

Eye Injuries and Prosthetic Restoration in the American Civil War Years

ABSTRACT: *The American Civil War was a sad, ugly war. Nearly 2% of the U.S. population participated, and more than 600,000 died during the 4 years of conflict. The prevalence of casualties and disease, coupled with advances in battlefield technology and medicine, made the time period, 1861–1865, a pivotal moment for American medicine. Veterans’ disabling or disfiguring wounds led to advances in prosthetic technology. Ocular prostheses were not widely available; ophthalmology was far from producing the comfortable, appealing prostheses patients wear today. How soldiers coped with eye injuries reflected 19th-century attitudes toward disability and the war itself, and indirectly contributed to later advances. Sadly, medical care for wounds incurred in war is once again in many practitioners’ minds.*

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INTRODUCTION

Writing about the American Civil War has at times devolved into romanticized tales. This may be due to a modern perception of the 19th century as a more innocent time than our own. Perceptions of which side was “good” or “bad,” brutal or heroic, have also evolved and become distorted with the years. Soldiers and their commanders have also been stereotyped. Examining the war from the perspective of how Northern and Southern veterans were treated and how they coped with their wounds humanizes the conflict. From the standpoint of ophthalmology, Civil War wounds and their treatment highlight the need for the profession and the advances in reconstructive surgery that did not develop fully for many years.

The American Civil War (1861–1865) was one of the most significant periods in United States history. It has been said that every family in the country was affected by the war in some fashion, whether by loss of life, property, or freedom.¹ On the Union side, 604,000 combatants were wounded, of whom 360,000 died; of the Confederacy, 480,000 soldiers were wounded and 244,000 died.^{1,2} For every combat casualty, two soldiers suffered from disease. Medical illness, especially infectious disease, resulted in more deaths during the war than combat.¹

CIVIL WAR WOUNDS AND MEDICAL CARE

Medicine in the Civil War era differed profoundly from today’s standards of care. In the 19th century, most medical education in the United States was administered through one of three basic systems: an apprenticeship system,

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in which students received hands-on instruction from a local practitioner; a proprietary school system, in which groups of students attended lectures by the physicians who owned the medical college; or a university system, in which students received some combination of didactic and clinical training at university-affiliated lecture halls and hospitals. Because of the heterogeneity of educational experiences and the paucity of licensing examinations, 19th-century American physicians varied tremendously in their medical knowledge, therapeutic philosophies, and aptitudes for healing the sick. Medical schools proliferated in the early years of the century, with 100 institutions opening their doors before 1860. Some of these were short-lived. While 57 schools were founded before the American Medical Association (AMA) organized in 1847, just 64 of the 100 founded before 1860 were still in operation at the start of the Civil War. The South, as well as the North, had facilities for medical education, with 24 medical schools south of the Mason-Dixon Line in 1860. Although U.S. medical schools taught diverse types of medicine, including scientific, osteopathic, homeopathic, chiropractic, eclectic, physiomedical, botanical, and Thomsonian, their founding and the establishment of the American Medical Association (1847) helped to regularize medical practice and education.^{1, 3} In addition, wealthy and industrious medical students supplemented their education with clinical and laboratory training in European hospitals and universities, primarily in England, Scotland, France, and Germany.

By the turn of the 20th century, the microbiological theory of disease had altered the values held by the public and the medical profession. Clinical and laboratory research had exposed the irrationality of "heroic" treatments, such as bleeding, purging, and blistering, and had proven the therapeutic efficacy and scientific rationale for modern practices, such as antiseptic surgery, vaccination, and public sanitation. Sadly, when the Civil War's first shots were fired, these advances had not become standard practice. The technology of modern war, however, had crossed the Atlantic and would devastate armies on both sides of the conflict.

The Minié Ball

Many physicians who performed surgery during the

American Civil War had no prior surgical experience at all, still less had training or experience in military surgery.⁴ However, the nature of Civil War injuries meant surgery was often necessary if soldiers were to have a chance of surviving their wounds. The devastating injuries caused by advances in artillery, combined with field surgeons' lack of training and experience, meant a high rate of surgical mortality, especially in the war's early years.¹

The technology that caused most Civil War wounds was a projectile called the Minié ball after its inventor, French gunsmith Claude Etienne Minié. Despite being called a ball and popularly pronounced "minnie," this bullet was fired from muzzle-loading rifles.

