Historical Vignette

Treatment of head injuries in the American Civil War

HOWARD H. KAUFMAN, M.D.

Department of Neurosurgery, West Virginia University School of Medicine, Morgantown, West Virginia

At the time of the American Civil War (1861–1865), a great deal was known about closed head injury and gunshot wounds to the head. Compression was differentiated from concussion, but localization of lesions was not precise. Ether and especially chloroform were used to provide anesthesia. Failure to understand how to prevent infection discouraged physicians from aggressive surgery. Manuals written to educate inexperienced doctors at the onset of the war provide an overview of the advice given by senior surgeons. The Union experiences in the treatment of head injury in the Civil War were discussed in the three surgical volumes of The Medical and Surgical History of the War of the Rebellion. Wounds were divided into incised and puncture wounds, blunt injuries, and gunshot wounds, which were analyzed separately. Because the patients were not stratified by severity of injury and because there was no neuroimaging, it is difficult to understand the clinical problems and the effectiveness of surgery. Almost immediately after the war, increased knowledge about cerebral localization and the development of antisepsis (and then asepsis) permitted the development of modern neurosurgery.

KEY WORDS • head injury • gunshot wound • neurosurgical history • infection

By the time of the American Civil War (1861–1865), a considerable amount was known about the pathophysiology of closed head injuries. Gunshot wounds of the head particularly had been seen in great numbers in more than 100 wars that had occurred in the world between the American Revolutionary War and the Civil War. Also, ether and chloroform had been used since the 1840’s and morphine, isolated in 1806, was first used extensively during the Civil War. But due to the formidable problem of postoperative infections, brain surgery had not progressed very far. In 1920, Paget described the state of the art at that time:

"Fifty years ago (1869), and less than fifty years, the rules for operating on the head were those which Ambrose Pare had taught and followed in the sixteenth century. The conditions requiring operation, and the precautions to be observed, were well known. The operation of trephining the skull could not improve itself: it could only wait for some outside discovery to improve it.

"...a surgeon, half a century ago... must have something to guide him... a wound or scar or depressed fracture. Trephining of itself was not brain surgery, but skull surgery; it was the repairing of the roof of the house of life. The skull must be dealt with for the sake of the brain: but the less that the surgeon saw of the brain, the better he was pleased."

The physicians of America were ill prepared for war. Since there had been no major conflicts in which American physicians had served for many years, they were not experienced in war surgery. The surgical instruments of the time have been well described, and surgical kits in various museums and private collections contain such instruments as were used. Two surgical kits from the author’s collection, one a trephination set, are examples of this equipment (Fig. 1). In April, 1861, the Union medical department consisted of 86 surgeons and assistants (after Southern sympathizers had left).

To educate the American physicians inexperienced in the medical problems encountered in war, several senior surgeons wrote a series of "pocket manuals." These provide a detailed record of the approach to brain surgery in America at the time. A prospective study of the neurosurgical experiences in the war was published as part of The Medical and Surgical History of the War of the Rebellion. Unfortunately, most Confederate records were lost in a fire in Richmond at the end of the war.

Surgical Manuals

The so-called “pocket manuals” were designed to be used as easily transportable guides. In the last few years,
Treatment of head injuries in the Civil War

![Fig. 1. Surgical kits used in the American Civil War.](image)

eight such manuals have been reprinted (edited by Ira M. Rutkow, M.D., Ph.D.)\textsuperscript{2,3,5,14,24,25,27,29} Each reprinted volume begins with a historical sketch of its author(s) or editor. The authors were often self-made men, of whom some were graduates of the great medical schools of the country and a few were even exposed to European medicine. A number of them rose to the heights of leadership in scientific and political medicine in the United States.

In aggregate, the surgical manuals describe all aspects of military medicine, ranging from screening of recruits through sanitation and reporting forms to medical care. They also discuss, at times in detail, the experiences and judgments of 18th and early 19th century surgeons with regard to the treatment of head injuries.

**Northern Authors**

Included among the Union authors of the surgical manuals was Samuel David Gross (1805–1884), one of the most influential surgeons in American history. Initially self-taught, he received his medical degree from Jefferson Medical College of Philadelphia in 1828. An intellectual giant, he eventually became professor of surgery at Jefferson, was elected president of the American Medical Association in 1868, and was a founder and first president of the American Surgical Association in 1880. His manual\textsuperscript{9} was also printed in the Confederacy.

