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CASE REPORT

ANTHROPOLOGY

Katy L. Shepherd,[1] *B.S.; Heather Walsh-Haney,*[1] *Ph.D.; and Marta U. Coburn,*[2] *M.D.*

Surgical Sutures as a Means of Identifying Human Remains*

ABSTRACT: The Food and Drug Administration does not require surgical sutures to be tracked by manufacturer, physician, or patient; thereby, surgical sutures have been of little use to forensic practitioners who are tasked with establishing a positive identification with biological evidence. This study demonstrates the investigative process used to pinpoint suture manufacturers by presenting a case where surgical sutures were a distinctive characteristic that aided in the positive identification of skeletal remains. The suture's manufacturer, construction material and structure, size, and medical use was determined by contacting a local surgical suture and orthopedic implant manufacturer and utilizing publicly available manufacturer websites, which provide catalogs and specific product details. This research was one of many lines of evidence used to establish the positive identification of a 47-year-old male.

KEYWORDS: forensic science, forensic anthropology, surgical sutures, nonabsorbable sutures, identification, human skeletal remains

The Food and Drug Administration's (FDA's) Modernization Act of 1997, a revision of the Safe Medical Devices Act of 1990, requires the ability to track certain medical devices to the manufacturer, physician, and patient (1–3). The medical devices include: (i) devices in which failure would cause serious injury or death, (ii) devices which are intended to be implanted in the body for more than one year, and (iii) a life-saving or life-supporting device for use outside of a medical facility. Because surgical sutures do not meet the three aforementioned criteria, manufacturers are not required to track the surgical sutures to specific physicians or patients. In many cases, death investigations become more complicated because surgical sutures, when present, can be extremely unique and identifiable but difficult to trace to the individual. Law enforcement agents, and those tasked with making identifications, are often at a dead end because suture data are not easily accessible and referenced. We report a case which demonstrates the process utilized to accurately identify suture characteristics and how surgical sutures, when found within human remains, may be used to help positively identify the individual.

Case Report

In 2006, a set of skeletonized remains was discovered in a dense, wooded area adjacent to a residential gated community in Naples, Florida. The human remains consisted of a nearly complete skeleton and associated physical evidence that included a 0.357 magnum (found beside the remains), one spent bullet and shell casing, several unfired bullets contained within a box of ammunition, and a bicycle. Upon initial examination by the medical examiner and law enforcement personnel, the cranium was found to be fragmented, and the mandible had a midline fracture. Based upon the scene evidence, the preliminary cause and manner of death appeared to be consistent with a single gunshot wound to the head and suicide, respectively. No identification card was found with the remains, nor was fingerprint evidence an option. A tentative identity was established by tracing the serial number on the gun.

The forensic anthropologist, Dr. Heather Walsh-Haney, conducted an osteological analysis of the skeletal remains for identity, trauma, and time since death. The skeleton was grossly and radiographically examined for age, sex, ancestry, forensic stature, and evidence of ante-, peri-, and postmortem trauma. Because the cranium was fragmented, a reconstruction was necessary. Sex, ancestry, and stature were metrically analyzed using FORDISC 3.0 (4). Skeletal age was determined through visual examination of all joint surfaces and comparison with known standards for the pubic symphysis (5), auricular surfaces of the ossa coxae (6), and sternal end of the right fourth rib (7).

Metric analysis of the decedent by FORDISC 3.0 indicated the remains were those of a 5′7″–6′0″ European American (e.g., White) male. Nonmetric analysis of the skull and pelvic morphology supported the metric sex and ancestry findings. Radiographic and gross examination of the skeletal remains, both before and after reconstruction, evidenced one cranial gunshot wound that entered the right temporal and exited the left temporal-occipital region. The most accurate age estimation was determined to be between 45 and 60 years of age. Time since death was determined to be from weeks to months as evidenced by the extent of skeletonization, relative completeness of the remains, the mechanical integrity of the bones and a fairly recent land survey of the area, which did not uncover the remains.

