The child mortality rate accompanying the different methods of treatment was as follows: Caesarean section 28%, rupture of membranes 37%, Willett's forceps 56%, version 93%. An unusually high neonatal death rate was encountered in this series, due to the frequent combination of prematurity with malnutrition and B₁ avitaminosis in the newborn.

The use of Willett's forceps in the treatment of placenta praevia is advocated in cases in which Caesarean section is contraindicated and in which artificial rupture of the membranes fails to control the haemorrhage.

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NYLON FOR BURIED SUTURES

BY

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"All real surgeons have been interested in wound repair" (Whipple, 1940). The nature of the material used for suturing wounds has an important influence on their healing, and it behoves all whose work involves the inflicting and the repair of wounds to give much thought to the subject of suture materials.

Catgut

Catgut is easily the most popular substance for buried sutures. Most surgeons get what appear to be reasonably good results with it, and the property of absorbability is one which has a popular appeal. Nevertheless, its disadvantages are not few, and they have been repeatedly pointed out in surgical literature. Inherently infected with spore-bearing organisms as catgut is, its sterilization has always been a difficult problem. The serious infections which all too often followed its use caused Kocher, quoted by Halsted (1913), to exclaim, "Away with the catgut," and persuaded him to use silk instead. In recent years the sterilization of catgut has become effective on the whole; it is stringently supervised, and rightly so. Nevertheless there is always a possibility of a dangerous infection arising from its use.

The fact that catgut is an animal material capable of absorption in the tissues of the body is in some respects a disadvantage. Catgut can produce an allergy, when its subsequent use results in a marked local reaction, rapid absorption, and disruption of the wound (Kraissl, Kesten, and Cimiotti, 1938). Furthermore, it can be absorbed only by provoking an inflammatory reaction, with leucocytic infiltration and exudation of serous fluid, accompanying the resolution of which is an extensive fibrosis. This reaction often causes a serous discharge from the wound which delays healing. Babcock (1935) reported oedematous wound-edges which separated and remained moist for several weeks following the use of subcuticular catgut sutures in thyroidectomy. This did not occur when silk was used. Dunphy and Botsford (1939) and Puestow (1940) reported identical findings. Jenkins and Dunham (1943) attributed part of the inflammatory reaction to the irritant hydrocarbons with which the catgut is treated during its preparation. That wounds sutured with catgut gain tensile strength more slowly than those repaired with silk was shown by the experiments of Howes (1933) and of Localio, Casale, and Hinton (1943). Confirmation is found in Whipple and Elliott's (1938) findings that the incidence of wound disruption was more than eight times greater after catgut had been used than after silk. Jenkins (1937) noted a marked degree of catgut digestion, and Fallis (1937) an inflammatory reaction with serous exudation in disrupted wounds after catgut suture. Parsons (1937) had a recurrence rate of 12.7% for hernias repaired with catgut and only 3.5% with silk, using the same technique.

In his famous paper on surgical technique Halsted (1913) remarked: "It should be borne in mind that during the greater part of the period of its disintegration the catgut suture is not only serving its purpose but is playing the role of necrotic tissue, of a culture medium." This dead animal tissue is indeed a favourable soil for bacterial growth, maintained as it is at body temperature in wounds, and it is not surprising to find that observers have noted that wounds in which catgut has been buried are peculiarly prone to infection. Meleney (1935), in a large series of clean cases, found that the incidence of infection in wounds sutured with catgut was three times as great as in those sutured with silk. Whipple (1940) extended the same series to several thousand cases, for which the figure was 2.5. In Shambaugh's (1937) series of hernias catgut repairs were infected twice as often as silk, while the incidence of minor complications, such as serous discharge, was eight times as great in the former as in the latter. Elkin (1940) found the incidence of infection after catgut to be 4.5 times as great as after silk. Meleney (1935) reported Vivier's findings that, of experimental wounds sutured aseptically with fine silk and catgut, the latter contained more bacteria throughout the healing period. Shambaugh and Dunphy (1937) found that experimental wounds sutured with silk tolerated bacterial contamination better than those in which catgut was used, and Cutler and Dunphy (1941) concluded that the degree of infection in infected wounds sutured with silk was, on the whole, less than in those repaired with catgut.