Frank Hastings Hamilton (1813–1886), a prodigy and artist, received his medical degree from the University of Pennsylvania in 1835. In 1861, he was named to the first chair of military surgery in America at Long Island College Hospital. He was captured by Confederates twice during the war but was released in both instances. Hamilton\textsuperscript{13,15} continued to write about gunshot wounds as he gained more experience. A noted author, he was also active in organized medicine and attended President James Garfield when he was injured by an assassin. In addition to his surgical manual,\textsuperscript{14} he edited the two-volume work, *Surgical Memoirs of the War of the Rebellion*, which was collected and published by the United States Sanitary Commission in 1870 and 1871.

Stephen Smith (1823–1922) received a medical degree from the College of Physicians and Surgeons in New York City in 1850. At the time of the Civil War he was a professor of surgery at the Bellevue Hospital Medical College. His handbook\textsuperscript{24} was written in 1862. An outstanding author, he was also a leader in public health.

Charles Stuart Tripler (1806–1866) received his medical degree from the College of Physicians and Surgeons in New York City in 1827. A regular army surgeon, he was criticized after the Peninsula Campaign in 1862, after which his career lagged. His manual\textsuperscript{15} was authored by George Curtis Blackman (1819–1871), who received his medical degree from the College of Physicians and Surgeons in New York City in 1840 and also studied in London and Paris. He was a senior military medical administrator during the Civil War.

**Southern Authors**

John Julian Chisolm (1830–1903), who wrote one of the Confederate manuals,\textsuperscript{2} was also one of the giants of American surgery. He graduated in 1850 from the Medical College of the State of South Carolina and subsequently studied in Paris and London. In 1859, he observed military hospitals in Italy during the wars for unification there, and was later appointed professor of surgery at his alma mater. He was the first medical officer commissioned by the Confederacy and rose in the ranks. After the war he eventually moved to Baltimore, where he was appointed dean of the medical school at the University of Maryland and subsequently professor of ophthalmology and otology. He helped facilitate the education of Helen Keller. He was first vice president of the American Medical Association in 1895.

Samuel Preston Moore (1813–1889) received his medical degree from the Medical College of South Carolina in 1834. A professional Army surgeon, he became surgeon general of the Confederate States
Army. In this capacity he edited a multiauthored manual, but the individual authors remain anonymous. He left the practice of medicine after the war.

Edward Warren (1828–1893) received his medical degrees from the University of Virginia in 1850 and Jefferson Medical College of Philadelphia in 1851. He studied in France and was later appointed surgeon general of North Carolina. He wrote a manual which was issued to every Confederate medical officer. Later in his career he was surgeon-in-chief to the Egyptian Army. He eventually settled in Paris.

Felix Formento, Jr. (1837–1907) received his medical degree from the Royal University of Turin about 1858 and also studied in France. He served in the Franco-Sardinian Army in 1859 and subsequently in the Confederate Medical Corps, when he published his Notes and Observations. He eventually settled in New Orleans where he was active in the field of public health, being president of the American Public Health Association in 1892.

Neurosurgery in the Surgical Manuals

All head injuries were considered very serious. Battle injuries were classified in a fashion similar to that which we would use today. There was discussion about blunt injuries and penetrating injuries, separating gunshot wounds from injuries with blades and dividing the last into stabbing and slitting injuries. Chisolm noted that closed head injuries can be fatal and gave a description of the pathology of diffuse axonal injury. Any break in the skin was considered to be a potential problem because of the risk of infection and particularly spread of infection into the brain. Fractures of a variety of types were described in detail, including linear and depressed fractures. It was recognized that dural and brain penetration were important. Epidural and subdural hematomas were well described. With regard to gunshot wounds, it was appreciated that the trajectory of the bullet would be unpredictable, that the bullet could break up, and that the bullet could cause clots. It was also well recognized that many patients will die immediately or very shortly after a gunshot wound. It was also appreciated that the bullet might be tolerated. Delayed complications including clots and infections (such as from gunshot wounds) were well known; on the other hand, it was known that the brain seemed to adjust to deformities and that clots can be absorbed. Chisolm mentioned that displacement of cerebrospinal fluid and blood permits this adjustment.