One green surgical suture was discovered within the right acromial process of the scapula, which suggested that the decedent had

[1]Division of Justice Studies, Florida Gulf Coast University, 10501 FGCU Blvd. South, Ft. Myers, FL 33965.
[2]District 20 Office of the Medical Examiner, 3838 Domestic Avenue, Naples, FL 34104.
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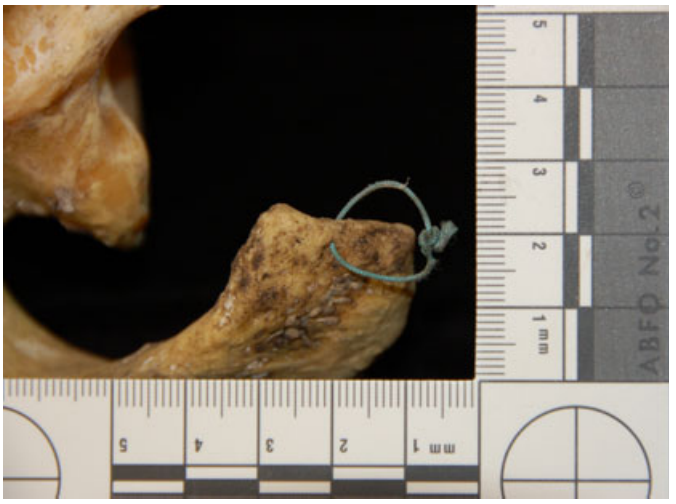

FIG. 1—*Surgical suture embedded in decedent's right scapula.*

undergone rotator cuff surgery—either as rotator cuff tendon repair, acromioplasty, or subacromial decompression (Fig. 1). Macroscopic photos with a scale in place (mm) were taken (Fig. 2) and provided to law enforcement and the medical examiner with information concerning the types of in-life shoulder surgery the decedent probably received. The dearth of published casework and research concerning the use of surgical sutures in human identification and the establishment of time since death required a consultation with a local suture and orthopedic implant manufacturer. The discussion with the suture manufacturer and culled product details from several manufacturers' websites demonstrated that the surgical suture was green, braided polyester, manufactured by Ethicon and commonly used in rotator cuff repair surgery.

Medical records of the presumed decedent, which were not available at the time of the initial examination, also referenced previous rotator cuff surgery. However, the records were incomplete and an exact date and surgical details could not be verified. Yet, the consistency of the biological profiles of the unknown individual and presumptive individual was further bolstered by the identification of the suture—especially as it related to the rotator cuff surgery. The biological evidence combined with law enforcement and scene investigation data helped to establish the positive identification and resolve this forensic case.

Although the identification of the Ethicon suture in this case study did not solely establish the positive identification, the *process* of identifying the nonabsorbable suture by coating, color, and fiber construction and tracking manufacturers and vendors helped to fill in a gap in the identification literature.

Discussion

Nonabsorbable sutures, because they are designed to be implanted in the human body for longer periods of time than absorbable sutures, are the focus of this paper. There are several types of nonabsorbable sutures, including silk, nylon, polyester, polypropylene, polyethylene, and surgical steel. Each manufacturer produces nonabsorbable sutures of various colors and diameters that are determined by the suture material and the intended medical use. The sutures may be uncoated or coated, uncolored, naturally colored, or dyed with an FDA-approved dye to improve visibility during surgery (8).

Nonabsorbable sutures are further differentiated based on whether they are constructed as a monofilament or multifilament (e.g., twisted together, spun together, or braided). Nonabsorbable sutures are classified into one of three types: Class I sutures are constructed of silk or synthetic fibers (monofilament, twisted, or braided) in which the coating (if present) does not affect thickness, Class II sutures are constructed of cotton or linen fibers, or coated (natural or synthetic) fibers where the covering significantly affects thickness, but does not contribute to strength, and Class III sutures are composed of surgical steel (monofilament or multifilament) (9).

In addition to color, diameter, and construction materials, a nonabsorbable suture's degradation may also help provide information concerning when surgery may have occurred which in turn, may help to narrow the time since death estimation. While most nonabsorbable sutures do not degrade completely, some materials, such as silk and nylon, progressively lose their tensile strength (e.g., the ability to resist deformation or breakage) (10,11). As such, suture manufacturing companies may be able to assist in future research that should investigate estimating timelines concerning the death scenario based on degradation of the suture's mechanical properties. Other characteristics that may help to determine the suture manufacturer are the braid angle and the picks (the number of times the threads cross each other) per inch of braided sutures (12).