While the North introduced the Minié ball, Confederate soldiers used it when they fired captured rifles and ammunition, and it was later produced in the South.⁵ The Minié ball had greater range, accuracy, and velocity than the old, round musket ball. As Hertle notes, "Wounds of the torso, chest, and head were almost uniformly fatal due to the massive, lacerating, avulsive . . . destruction of the internal organs by this lead bullet after [it entered] the body."¹ The bullet carried clothing, dirt, and other organic matter into wounds, increasing the likelihood of infection.⁶

Because Civil War soldiers formed up for battle shoulder to shoulder, many suffered multiple wounds as their lines met an attack.¹ Doctors commonly amputated wounded limbs to reduce soldiers' risk of dying from secondary complications, or what we now know as sepsis, pneumonia, pulmonary emboli, heart attacks, and seizures. These complications were then grouped under the term, hospital gangrene.⁷ The Minié ball's effectiveness in destroying tissue was responsible for thousands of amputations performed during the Civil War. Since, in this era before antiseptic practice, patients who underwent surgery promptly had a better chance of survival, causing many amputations to be performed in field hospitals.¹

Eye Injuries and Their Treatment

The incidence of eye injury in general is 20 to 50 times higher than would be expected by ocular surface area alone. The human eye makes up just 0.27% of the body's surface area and less than 4% of facial surface area. Because Civil War soldiers firing muskets from the standing or prone position needed to sight in their



FIGURE 1 These images illustrate the vulnerability of the human eye to foreign objects. The tintype of the soldier,* shown at left (standing) and bottom center, demonstrates how small the surface area of the eye is compared to the rest of the body and the face. The skull photo at top right is from the photographic series compiled by Assistant Surgeon General George A. Otis. Taken in 1862, it shows injuries to the skull and orbital area from a Minié ball. At bottom right, a Minié ball is shown at actual size.

arms, their heads, faces, necks, and eyes were frequently exposed during combat. The eye and orbital areas were usually unprotected. (While eye shields were available to protect against the force of exploding gun caps, they were not always effective even when worn.) Soldiers' eyes were thus exceptionally vulnerable to injury from small arms, fragments of shrapnel, rock, battlefield debris, and dirt. Because of the Minié ball's explosiveness and tendency to destroy all tissue near the entry wound, the eyelids of Civil War soldiers rarely escaped injury from gunshot wounds to the face, neck, or head. In addition, missiles seldom penetrated or destroyed the eyeball without injuring the bones of the orbit (Figure 1). A study of eye injuries in Civil War soldiers reported that the

loss of one eye occurred in two-thirds of 1,190 soldiers with isolated eye injuries, while only 5% of these soldiers lost sight in both eyes or died from their wounds.¹

The period, 1850–1870, is sometimes considered the “golden age” of ophthalmology⁸ in that knowledge and treatment methods developed at this time are reflected in patient care today. These developments include the invention of the ophthalmoscope, the discovery of the eye's optics, and the treatment for cataract and glaucoma. Snellen testing of visual acuity and correction for astigmatism were available; spectacles for the correction of myopia were worn by some soldiers and officers during the war.¹ Other new ophthalmic knowledge included more accurate descrip-

tions of anatomic localization of inflammation.

However, despite this flowering of knowledge and the founding of several eye hospitals prior to 1850, most Civil War soldiers received only rudimentary care for eye and facial wounds. Because U.S. ophthalmology was in its infancy—the first journal devoted to the specialty, the *American Journal of Ophthalmology*, was not founded until 1862—little specialty care was available in field hospitals. Confederate soldiers with eye injuries might be transferred to a specialty ward established at Forsythe, Georgia, in 1864, or sent from there to an eye hospital founded by the ward's director, Bolling A. Pope, in Athens, Georgia.¹ Available treatments ranged from bed rest and compressive bandages to cataract removal and iridotomy.⁹ Given nineteenth-century wartime communication and transportation networks, however, even this level of specialized treatment was available to only a few.