With regard to clinical presentation, the authors recognized that there were two basic conditions, concussion and compression. Concussion was immediate, and compression was characterized as generally being delayed. The descriptions of vital signs are interesting. Compression was associated with a slow pulse, and some authors described a bounding pulse which suggests elevated blood pressure. Stertorous breathing ("le malade fume la pipe") was well described by Formento.

Some authors mentioned diluted and fixed pupils, as well as crossed facial weakness and hemiparesis from a clot.

Tripler and Blackman cited Guthrie as associating speech problems with a left parietal lesion; however, the problem of localizing lesions precisely is well noted by Formento. It was appreciated that even depressed fractures and gunshot wounds might not be associated with compression. The patient's course was considered extremely important, and it was understood that patients could recover, even when they had suffered hematomas.

The indications for surgery were a little more problematic. Warren noted that surgeons had been more aggressive in the 18th century than in the 1860s. Gross reviewed in detail the current controversies relating to surgery, particularly regarding the fear of what we now know to be infection. He reviewed recent wartime statistics, which suggest the reasons for the change away from surgery. He cited figures presented by McLeod on gunshot wounds in the Crimean War: of 630 patients with contusion, eight (1%) died; of 74 with fracture and loss of consciousness, 53 (72%) died; of 67 with penetration wounds, 67 (100%) died; of 19 with perforation wounds, 19 (100%) died; and of 28 with trephination, 24 (86%) died. Gross also quoted Stromeyer, who described 41 patients injured by gunshot of whom 41 had a skull fracture; 34 of these were cured, and only one underwent trephination.

Some of the surgical manuals suggested that it was important to remove foreign material and loose bone fragments from open wounds expeditiously to minimize infection. Other than this, most authorities recommended an expectant approach, fearing that surgery would introduce infection and realizing that patients can recover spontaneously from concussion and even clots. Indeed, there are recommendations that probing only be carried out a minimal number of times and that a wound not be dilated. Warren recommended surgery to remove foreign bodies, and in cases of depressed fractures, dural penetration, epilepsy, and collections of blood or pus. Bone fragments were also to be removed when there was suppuration and these were to be loosened from the soft tissues. Philosophically, there seemed to be a spectrum of opinion with Gross and Tripler and Blackman being more aggressive, Warren apparently in the middle, and Formento, Moore, and Smith being very anti-surgery. It was reported that the young did better than older patients after head injury.

Surgical techniques were described in detail, notably for removal of bone fragments and trephination. It is not clear when trephination was to be employed; use of a trephine for a depressed fracture was described, but in such a way as not to move bone that is loose. It was well appreciated that, when trephining, there was danger of bleeding from the venous sinuses and from the middle meningeal artery, and that the latter could be stopped with wax (mentioned by Chelius in 1826). There were suggestions as to how to trephine through the frontal sinus. When probing was considered, the finger was to be used, for it was recognized that a stiff probe can create its own track. When epidural hematomas were encountered, they were to be broken up with the finger. Some authors suggested opening the dura when there was an obvious clot beneath it. It was
Treatment of head injuries in the Civil War

<table>
<thead>
<tr>
<th>TABLE 1</th>
</tr>
</thead>
<tbody>
<tr>
<td>Injuries and disease sustained by the armies in the Civil War</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Etiology</th>
<th>Outcome</th>
<th>Union</th>
<th>Confederacy</th>
</tr>
</thead>
<tbody>
<tr>
<td>injuries</td>
<td>survival</td>
<td>400,000</td>
<td>134,000</td>
</tr>
<tr>
<td></td>
<td>death*</td>
<td>110,000</td>
<td>20,000</td>
</tr>
<tr>
<td>disease</td>
<td>survival</td>
<td>6,000,000</td>
<td>3,600,000</td>
</tr>
<tr>
<td></td>
<td>death</td>
<td>225,000</td>
<td>150,000</td>
</tr>
</tbody>
</table>

* More than half of those dying were killed outright.

noted with some awe that Dupuytren had plunged an instrument into the brain and drained an abscess. Gross\(^4\) and Moore\(^2\) suggested replacing bone. Both Gross\(^4\) and Warren\(^9\) considered it too dangerous to use chloroform for cranial surgery.