Nonabsorbable sutures may be found in many locations throughout the human body. The characteristics of these sutures are usually

FIG. 2—*Closer view of the suture, displaying identifiable suture characteristics.*

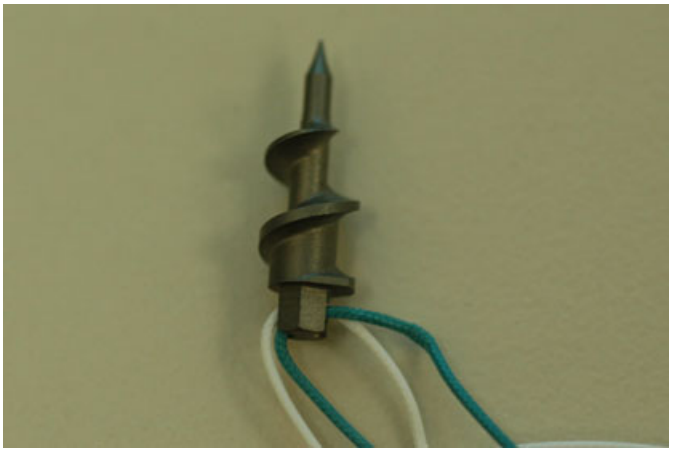

FIG. 3—*Typical nonabsorbable suture anchor (5.0 mm) with suture material.*

TABLE 1—*Suture manufacturer and product information.*

Manufacturer	Address	Contact Information	Suture Material	Suture Colors	Designed Medical Use
Aesculap© (owned by B.Braun©)	3773 Corporate Pkwy, Center Valley, PA 18034	(800)258-1946 http://www.aesculapusa.com	Polypropylene, polyester, braided silk, twisted or monofilament steel	Green, white, blue, black, silver	Soft tissue, cardiac, neurosurgery, orthopedics
Arthrex®	1370 Creekside Blvd, Naples, FL 34108	(800) 933-7001 http://www.arthrex.com	Braided polyblend, silk	Blue, green, white, black	Meniscal repair, orthopedic soft tissue, joint reconstruction
Aurolab	LAICO Bldg. 72, K.K.Salai, Gandhi Nagar, Madurai-625 020, Tamil Nadu, India	+91-452-2535573 sales@aurolab.com http://www.aurolab.com	Monofilament nylon, braided silk, polypropylene	Black, blue	Cardiovascular
Axya Medical©	100 Cummings Center, Suite 444C, Beverly, MA 01915	(800)611-2992x611 info@axya.com http://www.axya.com	Nylon monofilament	Green, light green	Shoulder orthopedics (rotator cuff)
Conmed Linvatec©		(800) 237-0169 http://www.conmed.com	Braided polyethylene	White, white/blue stripes	Soft tissue repair in orthopedic procedures
CP Medical®	803 NE 25th Ave, Portland, OR 97232	(800) 953-2763 http://www.cpmedical.com	Polypropylene, braided silk, nylon monofilament, braided polyester, steel	Clear, blue, white, black, green, silver	Soft tissue, cardiovascular, dental, abdominal closure, sternal, orthopedic
DemeTECH®	3530 NW 115th Ave, Miami, FL 33178	(305) 597-5277 info@demetech.us http://www.demetech.us	Braided polyester, nylon monofilament, braided silk, surgical steel	Green, black, blue, silver	Bone fractures, muscle, tendon, fasciae articulation/joints
Ethicon© (owned by Johnson & Johnson)	Route 22 W, Somerville, NJ 08876	(908) 218-3500 ecatalog.ethicon.com	Polyester, nylon, silk, braided nylon, polypropylene, steel	Blue, green, clear, black, silver	Cardiovascular, vascular, soft tissue, sternal closure, orthopedic
Gramsmed LLC	2225 Dakota Dr., Grafton, WI 53024	(262) 375-9099 http://www.gramsmed.com	Braided silk, polypropylene, nylon, polyester	Black, blue, green, white	General soft tissue, dental
Hu-Friedy © MFG.		800-483-7433 http://www.hu-friedy.com	Polyester, silk, nylon, polypropylene	Green, black, blue	General soft tissue, cardiovascular
Kollsut Scientific®	3826 N. 29 Ct, Hollywood, FL 33020	(954) 922-7332 http://www.kollsut.com	Nylon, braided polyester, polypropylene, braided silk	Black, green, blue, beige	General surgery, cardiology, retention
S. Jackson (Supramid®)	P.O. Box 4487, Alexandria, VA 22303	800-368-5225 http://www.supramid.com	Nylon monofilament and cable	Black, white,	General surgery, tendon repair
Surgical Specialties Corp. (formerly Sharpoint)	100 Dennis Dr., Reading, PA 19606	800-523-3332 info@surgicalspecialties.com http://www.surgicalspecialties.com	Nylon, polyester, polypropylene, silk	Black, blue, clear, green, white	General surgery, plastic surgery, dental
Surgik LC	413N. Astor Place, Broken Arrow, OK 74012	sales@surgik.com http://www.surgik.com	Braided silk, polyester, braided and monofilament nylon, polypropylene		General soft tissue, cardiovascular
Sutures, Ltd.©	Vauxhall Industrial Center, Ruabon, Wrexhem, Wales, UK LL146HA	44(0)1978-823664 http://www.sutures.co.uk	Polyamide, polyester, monofilament polypropylene, steel	Blue, black, white, silver	Soft tissue, cardiovascular, orthopedic, sternal closure
Syneture™ (Covidien™) (U.S. Surgical™) (formerly Davis & Geck)	15 Hampshire St, Mansfield, MA 02048	(508) 261-8000 http://www.syneture.com	Nylon monofilament, braided nylon, monofilament polypropylene, silk, steel	Blue, black, clear, white, silver	Soft tissue, general surgery, bone (sternotomy)
Synthes (USA)	1302 Wrights Lane, E. West Chester, PA 19380	800-523-0332 us.synthes.com	Stainless steel	Silver	Orthopedic surgery
Teleflex Medical©	4024 Stirrup Creek, Research Triangle Park, NC 27703	866-246-6990 http://www.teleflexmedical.com	Nylon monofilament, braided silk, braided polyester, steel	White, silver	Cardiovascular, general surgery, sternotomy
Zimmer®	1800W. Center St, Warsaw, IN 46581	800-613-6131 http://www.zimmer.com	Stainless steel	Silver	Orthopedic surgery

