Surgical Knives—Once Holy, Now Disposable

Prehistoric (~2000 BCE) surgical tools were made from natural materials including small pointed animal bones; shell or rock fragments ground at their edges; and flint, chert, jasper, or obsidian (natural volcanic silicate glass). Possibly, the earliest known documented use of lithic materials for surgery is found in *Exodus* 4:25, "Then Zipporah took a sharp stone, and cut off the foreskin of her son"; and also in *Joshua* 5:2–3, "Make thee sharp (flint) knives, and circumcise again the children of Israel." In Egypt, knives and scrapers made from lithic materials were used during mummification. These materials possess excellent cutting capability and were broadly available. They were not displaced by other materials for a long period of time because the instruments themselves acquired a holy status through use in conjunction with religious practices. Stone knives were also used for trephination (cutting a hole in the skull), and skulls showing these trephination marks have been found in locations ranging from the Middle East, to Europe, to the Mayan civilization in the Americas. Whether trephination was performed to cure bad headaches or for some ritual purpose is unclear.

An indication of the transition from lithics to metal knives is found in the Code of Hammurabi (Sentences 215–219) in which a bronze lancet—a surgical knife with a short, wide, pointed double-edged blade—is described. Bimetallic Roman surgical knives were found in Pompeii, dating back to at least 79 CE. These were made with iron blades and copper-based alloy handles. Chemical analysis of these handles as well as other Roman medical instruments has shown these to be made from either copper, bronze (copper-tin), or brass (copper-zinc). The iron blades of these Roman knives have all been so badly corroded that it has not been possible to examine them and determine the quality of the iron or steel edges. Because of their rarity, only a very few studies have been done on the analysis of ancient medical implements.

The development of the iron and steel industry in conjunction with the growth of the Industrial Revolution, especially in England in the 19th century, brought the fabrication of surgical instruments made from steel alloys. In the 1820s, James Stodart (1760–1823), a maker of surgical instruments, and Michael Faraday (1791–1867), in conjunction with studies trying to understand the nature of ancient steels ("wootz") from India, experimented with the development of the first alloy steels. These alloys were high in carbon with slightly lower levels of alloy additions using either platinum, rhodium, palladium, or nickel.

In the 1860s, Robert F. Mushet (1811–1891) produced steel tools with about 10% tungsten. Mushet experimented with manganese steels that showed a degradation of mechanical properties with further addition of manganese above a few percent. Not until nearly 20 years later did Robert A. Hadfield (1859–1940) show that very high levels of manganese (7–20%) in steel produced a material with superior properties. This was the first engineered alloy that possessed both high toughness combined with high hardness. With this discovery, Frederick Winslow Taylor (1856–1915)—an American who developed methods for time and motion study—in 1907, developed high speed alloy tool steels. All of these new alloys found their way into use for surgical blades within a short time of their discovery.

Alloyed steels, however, met with the problem of corrosion, which was particularly a problem for surgical instruments at a time when people were first becoming aware of infection and its causes. Sterilization to prevent infection often involved heat and exposure to caustics that left surgical implements prone to severe corrosion attack. In 1822, Stodart and Faraday performed studies with 1–3% chromium additions to steels. In 1892, Hadfield reported (in error) that the addition of chromium actually impairs corrosion resistance in steel. Harry Brearley (1871–1948), in 1916, during his research to make better gun barrel linings, patented a "stainless steel" for use in cutlery that contained about 13% chromium and about 0.35% carbon, and which was soon found useful for surgical tools. At the turn of the 20th century, nickel-plated instruments were found on the market, especially in Europe and North America, but the development of stainless steels quickly displaced the use of nickel-plated blades. Today, nitrogen alloying has been found to considerably increase the corrosion resistance of stainless and tool steels; molybdenum in chromium-nickel-molybdenum maraging steel has been found to increase its resistance to corrosion in banked blood, physiological and tissue solutions, and during washing and sterilization procedures. Aeromet 100 (13.4% cobalt, 11.1% nickel, 3.1% chromium, 1.2% molybdenum, 0.23% carbon, and balance iron) has been used for microsurgical blades because it offers high strength and hardness, extreme sharpness, and superior cutting edge retention. These instruments have been found not to be as brittle as other steels and tend not to break or dull under normal forces encountered during microsurgical procedures. The good ductility of the alloy enables the blade to bend in use during cardiological microsurgical procedures.

The growth of medical technology has also far outpaced just the use of new metal alloys. Currently, surgeons use laser scalpels, ultrasound scalpels, and zirconia ceramic or diamond microknives. However, as sterilization and disposability have become important in the 1990s, disposable surgical blades that are both inexpensive and maintain a good cutting edge are made from carbon steel or low-cost stainless steel, a far cry from the holy status of early lithic knives.

M.R. Notis

For Further Reading: G. Majno, *The Healing Hand* (Cambridge, Harvard University Press, 1975) contains information on surgical instruments from prehistoric to modern times; L.M. Zimmerman and I. Veith, *Great Ideas in the History of Surgery*, 2d rev. ed. (Mineola, New York, Dover, 1967); and R. Jackson, "A Set of Roman Medical Instruments from Italy," *Britannia* **17** (1986) pp. 68–113.

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