General surveys of gunshot injuries to the eye reported during the war indicate that, whenever foreign bodies were lodged in the globe, they were removed¹ in order to preserve the other eye. From the 1860s to the 1920s, enucleation or removal of an injured or inflamed globe, was practiced in hopes of preventing sympathetic ophthalmia. (Because of the severity of this condition, which occurs when the globe of one eye is penetrated or ruptured, prompting an inflammatory response in its fellow, enucleation is still a treatment option today, although steroids and other anti-inflammatory drugs are effective in preventing sympathetic ophthalmia.¹⁰) Enucleation after traumatic wounds was often treated by careful readjustment of the mutilated tissue with coaptation by twisted suture. In some instances the contused edges of the wound were pared.¹¹ Such treatment affected the foundation that would be available for prostheses. Today, ophthalmology can provide patients with excellent cosmetic results in the form of (nearly) undetectable prostheses; for most soldiers in the Civil War years, undergoing enucleation meant being obviously monocular for the remainder of their lives.

PHOTOGRAPHIC DOCUMENTATION OF THE ERA

It was during the American Civil War that the civilian population first saw photographs taken on the battle-

field. These images had a tremendous impact on the U.S. population. Many of the best-known are credited to Matthew Brady, who took Americans right to the edge of the battlefields. Alexander Gardner, a Brady assistant, Timothy O'Sullivan, and James Gibson also traveled to battlefields to document the war.

Nineteenth-century photographs included the daguerreotype, named after J.L. Daguerre. In 1839, Daguerre invented a process that enabled a laterally-reversed image of an illuminated portion of the visible world to be transferred in monochrome through a lens onto a chemically treated plate. The daguerreotype, unlike a process for transferring images onto paper that was developed in England at the same time, created a unique image in which both the negative and the positive were incorporated in the same picture. From 1840 to 1860, finely detailed daguerreotype portraiture was a thriving industry.

Photography, in which an image was printed on paper, became more popular in the United States after 1851. One of the first applications was a surrogate daguerreotype called the ambrotype. This technique used a negative on glass, which reversed itself into a positive when backed with black paint or fabric. After short-lived popularity, the ambrotype was supplanted by another nonduplicable process, the tintype. Tintypes, which were light and less easily destroyed than paper ambrotypes, filled the portrait needs of Civil War soldiers and their families. In 1860, photographers using glass negatives to produce regular paper prints and stereographs were eager to record the struggle between the Union and the Confederacy. Other early photograph types included the carte de visite, sometimes abbreviated CdV or CDV. These photographs were popular in the mid-1850s in Europe and 1860s in the United States, and were named for their similarity to the calling, or "visiting," cards of the day, which were approximately the same size. Images were mounted on card stock measuring 2.5 inches by 4 inches. Cabinet cards were originally used for mounting landscape views, as images were mounted on larger (4.5 inches x 6.5 inches) card stock. They were adopted for portraiture and became popular in the mid 1860s. Elaborate logos on the reverse side of the cards advertise the photographers' services. The last cabinet cards were produced in the 1920s.¹²

Reed B. Bontecou, a surgeon from Troy, New York, who served as chief surgical officer of Harewood General Hospital in Washington, D.C., contributed greatly to the use of photography for documenting battlefield casualties in both the North and South. From late 1863 until the war's end, Bontecou and his colleagues, surgeon Gordon Buck, M.D., and Army photographers, William Bell and Edward J. Ward, photographed injured soldiers (Figure 2).^{13, 11} These photographs helped the government verify the severity of soldiers' injuries and determine the amount of their postwar pension payments.¹⁴ Most of these photos are assembled in the Otis Archives of the National Museum of Health and Medicine in Washington, D.C.¹³

Civil War medical photographs became medical research materials; evidentiary documents to support

disability and pension claims; commodities to be sold or traded for personal, commercial or institutional gain; historical artifacts, fine art images, and occasionally, worthless scraps. The Army Medical Museum published 400 photographs between 1865 and 1882 in an 8-volume series entitled, *Photographs of Surgical Cases and Specimens*, or simply *Surgical Photographs*.¹⁵ The surgical photographs became widely distributed after the war. Museum curator, Dr. George Otis, had 8-inch by 10-inch photographs taken of surgical cases or specimens. Many of these photographs were taken at the Army Medical Museum in the 1860s and 1870s to illustrate the outcomes of interesting surgical operations or difficulties.