The antiphlogistic regimen, an esthetic routine, had followers, but some manuals advised trying to strengthen the patient through good nutrition.\(^5\) The use of soothing or "cold water" dressing was the state of the art.\(^6\) People still talked about such treatments as venesection, cupping, and leeches to decrease the congestion of the affected part.

Medical Care in the Civil War

**Personnel and Conditions**

The Civil War lasted from April, 1861, to April, 1865. Three to 3.5 million men fought in over 2000 battles and over 600,000 died. The numbers affected by wounds and particularly by illness were appalling (Table 1). These statistics are approximations, and estimates vary from source to source. It is thought that many casualties were not recorded.

The technologies of battle were evolving with advances in cannons and handheld weapons. Recent developments in handguns included caps, conical bullets with bases of clay (minie balls), and rifling which improved speed and accuracy.\(^6\) Breech-loaded rifles for self-contained cartridges fired by pins were also being introduced, as were repeating pistols and rifles.\(^6,11\) The Civil War became the first conflict in which there were more gunshot wounds than incised or puncture wounds. It has been suggested that 94% of wounds were caused by bullets and that 92% of fatal wounds were caused by minie balls.\(^8\)

Military medicine in the Civil War is detailed in *Doctors in Blue*\(^1\) and *Doctors in Gray*\(^2\) and nursing in *Nursing: The Finest Art.*\(^3\) Credit for the successful reorganization of the Union medical services was attributed to William Alexander Hammond (1828–1900), who was surgeon general from 1862 to 1863.\(^4\) Eventually, there were 11,000 to 12,000 physicians and 9000 female nurses serving the Union and 3300 physicians and 100 female nurses serving the Confederacy,\(^5,12,18\) as well as male nurses and hospital stewards.\(^8\) Only one in 15 physicians was skilled enough to be allowed to operate.\(^8\) There were huge general hospitals arranged in pavilions as well as field hospitals. On the Union side, there were eventually 204 hospitals with about 120,000 hospital beds, including over 21,000 in Wash-

ington, D.C., and over 14,000 in Philadelphia.\(^18,21\) There were 150 Confederate general hospitals.\(^6\) Field hospitals around battlefields were utilized extensively.\(^3,4,8\) As the war progressed, the concept of care by echelons was evolved.

Chloroform (76%, which had one-fifth less bulk and twice the speed of action of ether, in addition to being nonflammable), ether (14%), or a mixture of the two was widely used for anesthesia.\(^1\) Morphine was used parenterally for the first time and was administered more than 80,000 times. Some antiseptics were used.\(^3\) Surgical care took place in appalling circumstances. Keen\(^7\) gave the following description:

"...Our hands were as a rule, as clean as those of a gentleman, but were never disinfected. The patient's skin was similarly clean or cleansed, but not disinfected. ... Our instruments, from germ-gathering, velvet-lined cases, were laid out on a table — and not disinfected. If they needed a little sharpening, ... I have seen them strapped on the boot, and even on its sole. If an instrument fell on the floor, it was swished in a basin of unsterilized water, and plunged into the wound without disinfection."

The actual details of the surgery are not known. Mitchell\(^22\) stated: "... Except as to our technical story we alone are unrecorded. ... I know of no book which tells the personal life of a war surgeon: what he did day by day on the field or in the hospital."

Medical and Surgical History

The massive work initiated by Surgeon General Hammond,\(^28\) entitled *The Medical and Surgical History of the War of the Rebellion*, was unique in its scope. Its six illustrated volumes, three concerning surgery, appeared serially over several years. Prepared under the direction of Surgeon General Joseph K. Barnes, initially by George A. Otis, Assistant Surgeon, United States Army, the first volume was printed in a run of 5000 copies in 1870. It had actually been planned as a prospective study, and the orders for data collection and forms used are included in the introductory sections. A staff consisting (at the most) of a medical officer, a clerk, and 16 hospital stewards also used contemporary sources such as reports of the Medical Directors and Confederate records, as well as later sources such as state records, pension information, and pathological and autopsy material sent to Washington, D.C. The surgical volumes are organized by body region and injury types. The treatise lists the standard texts of the day and contains well-referenced discussions, alluding to authors from hundreds of years before. In the introduction are amusing complaints about the inadequacy of the information on the forms and the problems with limited follow-up data, all too familiar to clinical investigators even today.

