Evolution of the Surgical Glove

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The early story of the use of gloves by surgeons and obstetricians has been well documented by Randers-Pehrson and by Miller. Walbaum, in 1758, used the cecum of the sheep as a partial hand covering in his obstetric practice, and gloves made successively of cotton, silk, leather, and finally rubber were used in the 19th century. Rubber became the material of choice after Charles Goodyear developed the vulcanization process to stabilize it in 1844. Initially, gloves were used to protect the surgeons’ hands from injury during operations and autopsies. It was the introduction of the antiseptic technique of operating by Joseph Lister in 1867 that initiated a new hazard for the introduction of the antiseptic technique of operating and from injury during operations and autopsies. It was the initially, gloves were used to protect the surgeons’ hands from injury during operations and autopsies. It was the introduction of the antiseptic technique of operating by Joseph Lister in 1867 that initiated a new hazard for the surgeon. This was the high incidence of skin sensitivity to the antiseptic agents used at that time, at first carbolic, then a variety of chemicals, which included picric acid, iodine, and perchloride of mercury.

Interestingly, introduction and then widespread use of surgical gloves was to protect the hands of the surgeon and the theater staff from antiseptic solutions rather than to protect the patient from infection.

Certainly, William Halsted of Baltimore was one of the pioneers of the use of rubber gloves, soon after the Johns Hopkins Hospital was opened in 1889, and although he did not publicize this advance, his trainees no doubt spread the idea. Johann Mikulicz of Breslau observed Halsted at work and helped to popularize the use of gloves in Germany.

The first publication on the use of boiled sterilized rubber gloves in surgery appears to have been by Werner von Manteuffel, Professor of Surgery at Tartu, Estonia, in 1897. “To wear boiled gloves is to operate with boiled hands,” he said.

Initially, rubber gloves were sterilized by boiling and then put on wet over the wet scrubbed hands. With the introduction of dry heat sterilization it was necessary to use a dusting powder to facilitate the donning of the gloves. The first powders to be used were lycopodium (the spores of club moss) or talcum powder, which is a combination of magnesium silicate (chemically pure talc) and calcium carbonate, calcium magnesium silicate, and traces of other related substances. Several decades passed before problems caused by these agents were reported with increasing frequency, particularly talc granulomas in the peritoneal cavity after laparotomy.

By the early 1940s, the dangers of talc were well recognized and a search was made for substitutes. In 1947, Lee and Lehman reported the use of cornstarch powder treated with epichlorhydrin and mixed with 2% magnesium oxide (as a desiccating agent) as a safe glove lubricant, and this soon became the standard agent for this purpose.

Although talc is no longer used as a glove lubricant, talc granulomas are still encountered, but rarely. In some instances, this can be the result of talc contamination of the gloves; in others, talc used by members of the surgical team as talcum powder might be responsible.

The early hope that the starch glove lubricant would prove inert in clinical practice was soon unfounded. In 1955, two cases of wound granulomas from starch were reported, and the next year, McAdams described three examples of granulomatous IP foreign-body reaction to starch powder.

Paine and Smith reported three cases of IP starch granulomas in women who had not undergone previous abdominal operations and suggested that the starch had been introduced on the gloves used in their previous vaginal examination. An interesting report traced the ascites and pelvic granulomata in a young woman to the emulsion on the condom used by her husband. We have demonstrated retrograde migration of starch dusting powder from the vagina into the peritoneal cavity in rabbits, and then went on to show that starch particles were present in the genital tract and peritoneal cavity in women undergoing hysterectomy who had had a vaginal examination with powdered gloves the day before operation. In 1960, Myers and his colleagues described three examples of patients who presented with ascites, granulomas, and, in one case, dense adhesions after laparotomy. Starch powder was demonstrated by paraaminosalicylic acid stain and also by the characteristic refraction properties of starch viewed under polarized light, the so-called “Maltese crosses.” They introduced the term granulomatous peritonitis due to starch, and during the next decades numerous reports of this condition were published.