The photographs usually show either a damaged bone or a soldier showing his wound. As the war came to a close, the pictures began to include civilians and

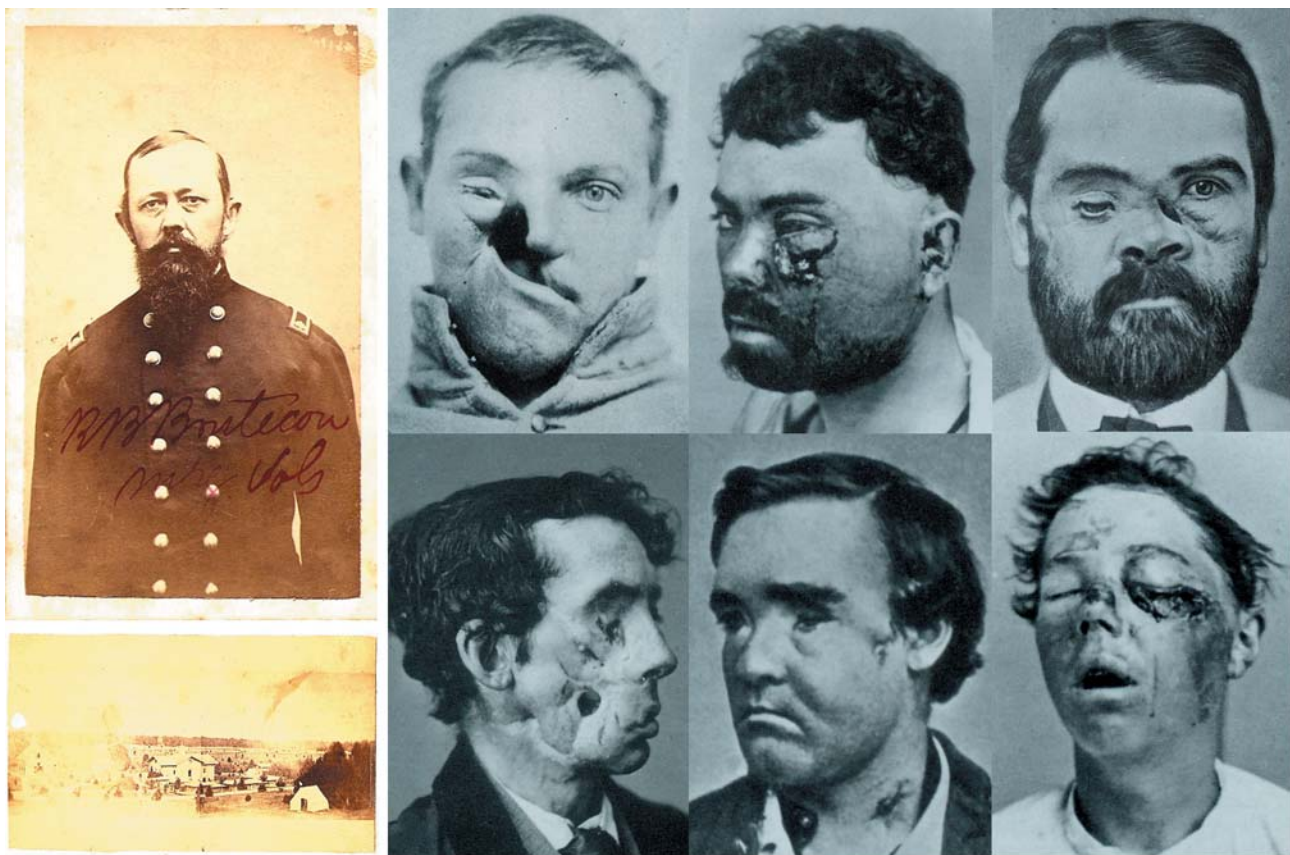


FIGURE 2 An autographed carte de visite (CDV) photograph,* far upper left, of Major Reed Brockway Bontecou, M.D., Brigade Surgeon U.S. Volunteers, (1824–1907). Bontecou was one of the foremost surgeons of the Civil War and surgeon-in-charge of U.S. Army Harewood Hospital, Washington, D.C. (shown in the CDV at lower left).* He is particularly well known for his medical and surgical photographs, many of which are reproduced in the *Medical and Surgical History of the Rebellion*. The six photographs at right from the Otis Historical Archives are examples of his work, showing Civil War veterans with various traumas of the eye and orbital area.