This report describes 408,000 injuries, including 245,790 from gunshot wounds (13.6% fatal) (Fig. 2). Conical balls caused 76% of the gunshot wounds. The authors appreciated that conical bullets, rifled barrels, breech loading, and weapons with magazines contributed to the number and severity of wounds (Vol II, Part III, pp 695–696).\(^28\) The volume indicates 37,531 deaths among Union and Confederate soldiers, far below later esti-


TABLE CXXIX.

Table indicating Percentage of Fatality and Relative Frequency of Shot Wounds recorded during the War of the Rebellion.

<table>
<thead>
<tr>
<th>SEAT OF INJURY</th>
<th>RECOVERY</th>
<th>DEATHS</th>
<th>UNDER-TREATED RESULTS</th>
<th>NUMBER OF CASES</th>
<th>RELATIVE FREQUENCY</th>
</tr>
</thead>
<tbody>
<tr>
<td>Shot Injuries of the Head</td>
<td>12,076</td>
<td>2,074</td>
<td>2,940</td>
<td>26,950</td>
<td>14.91</td>
</tr>
<tr>
<td>Shot Injuries of the Face</td>
<td>9,416</td>
<td>1,485</td>
<td>3,598</td>
<td>16,390</td>
<td>15.74</td>
</tr>
<tr>
<td>Shot Injuries of the Neck</td>
<td>3,883</td>
<td>618</td>
<td>781</td>
<td>13,280</td>
<td>12.07</td>
</tr>
<tr>
<td>Shot Injuries of the Spine</td>
<td>546</td>
<td>110</td>
<td>14</td>
<td>22,050</td>
<td>1.99</td>
</tr>
<tr>
<td>Shot Injuries of the Chest</td>
<td>30,660</td>
<td>5,732</td>
<td>1,250</td>
<td>28,920</td>
<td>16.7</td>
</tr>
<tr>
<td>Shot Injuries of the Limb</td>
<td>2,420</td>
<td>507</td>
<td>13</td>
<td>2,230</td>
<td>0.28</td>
</tr>
<tr>
<td>Shot Injuries of the Pelvis</td>
<td>3,453</td>
<td>327</td>
<td>1,146</td>
<td>1,210</td>
<td>2.45</td>
</tr>
<tr>
<td>Shot Injuries of the Back</td>
<td>2,104</td>
<td>438</td>
<td>30</td>
<td>2,360</td>
<td>1.35</td>
</tr>
<tr>
<td>Shot Injuries of the Upper Extremities</td>
<td>12,320</td>
<td>2,080</td>
<td>1,005</td>
<td>12,185</td>
<td>1.25</td>
</tr>
<tr>
<td>Shot Injuries of the Lower Extremities</td>
<td>15,030</td>
<td>2,512</td>
<td>1,522</td>
<td>12,390</td>
<td>1.40</td>
</tr>
<tr>
<td>Aggregation</td>
<td>12,900</td>
<td>2,774</td>
<td>2,589</td>
<td>11,820</td>
<td>2.046</td>
</tr>
</tbody>
</table>

Fig. 2. Reproduction of a table summarizing the number of gunshot wounds to various parts of the body and outcome in 245,790 cases. (Reproduced from The Medical and Surgical History of the War of the Rebellion, Vol II, Part III, p 691.)

mates, and the work acknowledges problems in data collection. The descriptions of surgery and outcomes are not complete, are sometimes inconsistent, and may not be fully representative.

About 13,000 head injuries were summarized (Fig. 3). It is clear from quotations of contemporary authors that head injuries were greatly feared, and that their complexity was well appreciated. In 1842, Guthrie stated (p xxviii):

"Injuries of the head affecting the brain are difficult of

TABLE VII.

Nature and Results of Twelve Thousand Nine Hundred and Eighty Injuries of the Head from all Causes as reported during the War.

