper (1)</td>
<td>1.5x1.5x1.0</td>
<td>Enucleation</td>
<td></td>
</tr>
<tr>
<td>8</td>
<td>20/M</td>
<td>Posterior scleral wall(1)</td>
<td>2.0x2.0x2.0</td>
<td>Enucleation</td>
<td>Profuse spray artifact</td>
</tr>
<tr>
<td>9</td>
<td>21/M</td>
<td>Vitreous proper (1)</td>
<td>1.5x1.5x1.0</td>
<td>Vitrectomy with IOFB removal</td>
<td></td>
</tr>
<tr>
<td>10</td>
<td>22/M</td>
<td>Vitreous proper (2)</td>
<td>2.5x2.5x2.0</td>
<td>Vitrectomy with IOFB removal</td>
<td></td>
</tr>
</tbody>
</table>

Most of the lens had extruded through the corneal wound. Gonioscopic examination showed profuse vitreous hemorrhage which obscured visualization of the retinal state.

Orbital radiographs showed the presence of an intraocular foreign body. Ultrasonography was not possible because of the patient’s conduct. However, CT scan was performed (Fig. 1). It showed one.

Fig. 1. CT scan of case 1. Axial CT scan shows the flattening and discontinuity of posterior wall. Also notice the absence of lens and large metallic foreign body in the lateral rectus muscle.
foreign body of metallic density in the lateral rectus muscle. With clinical information, CT scan corroborated that a double perforation had occurred. The patient was enucleated. Also 3.5 mmx3 mm sized metallic foreign body in the lateral rectus muscle was removed and confirmed the double perforation through the posterolateral scleral wall.

Case 2.

A 22-year-old man was struck with metal by blast injury in the right eye. Physical examination revealed the laceration in the superior limbal area and ruptured lens with hyphema. So it was impossible to evaluate the status of vitreous compartment and retina.

Routine localizing techniques demonstrated multiple foreign bodies within the orbit. CT scan showed five small metallic foreign bodies in the intraocular and extraocular area(Fig. 2).

About 1 mmx1 mmx1 mm sized multiple punctate metallic foreign bodies were noted in the posterotemporal scleral wall, in the anterior vitreous compartment, in the soft tissue of medial cantal area.

Lensectomy and vitrectomy were done with the removal of intraocular foreign bodies.

Case 3.

A 25-year-old man was admitted due to visual loss of the right eye by blast injury. Physical examination was unsatisfactory because of poor patient cooperation.

Orbital radiographs showed an intraocular metallic foreign body.

CT scan demonstrated round metallic foreign body in the temporal side of the vitreous compartment(Fig. 3). Vitrectomy and repair of anterotemporal scleral laceration wound were done with the removal of 2.5 mmx2.5 mmx2 mm sized metallic foreign body showed in the CT scanning.

Fig. 2. CT scan of case 2. Multiple fine metallic foreign bodies are demonstrated in the anterior vitreous compartment(A), adjacent to the posterior scleral wall(B), and in the soft tissue of medial cantal area(C).
Case 4.

A 29-year-old man was admitted due to blindness of the right eye by blast injury. Physical examination revealed a dense vitreous hemorrhage. There was small entry site through the cornea. Routine radiological localizing techniques demonstrated a foreign body within the orbit.

CT scan demonstrated that the foreign body was located in the retrobulbar area (nasal surface of the proximal optic nerve).

Also, the irregular thickening and discontinuity of the posterior scleral wall were noted (Fig. 4).

Therefore, the CT scan confirmed that a double perforation had occurred.

This patient was enucleated and 1.0 mm x 1.0 mm x 1.5 mm sized metallic foreign body was removed.

It was firmly attached in the superonasal surface of the proximal optic nerve.

Discussion

Since Kollarits et al.⁴, in 1977, introduced the use of CT scan for intraocular foreign body detection, the advent of the third and fourth generation CT scanners have permitted the clear delineation of ocular and intraocular structures such as the entire scleral wall, the lens, the anterior chamber, the optic nerve, the extraocular muscles, and the posterior orbital space.