women. The very last pictures are long-term followups of specimens from two soldiers, 12 years and 18 years old, respectively, who were wounded during the war. Following a patient over the course of years is common now, but rarely done before the Civil War.^{15, 11}

PROSTHETICS IN THE CIVIL WAR YEARS

Congress approved minimal pensions for government

employees, including compensation for soldiers' service-related injuries. The first Pension Act for assistance of disabled employees had been passed in 1776. At the time of the Civil War, a veteran who was deemed severely wounded was eligible for a monthly pension of \$6.00. In most cases, such pensions were awarded to amputees and veterans who had been blinded in both eyes. A soldier with one remaining eye could expect less.¹⁶ Funds for the purchase of



FIGURE 3 Some soldiers wore eye shields (top row, far left and far right) to protect their eyes from exploding gun caps, but this protection was not always effective. Veterans sometimes chose to wear eye shields after a blinding or disfiguring injury. Brigadier General Adam Johnson, who was blinded during a battle at Grubbs Crossroads, Kentucky, in August 1864, is shown before his injury (top row, center left) and afterwards, wearing eye shields to cover his eyes (top row, center right).

The carte de visite (CDV)* at far left shows another soldier wearing eye shields after a disfiguring injury. The ambrotype (center row, left and right) (1856),* predates the Civil War and shows a man wearing an ill-fitting left ocular prosthesis. The daguerreotype (center row, far right),* and tintype* (bottom row, far right), show veterans wearing no eye patches or eye shields. The two CDVs* (bottom row, center left and right) show blind veterans, also without eye coverings.

prosthetics were allocated according to the limb lost. The U.S. government gave Union veterans \$50.00 toward the purchase of a prosthetic arm, \$75.00 for a leg, and provided transportation to and from prosthetic fittings; the former Confederacy formed a charitable association in 1864 to purchase artificial limbs for wounded veterans followed by the development of state programs to provide prosthetic limbs.¹⁷ Among the first of many soldiers to undergo amputation for Civil War wounds was James Edward Hanger, whose leg was injured by cannon fire at the Battle of Phillipi in 1861. Disabled and dissatisfied with the prosthetic issued to him, the young exsoldier devised and built in his home in Churchville, Virginia, an artificial leg suitable for his above-knee stump. Later, he created the J.E. Hanger Company for the manufacture of prosthetic limbs. (Today, the company is Hanger Orthopedic Group, Inc., with facilities for fabrication, fitting, and servicing artificial limbs across the United States.)¹⁸

War has always driven the development of medical techniques, medical technology, and prosthetics. In future years, American sculptor, Anna Coleman Ladd, and others would assist wounded veterans of World War I, creating silver electroplate masks for soldiers with disfiguring facial injuries.¹⁹ Progress after World War II included the development of rehabilitation medicine as we know it today¹⁶ and the implementation of techniques from the field of reconstructive dentistry to create the modern-day ocular prosthesis.²⁰⁻²³

Ocular prosthetics and the refinement of surgical procedures for treating soldiers with eye injuries would evolve at a much slower rate than prosthetics and rehabilitation for amputees. The need for recovering mobility took precedence over repair of an unsightly eye or socket. Additionally, eye injury and loss happened less frequently than loss of limbs. Between July 16, 1862, and May 4, 1867, just 49 prosthetic eyes were furnished to wounded soldiers, compared to 61 hands, 2,391 arms, 4,095 legs, and 14 feet.²⁴ While it is difficult to determine if these figures, compiled by the U.S. Surgeon General from field reports after the war are exact, they provide a reference point and lead to the conclusion that orthotics were much more common than ocular prosthetics.

The social and symbolic value of ocular prostheses was not yet distinguished from the physical need for

them, and many soldiers wore only an eye shield or occlusive patch over the deformed eye and orbit (Figure 3). Many soldiers, who returned home, simply could not find prostheses, as few “glass eyes” were available.²⁴

While a few Civil War veterans were furnished with artificial eyes, in most instances the tissue destruction in gunshot wounds involving the globe made inserting a prosthesis inadvisable or impossible.²¹ Ironically, the president of the Confederacy, Jefferson Davis, was himself monocular, although this was caused by relapsing ocular inflammation, not injury.²⁵ Although, as noted above, most injuries to the globe were treated with enucleation, the surgical technique of removing the entire globe had only recently been perfected. Prior to the 1860s, the operation was very bloody and messy. Mortality was high. Under wartime conditions, there is no doubt that Civil War soldiers were left with difficult-to-fit eye sockets. Materials used for implants in reconstruction of the orbit included glass, gold, aluminum, cotton, asbestos, wool, silver, rubber, silk, catgut, peat, wire, agar, bone, fat, petroleum jelly, and paraffin.¹