<table>
<thead>
<tr>
<th>INJURIES</th>
<th>CASES</th>
<th>DEATH</th>
<th>DISCHARGE</th>
<th>DUTY</th>
<th>RESULT UNKNOWN</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Incised Wounds of the Scalp</td>
<td>928</td>
<td>6</td>
<td>68</td>
<td>206</td>
<td>206</td>
<td></td>
</tr>
<tr>
<td>Incised Fractures of the Cranium</td>
<td>49</td>
<td>13</td>
<td>19</td>
<td>94</td>
<td>94</td>
<td></td>
</tr>
<tr>
<td>Incised Wounds of Scalp</td>
<td>26</td>
<td>1</td>
<td>10</td>
<td>17</td>
<td>17</td>
<td></td>
</tr>
<tr>
<td>Punctured Wounds of the Scalp</td>
<td>20</td>
<td>1</td>
<td>4</td>
<td>12</td>
<td>12</td>
<td></td>
</tr>
<tr>
<td>Punctured Fractures of the Cranium</td>
<td>23</td>
<td>1</td>
<td>11</td>
<td>12</td>
<td>12</td>
<td></td>
</tr>
<tr>
<td>Contusions and Lacerations of the Scalp</td>
<td>55</td>
<td>12</td>
<td>10</td>
<td>10</td>
<td>10</td>
<td></td>
</tr>
<tr>
<td>Contusions from Blows, Falls, Railway accidents, etc...</td>
<td>72</td>
<td>14</td>
<td>43</td>
<td>13</td>
<td>13</td>
<td></td>
</tr>
<tr>
<td>Fractures of Skull from similar causes</td>
<td>105</td>
<td>57</td>
<td>28</td>
<td>17</td>
<td>17</td>
<td></td>
</tr>
<tr>
<td>Gunshot Wounds of the Scalp</td>
<td>7,793</td>
<td>102</td>
<td>1,176</td>
<td>3,889</td>
<td>3,712</td>
<td></td>
</tr>
<tr>
<td>Gunshot Contusions of the Bones of the Skull</td>
<td>300</td>
<td>55</td>
<td>173</td>
<td>100</td>
<td>100</td>
<td></td>
</tr>
<tr>
<td>Gunshot Fractures of the Outer Table(*)</td>
<td>138</td>
<td>19</td>
<td>66</td>
<td>62</td>
<td>62</td>
<td></td>
</tr>
<tr>
<td>Gunshot Fractures of the Inner Table</td>
<td>20</td>
<td>19</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>Linear Fractures caused by Gunshot</td>
<td>19</td>
<td>7</td>
<td>12</td>
<td>12</td>
<td>12</td>
<td></td>
</tr>
<tr>
<td>Gunshot Fractures without known Depression</td>
<td>2,911</td>
<td>1,860</td>
<td>651</td>
<td>309</td>
<td>309</td>
<td></td>
</tr>
<tr>
<td>Depressed Gunshot Fractures of the Skull</td>
<td>294</td>
<td>129</td>
<td>190</td>
<td>42</td>
<td>42</td>
<td></td>
</tr>
<tr>
<td>Penetrating Gunshot Fractures</td>
<td>436</td>
<td>402</td>
<td>65</td>
<td>19</td>
<td>19</td>
<td></td>
</tr>
<tr>
<td>Perforating Gunshot Fractures</td>
<td>73</td>
<td>56</td>
<td>17</td>
<td>17</td>
<td>17</td>
<td></td>
</tr>
<tr>
<td>Smash</td>
<td>9</td>
<td>9</td>
<td>9</td>
<td>9</td>
<td>9</td>
<td></td>
</tr>
<tr>
<td>Centre-out(*)</td>
<td>2</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td></td>
</tr>
</tbody>
</table>

Fig. 3. Reproduction of a table summarizing 12,980 cases of head injury and their outcome. (Reproduced from The Medical and Surgical History of the War of the Rebellion, Vol II, Part III, p 308.)

842 J. Neurosurg. / Volume 78 / May, 1993
Treatment of head injuries in the Civil War

TABLE 2
Outcome related to surgery for certain injuries described in Part I

<table>
<thead>
<tr>
<th>Type of Injury</th>
<th>Surgical Group</th>
<th>Nonsurgical Group</th>
<th>Total Cases</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Total</td>
<td>Died</td>
<td>Total</td>
</tr>
<tr>
<td></td>
<td>No.</td>
<td>Percent</td>
<td>No.</td>
</tr>
<tr>
<td>incised/puncture wound</td>
<td>11</td>
<td>1</td>
<td>9</td>
</tr>
<tr>
<td>fracture</td>
<td>26</td>
<td>18</td>
<td>62</td>
</tr>
<tr>
<td>retained bullet</td>
<td>85</td>
<td>42</td>
<td>49</td>
</tr>
<tr>
<td>totals</td>
<td>122</td>
<td>59</td>
<td>48</td>
</tr>
</tbody>
</table>