determined by the type of surgery conducted. Below is a list of common areas where nonabsorbable sutures are used, as well as the types of surgeries that are associated with nonabsorbable sutures (10):

- Cardiovascular: polypropylene (arterial repair, prosthetic grafts).
- Abdominal: polypropylene (abdominal wall closure, gastrointestinal suture, small intestine, large intestine), braided nylon (gastrointestinal suture), silk (small intestine, large intestine).
- Bronchial, tracheal, and chest system: stainless steel (bronchial closure, sternotomy), polypropylene (bronchial closure), polyester (bronchial closure).
- Orthopedic: stainless steel, metal cable, nylon, polypropylene, polyester, polyethylene, and silk.

Suture anchors, the small fixtures drilled into bone to stabilize sutures, may be constructed of metal or various polymers, and are commonly associated with joint surgery (13,14) (Fig. 3). These devices, along with surgical staples, may also be found in human remains. There are several surgical suture manufacturers, each with readily available product information including: Arthrex®, CP Medical®, DemeTECH®, Ethicon©, Syneture™, United States Surgical™, and many others (Table 1) (15–33). Many manufacturing companies have employees who are able to identify their products by visual recognition and can reference in-house research reports that address suture use, properties, and degradation.

The table of manufacturers and suture information provided here is not complete, but may expedite the investigative process. The manufacturers included in the table: (1) market nonabsorbable and steel sutures for sale in the United States, and therefore, fall under the purview of the FDA, and (2) provide websites in English and searchable online catalogs.

Conclusion

As was demonstrated in the case above, a great deal of information can be obtained from a single surgical suture. A suggestion for future research is to study more suture manufacturers through the inclusion of absorbable sutures within the United States. Also, time since death studies using suture materials and color fading studies both in tissue and with exposure to the elements would be interesting and useful future research. When surgical sutures are encountered in association with human remains, investigators are able to utilize this process to narrow down the manufacturer and aid in determining the individual's identity and time since death.

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Additional information and reprint requests:
Katy L. Shepherd, B.S.
College of Professional Studies
Division of Justice Studies
10501 FGCU Blvd. South
Academic Building 3
Florida Gulf Coast University
Ft. Myers
FL 33965
E-mail: klshephe@eagle.fgcu.edu