Charred human bone made a particularly good implant material (Figure 4). Sterilized by fire, bone has spiculations and canals extending all the way through its mass, allowing living tissue to grow into and completely through it without leaving air pockets where bacteria can grow. Many early implant materials, including charred bone implant, were utilized well into the 1930s.²⁶ Because of the increased incidence of transmissible infectious diseases in human allograft materials, such as bone, materials such as hydroxyapatite (sterilized coral) are used today. Like bone, this tissue has full thickness microscopic holes, or fenestrations, that allow living tissue to be thoroughly incorporated. Minimal indentations and surface holes in synthetic materials and minerals, such as plastic and aluminum, only allow superficial tissue ingrowth.

The multivolume, 1870 *Medical and Surgical History of the War of the Rebellion*, edited by U.S. Surgeon General Joseph K. Barnes, is regarded as one of the most reliable sources of information on Civil War medicine. Barnes reports that artificial eyes were dispensed by the federal government. French- and German-made stock prostheses, made of lead and cryolite glass respectively, were most likely used by general physicians following enucleation.²⁴ In larger cities, several American companies dispensed similar



FIGURE 4 War injuries have always accelerated medical advances. One surgical advance resulting from the Civil War may have been the introduction of ocular implants. Above, a sphere of charred bone (inset) is shown being introduced into the orbit. The conjunctiva were closed with silk or gut sutures. Since spiculated bone is filled with natural canals (similar to hydroxyapatite), Civil War soldiers who survived their injuries may have worn the first truly integrated ocular implants.

We are without complete records of how many enucleations were performed on Civil War combatants, as eye injuries were often accompanied by other life-threatening traumas that were treated as the primary injury. However, records of eye injuries at Chimborazo Hospital, Richmond, Virginia, the largest triage hospital in the Confederacy (today part of the Richmond National Battlefield Park), show that more than 60% of patients returned to their units.

Though sophisticated eye surgery instruments were available, these may have only been utilized in secondary medical facilities in the North or in hospitals in the South that became Union dependents after 1865. Instruments designed by von Graefe in 1840s Germany and lid-eversion spatulas by Desmarres existed much as we know them today. Some appear in surgical kits in today's museum collections; however (like surviving medieval armor), these historical items may be extant due to their disuse rather than their popularity.

At right are photos from the Otis Historical Archives of two Civil War veterans who underwent orbital reconstruction for their combat wounds. The top photo, dated 1865, shows Private William H. Nims, who was wounded by a shell fragment to the face and is shown wearing no prosthesis. At bottom right is a photograph of Lieutenant Adam Miller, age 23, who was injured in 1863 by a musket ball that entered his right orbit and exited through his left eye. The photo is dated April 1866. His prosthesis is likely an imported "stock" eye made in France or Germany.



FIGURE 5 While Major Reed Brockway Bontecou, M.D., was one of the first to document Civil War injuries, some commercial photographers specialized in medical documentation and research. The business card of photographer Jas. F. Wood of Philadelphia is shown at top left.

The two veterans pictured in the cabinet cards* at top right wear their eye patches along with their Grand Army of the Republic (GAR) medals. The GAR was a fraternal organization composed of Union Civil War veterans. Established in 1866, it was one of the first organized interest groups in American politics. The influence of the GAR led to the formation of the United States Department of Veterans Affairs. In this context, the eye patches could be seen as additional badges of honor.

The CDV at lower left (two vertical panels) shows a man standing, wearing a patch over what appears on magnification to be an exenterated orbit. The patch seems to be a metal patch, and screws for bone repair are visible on magnification. The reverse of this CDV bears a revenue stamp dated September 29, 1864, indicating that a U.S. government tax was collected on the photographer's fee.

The group of four small photographs at lower right shows Civil War veterans without ocular prostheses. At top left in this grouping is a tintype of a monocular veteran wearing no cover. (This photograph is hand tinted, with color added to the subject's cheeks.) At top right, a cabinet card shows a veteran with a white eye patch and beard; at lower right, a daguerrotype shows a veteran in a black eye patch; and at bottom left in this grouping, a CDV shows a monocular veteran without cover.