* Data from *The Medical and Surgical History of the War of the Rebellion*, Part I. None of the differences are statistically significant.

distinction, doubtful in character, treacherous in their course, and, for the most part, fatal in their results. The symptoms which appear especially to indicate one kind of accident are frequently prevalent in another. It may be even said that there is no one symptom which is presumed to demonstrate a particular lesion of the brain, which has not been shown to have taken place in another of a different kind. Examination after death has often proved the existence of a most serious injury, which had not been suspected; and death has not infrequently ensued immediately, or shortly after the most marked and alarming symptoms, without any adequate cause for the event being discovered on dissection. Such are the deficiencies in our knowledge of the complicated functions of the brain, that although we think we can occasionally point out where the derangement of structure will be found, which has given rise to a particular symptom during life, the very next case may probably show an apparently sound structure with the same derangement of function. One man shall lose a considerable portion of his brain without its being productive at the moment, or even after his restoration to health, of the slightest apparent functional inconvenience; whilst another shall fall and shortly die without an effort at recovery, in spite of any treatment which may be bestowed upon him, after a very much slighter injury inflicted apparently on the same part."

McLeod also commented as follows:

"Of all the accidents met with in field practice, these are, beyond doubt, the most serious, both directly and remotely — the most confusing in their manifestations, and the least determined in their treatment, although they have engaged the attention of the master minds of all ages and countries from the time of the old surgeon of Cos down to the present day."

In this major work is a summary of incised wounds (Vol II, Part I, Section I), which were divided into 282 scalp wounds and 49 involving bone (Fig. 3). Most were due to sabers and swords. Loose clothing was recommended for scalp wounds. Wounds of the skull were categorized as involving the surface, the outer table, both tables, or the brain. Of 49 patients with skull wounds, 11 patients underwent surgery for bone removal, five immediately and three after months, and five received trephination (Table 2). Several of the injured did well and returned to duty. It was suggested that bone fragments that were firmly attached to scalp be put back into place.

Section II describes 508 blunt head injuries, including 72 significant brain injuries without fractures and 105 skull fractures. Scalp injuries were divided into contusions and lacerations. It was pointed out that contused wounds could mimic depressed fractures because of liquid blood in the center suggesting depression. Contusions were treated with elevation, pressure, ice, and various compounds. Subgaleal fluid was drained. Lacerations were reapproximated with bandages and with metallic sutures, but left open at their ends to drain. Bleeding was controlled with pressure bandages, tourniquets, or ligation. Infections with suppuration and sloughing were recognized and treated with irrigation and "lotions." All patients recovered.

Of the 72 patients with significant brain injuries, 14 died and 33 were disabled at discharge. Treatment included "quiet and abstinence." The table in Section II records 922 concussions with 215 deaths and 61 compressions with 17 deaths. The text cites Warren's statement about concern with the difficulty of separating compression from concussion, but seems to deride this. The diagnosis and treatment of compression are not discussed here.

Of 105 skull fractures described, 43 were open. Of the 46 patients with simple fractures, 65% recovered, including four with depressed fractures. On the other hand, of 43 patients with compound fractures, including seven with depressed fractures, only 35% recovered. Among causes of death were compression, extravasation of blood, encephalitis, and abscess. The analysis was not pursued. Of 58 patients with "compression," 46 died while only three were known to recover fully. Again, the analysis was not pursued. The site of the fracture was considered important, and those of "the side and base of the cranium" did worse. Otorrhea was noted in 11 patients, who were not described further. Rhinorrhea is not discussed, nor is secondary meningitis. Prognosis seemed worse in fracture patients who underwent surgery (Table 2).

Section III deals with shotgun wounds, which are divided into scalp, skull, and brain wounds. There were 7739 patients with scalp wounds, most of whom recovered. Problems noted included infections of the brain and scalp, hemorrhage, and tetanus. Of 4002 injuries, the causes were conical balls (65%), round balls (10%), and pistol balls (2%), as well as shell fragments (22%). Treatment consisted of shaving, debridement, and loose approximations of the wounds with adhesives. Missile tracks and sites of infection might be opened. Various "applications" were used.