So clinical usefulness of CT scan for the intraocular foreign body detection and localization has been reported by many authors⁵⁻⁷.

Therefore the CT scanner has been used routinely for intraocular foreign body localization with the traditional methods such as Sweets, Comber's, or ultrasonography.

It has been well recognized that the traditional methods have had many problems for localization of intraocular foreign bodies. The problems are as follows; 1) they can't be performed in the uncooperative patient. 2) they exert direct pressure to lacerated globe, so further loss of aqueous humor and additional damage to intraocular tissue can't be avoided. 3) they fail the detection and accurate localization of the multiple small foreign bodies and anterior located foreign body.

It is realized that the traditional methods for
Localization of intraocular foreign bodies have been dangerous, often impossible, or extremely difficult in providing accurate clinical information. Ultrasonography is more effective in determining the size of the eye and the foreign body's effects in causing vitreous hemorrhage or retinal detachment than it is in localizing an intraocular foreign body.

Unlike the traditional methods, CT scan has been uniformly convenient, atraumatic to the patient, and has provided extremely accurate and clinically useful information.

A clear visualization of the posterior scleral wall is important with the suspicion of double perforation, impaction of the foreign body in the retina, or an extrascleral location of a foreign body. Case 1, 2, 4, demonstrate foreign bodies in these three locations and the usefulness of the CT scan in allowing us to corroborate the information on the scan with clinical findings.

Especially CT scan has been very effective in the evaluation of double perforation\(^8\)\(^\text{--}\)\(^9\).

In the double perforation, CT scan shows various diagnostic findings such as the apparent exit site(scleral discontinuity), the scleral irregular thickening and flattening(flat-tire sign), the hemorrhagic tract through the globe, the foreshortening of the globe. Case 1, 4 illustrated well these findings.

Despite these well-known advantages of CT scan over other localization techniques in the presence of clear media, there are some problems in the evaluation of intraocular foreign body localization\(^10\). They are the spray artifacts produced by many of the dense metals and failure to scan through the entire orbit and poor visualization of secondary change by foreign body in the presence of opaque media. Because of the spray artifacts obscured regional anatomy around the metallic foreign body, precise localization of foreign body and evaluation of the adjacent anatomic changes could not be obtained(Fig. 5).

A foreign body obscured on scans obtained in one plane may be clearly visible on scans obtained in an orthogonal, perpendicular plane(coronal as well as axial planes).

It must be stressed that whatever artifacts are produced on the axial scans will be seen in the reformatted imaged as well, so that when metallic foreign bodies are present it may be necessary to perform direct coronal scans to accurately identify smaller foreign bodies.

Failure to scan through the entire orbit is another possible source of error in CT. This may lead to nonvisualization of a foreign body located at the periphery of the orbit, i.e. in the inferior or anterior portions of the globe. Case 2 represented this problem well.

In this case, total number of foreign bodies were six in fact, one in the far superior aspect of globe was missed in CT.

This problem can be avoided by meticulous technique.

When the first and last scans demonstrate structures adjacent to the orbit rather than simply at its edge, the study includes all intraorbital structures.

Lastly, the foreign body's effects in causing vitreous hemorrhage or retinal detachment can't be
precisely evaluated with CT. In case 2, retinal detachment was occurred by small foreign body embedded in the retina, but CT missed its presence. Therefore, when foreign bodies are located in the vicinity of the scleral in the retina, bath immersion ultrasonography should be performed prior to surgical removal of an intraocular foreign body to preoperatively determine the presence of retinal detachment or dense vitreous hemorrhage. With this additional information available, a more intelligent decision can be made as to the best route for foreign body removal.

Tate E et al. 1) made an experiment in vivo conditions for minimum detectable size varied according to the material, for example, 0.06 mm for steel, 1.82 mm for auto window glass in intraocular location. The advent of CT scanner will recover the size limitation.

CT scan will be an more important modality for the detection and localization of intraocular foreign bodies if increased resolution with further refinements in instrument design overcome these limitation.

REFERENCES