European-made prostheses. The New York American newspaper published one of the first advertisements for enamel prostheses in 1829. Early photographs show that these pioneering prostheses provided inferior or cosmetic appearance, most likely because of the severity of underlying injury.

By 1851, patronizing these establishments was not practical or convenient for the majority of wounded veterans. Prosthetic businesses tended to be family-run. Their specialized skills and knowledge were closely guarded secrets, solidifying the craft's insularity. Virtually no information on eye-making was publicly available or part of an educational curriculum in the 19th century. Ocularists were artisans, and internal pressures stifled any hope of an open forum on restorations.²⁷ Because of these factors, any of the conclusions regarding ocular prosthetics and cosmesis have to be drawn from photographs taken in the Civil War years.

The problems caused by inconsistent primary enucleation and lid and orbital reconstructive techniques and poorly fitting prostheses led many veterans to wear eye patches instead, or simply to go without any cover (Figure 5). Patches were a cheaper solution than prosthetics to an offensive appearance, and for some, they were a badge of their sacrifice and a symbol of heroic achievement.

CONCLUSION

Plastic and reconstructive surgery for eye and orbital injuries has evolved radically in the 140 years since the Civil War. This article documents the medical environment and some of the pioneering reconstructive and prosthetic work performed during that time. Despite the fact that both reconstructive surgery and oculiaristry were in their infancy, some reconstructions were accomplished. Ocularists and soldiers remain challenged by the same issues that were present during the Civil War era and include fabricating and fitting prostheses for the destructive effects of battlefield injuries. Soldiers still struggle to cope with eye loss, disfigurement, and monocular vision.

REFERENCES

- Hertle RW. Ophthalmic injuries and Civil War medicine. *Doc Ophthalmol* 1997;94:123-137.
- Livermoore TL. *Numbers and Losses in the Civil War in America: 1861-65*. New York:1901: Appendix 1.
- Slawson RG. American medical schools in 1860. *Surgeon's Call: The Journal of the National Museum of Civil War Medicine*. Fall 2006;14-15.
- Rutkow I. *Bleeding Blue and Gray: Civil War Surgery and the Evolution of American Medicine*. New York: Random House, 2005: 8-9.
- "About Minié Ball." Minié Ball Miniatures Web site. Available at: <http://www.minieball.com/about.html>. Accessed August 2, 2007.
- Murphy J. *The Boys' War: Confederate and Union Soldiers Talk About the Civil War*. New York: Clarion Books, 1993.
- Rutkow I. *Bleeding Blue and Gray: Civil War Surgery and the Evolution of American Medicine*. New York: Random House, 2005:234-239.
- Albert DM, Edwards DD. *The History of Ophthalmology*. Cambridge, Mass; Blackwell Science, 1996:305-320, 244-247
- Albert DM, Edwards DD. *The History of Ophthalmology*. Cambridge, Mass: Blackwell Science;1996, 199-201
- Chan CC. Sympathetic ophthalmia: A patient education monograph prepared for the American Uveitis Society. Available at <http://www.uveitisociety.org/pages/diseases/so.html> Accessed August 4, 2007.
- Rogers BO, Rhode MG. The first Civil War photographs of soldiers with facial wounds. *Aesth Plast Surg* 1995; 19:269-283.
- Zeller B. *The Blue and Gray in Black and White*. Westport, Conn: Praeger Publishers, 2005: 4-5, 20-21.
- Rogers BO, Reed B, Bontecou, M.D.: His role in Civil War surgery and medical photography. *Aesth Plast Surg* 2000; 24:114-129.
- Burns SB. *Early Medical Photography in America (1839-1883)*. New York: Burns Archive, 1983.
- Bengston BP, Kuz JE, eds. *Photographic Atlas of Civil War Injuries*. Grand Rapids: Medical Staff Press, 1996.
- Rogers BO. Rehabilitation of wounded Civil War veterans. *Aesth Plast Surg* 2002; 26:498-519.
- Wegner AH. *Phantom Pain: North Carolina's Artificial-Limbs Program for Confederate Veterans*. Raleigh, NC: North Carolina Department of