There were 4350 wounds to the skull. The bone injuries were classified into a multiplicity of categories.

"J. Neurosurg. / Volume 78 / May, 1993"
These wounds were noted to be followed by emotional and neurological sequelae including decreased mental function, aphasia, cranial nerve deficits, hemiparesis (occasionally noted to be crossed), postconcussion syndrome with headaches and vertigo, and epilepsy. Secondary local scalp or bone and brain infections including meningitis, encephalitis, and abscesses above and beneath the dura were reported. A small number of patients died from hematoma, and more from abscesses; it was noted that death from hematoma occurred earlier. Accessible bone and bullet were removed. Although prior successful cases were discussed, trephining to relieve compression from epidural blood or pus was decried, and the suggestions for nonoperative management by Stromeyer were mentioned.

It was noted that wounds in which the bullet entered the brain were usually and quickly fatal (54% of 186 cases). Those undergoing surgery did slightly better (Table 2). The diagnosis of penetration was made by probing, using only the weight of the probe. Several bullets were actually removed from "within the cranium," in some cases with recovery. Fourteen patients survived perforating injuries; two of these did well. Among the gunshot wounds described, superficial bone and bullet fragments were removed in 385 cases. Of these, 62% lived, but 80% of the survivors were disabled.

The 196 cases treated with formal trephination were reported separately, although the reasons for trephining were not discussed. The mortality rate was 56%, and was highest in patients with early trephination. Findings included depressed fragments, epidural and subdural hematomas, and brain abscesses, as well as injured dura and brain. It appears little was found in some cases. Silver plates were apparently inserted as cranioplasties.

Ulcerated cerebral hernia was described in 61 cases, apparently related to brain injuries or infections. These cases were treated with compression or debridement, but 50 cases were associated with a fatal outcome.

One issue that is today considered critical, and particularly important when considering surgery, is the presence of secondary hematomas with mass effect. Fifty-three instances were observed (the implication seems to be there were probably more), of which 50 were fatal (19 cases were treated surgically, nine by removal of fragments and 10 by trephining). Unfortunately, the findings and surgery are not described in detail. A tabulation of all 911 operations and their outcomes is reproduced (Fig. 4).

Section III concludes with several quotations emphasizing the difficulty of prognostication, including the following by Liston (p 312): "No injury of the head is too slight to be despised, or too grave to be despaired of." There is then a discussion by Brevet Lieutenant Colonel J. G. F. Holston (p 320), Professor of Anatomy at Georgetown Medical College, who speaks against trephination.

The risk to Union medical officers was stressed. 19 were killed in action, 13 were "assassinated," eight later died of wounds suffered in action, and nine died in accidents. Mitchell reported slightly higher numbers, adding that 283 physicians died of disease. The medical costs to the Union, excluding the salaries of commissioned officers, was a little more than $47 million.

Conclusions

It is clear that a great deal was known about the pathophysiology of head injury. Anesthesia and improved organization of military medicine took great strides forward. However, this was a time before sophisticated neurological examination, brain localization, radiology, and the understanding of infection, which made brain surgery problematic. The information available about the patients was rudimentary, and was not collected in sufficient detail. Therefore, since one cannot determine the condition of the patient before surgery, what operation was performed for which condition, what were the findings at surgery, or what were the outcomes stratified by patient condition and pathology, it is not possible to fully understand the...
Treatment of head injuries in the Civil War

extent or effect of surgery for head injuries in the Civil War. Ironically, the knowledge that would facilitate neurosurgery, particularly the understanding of antiseptic and aseptic surgery and the localization of brain functions, was developed only a very few years later.

Acknowledgments

I am grateful to Dr. Dale Smith of the Department of the History of Medicine, The Uniformed Services University of Health Sciences, for his many ideas, for guiding me into the literature, and for reviewing this manuscript. I would also like to thank Dr. James T. Goodrich, for educating me about the literature.

References


Manuscript received February 26, 1992. Accepted in final form September 29, 1992. Address reprint requests to: Howard H. Kaufman, M.D., Department of Neurosurgery, West Virginia University School of Medicine, Morgantown, West Virginia 26506.