Starch granulomatous peritonitis is now a well-recognized syndrome. Ten days to 4 weeks after a laparotomy, the patient develops abdominal pain, distention, vomiting, and low-grade pyrexia. White count is usually
mildly elevated, to the region of 12,000, and a plain abdominal x-ray shows distended loops of intestine. Not surprisingly, a diagnosis of intestinal obstruction from adhesions, or intraabdominal infection, or a combination of both of these, is made. The majority of reported patients have undergone reexploration, at which time the typical findings are of ascetic fluid (which can be yellow, green, or serosanguineous), a thickened nodular omentum, small miliary nodules scattered on the surface of the peritoneum and dense adhesions. Starch granules can be seen if the ascetic fluid is examined under polarized light (and, indeed, if the condition is suspected preoperatively, examination of peritoneal aspirate by this method might allow the diagnosis to be made). Examination of a frozen section of a biopsy of one of the nodules examined under polarized light will clinch the diagnosis.

If the surgeon is unfamiliar with this condition, miliary tuberculosis or even carcinomatosis might be diagnosed. Indeed, a report from the Norwegian Cancer Hospital in Oslo records no fewer than 10 patients, referred during a 4-year period, with multiple glove powder granulomas, who the referring physician believed to have carcinomatosis peritonei.

Although most publications are concerned with intraabdominal lesions, starch granulomas have been reported at most surgical sites, eg, meningism after craniotomy, synovitis after orthopaedic procedures, pleural reaction after thoracic operation, pericardial adhesions resulting from cardiac operation, and, perhaps most worrying of all, serious ocular reactions after eye operations. A recent case report records a 2-month-old child who presented with bilateral solid paratesticular masses after pyloromyotomy. Biopsy confirmed starch granulomata, the referring physician believed to have carcinomatosis peritonei.

Problems arising from use of surgical gloves were far from over. The 1980s, with the beginning of the epidemic spread of HIV infection and hepatitis, saw widespread use of cheap powdered latex gloves throughout the health care system; not just the operating room staff, but the ward and clinic staff, cleaners, kitchen staff, ambulance personnel, and even the police. Increasing numbers of health care workers reported a dermatitis reaction to latex proteins and chemical additives in the gloves, the type IV delayed cell-mediated reaction. Even more worrying are the type I immunoglobulin E–mediated systemic manifestations that result from adsorption of latex protein antigens onto the starch powder on the gloves. This forms an aerosol when gloves are donned or removed and contaminates the air, instruments, and surgical wounds. Allergic reactions include contact urticaria, commonly seen on the backs of the hands and wrists; rhinitis, conjunctivitis; asthma; and anaphylaxis. Both health care workers and patients are at risk, especially those who have undergone repeated exposure to the gloves—one group in particular is children with spina bifida.

Fortunately, these problems have their solutions. Several manufacturers produce low-allergen, starch-free gloves. Their widespread use has been shown to reduce the reported cases of occupational allergies, for example, in a recent study from Germany. Use of latex gloves by individuals not exposed to contaminated fluids, such as food handlers, should be discouraged, and cheap synthetic gloves can be used. For latex-sensitive individuals, nonlatex gloves and other surgical devices are available.

An important study using a rat model has demonstrated that surgical trauma to the peritoneum not only promotes adhesion formation but also facilitates tumor implantation. Using the same model, this group went on to show that both glove dusting powder and pure starch promoted not only adhesions, but also growth of implanted tumor cells. The most impressive tumor deposits were found at the directly traumatized peritoneal sites to which the glove powder or the starch were applied, but tumor load was also substantially higher at distant, nontraumatized, peritoneal sites. With increasing awareness of these various problems with hospital gloves, the dangers of these supremely valuable aids to surgical care should be all but eliminated by widespread use of good quality powder-free gloves.
REFERENCES