- Cultural Resources, 2004:20–21, 27–34.
18. Boltz MM. Making first artificial leg: war-wound amputation leads to crucial invention. *Washington Times*. July 21, 2007: D5.
 19. Alexander C. Faces of war. *Smithsonian* magazine, February 1, 2007. 72–80.
 20. U.S. Naval Medical Bulletin. “Eye replacement by acrylic maxillofacial prosthesis.” Phelps J. Murphy, Lieutenant Commander (DC) U.S. Naval Reserve and Leon Schlossberg, Lieutenant H- V(S) U.S. Naval Reserve. 1944; 43(6):1085–1099.
 21. Erph SF, Wirtz MS, Dietz VH. Plastic artificial eye program, US Army. *Am J Ophthalmol* 1946; 29:984.
 22. MacDonald GM. Plastic ophthalmic prostheses. *Treatment Bulletin*, Department of Veterans Affairs, Ottawa, Canada. 1949; 4:3–9.
 23. Sellers FJ. Acrylic ocular prosthesis. *Journal of the Royal Army Medical Corps*. 1947; 79:91–100.
 24. Otis GA, Barnes JE, eds. *Medical and Surgical History of the War of the Rebellion* (1861–65). Washington, DC: Government Printing Office, 1870.
 25. Hertle RH, Spellman R. The eye disease of Jefferson Davis (1808–1889). *Surv Ophthalmol* 2006; 51:596–600.
 26. Gougelman P. The fitting of artificial eyes, with special reference to gold ball implantation. *Arch Ophthalmol* 1929; 2:76–79.
 27. Ott K, Mihm S, Serlin D. *Artificial Parts, Practical Lives: Modern Histories of Prosthetics*. New York: New York University Press, 2002.

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AUTHOR’S NOTES

A Note on the Otis Historical Photographic Archives

George A. Otis, M.D., the second curator of the Army Medical Museum, collected 400 photographs of soldier injuries and anatomical specimens from 1865–1881. He compiled them into eight volumes, each containing 50 photographs with corresponding case histories. These original volumes, however, had a very limited circulation and only a few complete sets still exist. The original photographs were printed from wet collodion glass plate negatives and show a variety of poses, including numerous eye injuries. The negatives were extremely heavy, being made with ¼-inch thick exposed and developed. Collectively, they are an impressive portfolio.

Soon after Otis’s death in 1881, the museum was merged with the Surgeon General’s Library to create the Army Medical Museum and Library. This department lasted into the 20th century, but the Museum gradually shifted its work to pathology. After World War II, the Museum was reorganized into the Army Institute of Pathology. With the creation of the Department of Defense, it became the Armed Forces Institute of Pathology. The Museum later became a division of the Institute. The Museum was renamed first as the Medical Museum of the Armed Forces Institute of Pathology and later as the Armed Forces Medical Museum. In 1989, the National Museum of Health and Medicine was opened. During the 1980s, many of the Museum’s collections were assembled, and it became possible to view a complete set of the surgical photographs in the museum’s Otis Historical Archives. Named after George Otis, the photographic archives had been created when the Museum moved to the Walter Reed Army Medical Center in Washington, D.C., in the early 1970s. A digital inventory of the photographs is available in the museum.

The Otis photographs shown in Figures 2 and 4 are U.S. government works and, as such, are in the U.S. public domain.

On the Surgical Photographs

All of the surgical photographs and a selection of the

contributed photographs were reproduced in Bradley P. Bengston and Julian E. Kuz, eds., *Photographic Atlas of Civil War Injuries* (Grand Rapids: Medical Staff Press, 1996). See reference 15 above. For more information on the photographs, including Otis' role in creating them, see Rhode's "Foreword," pp. iv-ix. See also reference 11 above.

PHOTO CREDITS

The photos of Brigadier General Adam Johnson (Figure 4) are used by permission of the University of Texas at Austin.

The business card, Jas F. Wood (Figure 5) is used by permission of the Mutter Museum of The College of Physicians of Philadelphia. Thanks to curator Anna Dhody and Brandon Zimmerman, rights and reproductions manager. The CDV of the standing veteran with metal eye patch, shown in Figure 5, is in the possession of Janet and Bedford Hayes of Standish, Maine and used with permission. Many of the images used in this article are original, previously unpublished photographs in the author's collection. These images are indicated by an *. Copyright to these images is held by the author.

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