It is obvious, from this mass of evidence, that catgut is by no means the ideal suture material.

Silk, Linen, and Cotton

In the field of non-absorbable materials silk, cotton, and linen threads have been used with success in clean wounds. Halsted (1913) stated that the results with silk, properly used, were so perfect that he thought its use would become general. It has been the experience of many, however, that infection in a wound sutured with these materials often results in a discharging sinus which will not heal until the sutures and ligatures have been expelled—a process which may take several months. The reason for this severe drawback to their use probably lies in the fact that the threads are made up of many filaments, among which bacteria may multiply beyond the reach of the body's defences.

Nylon

Nylon is a new-comer to the field of filaments. Being a synthetic product it is sterile when manufactured, and it cannot harbour organisms in its interior. It is in common use as a substitute for silkworm-gut in skin sutures, but it has been little employed as a buried material. Nylon is obtainable as a solid, or monofilament, thread and as a woven or twisted multifilament thread. Nichols and Diack (1940) tested the latter in experimental wounds and found that it produced about the same cellular reaction as silk, both being much less irritant than catgut. Aries (1941) found that monofilament nylon produced still less reaction, and that when wounds were infected the inflammation and leucocytic reaction subsided more rapidly round nylon than round silk. Melick (1942) confirmed experimentally the minimal foreign-body reaction of nylon, and he used the multifilament material for the repair of 25 inguinal hernias with satisfactory results. Stonham (1942) used nylon for buried sutures in some operations, and concluded that it was superior to silk and silkworm-gut in clean wounds. Localio, Casale, and Hinton (1943) found that the tensile strength in wounds increased more rapidly when nylon was the suture material than when silk, cotton, catgut, or steel wire was used.

In a series of experimental wounds in the abdominal walls of rats, sutured with nylon and with catgut and examined from 2 days to 8 weeks after operation, I found that those sutured with catgut were always the more inflamed and more oedematous, were adherent to the overlying skin, and in 10% of them pus was present round the catgut. The wounds sutured with nylon healed smoothly and rapidly, with a minimum of inflammation and fibrosis.

In 300 operations I have used nylon for all buried sutures and ligatures, as well as for skin sutures, and have never had cause to regret it. The range of operations was very compre-

hensive, and the extremes of age were 12 hours (repair of exomphalos) and 91 years (cholecyst-gastrostomy). Even in the presence of infection (for example, 76 appendicectomies, in many of which free pus was present) there was no tendency for the sutures or ligatures to be extruded. Colostomies, too, have been closed without trouble. Wounds healed rapidly and soundly, and with a noteworthy freedom from complications. Sutures have been removed on the sixth post-operative day, as a rule, in abdominal cases, and it has been my experience that it is not safe to remove them so early when catgut has been buried in the wound, particularly if the superficial fascia has been sutured with it. On several occasions, when a second operation was necessary, the previous nylon sutures were found to have a minimum of surrounding fibrosis. The cases have been followed up for periods of from 1 to 9 months and no symptoms referable to the buried nylon have been elicited.

Technique

Several points of technique should be mentioned. Sterility is achieved by immersion in boiling water for 30 minutes. For nearly all purposes the fine (No. 3) monofilament nylon, prepared in 40-inch lengths, is used, the strong (No. 5) being reserved for the ligation of large vessels and where there is tension. Suturing is facilitated by tying the nylon to the eye of the needle with a half-knot. At first Halsted's principle of universal interrupted sutures was adhered to, but it was soon found that continuous sutures could be used with impunity.

It has been said that monofilament nylon is difficult to use because of its springy nature, its smooth surface which makes knots tend to slip, and the small diameter which makes it difficult to feel between the fingers. The technique of using it is easily acquired, however, and it soon becomes very pleasant material to handle. The smoothness with which it glides through the tissues is quite a revelation after catgut or silk. The so-called "nylon knot" is tedious to tie, and it slips easily; the one which I employ is made by tying two half-knots with one end—the long one—held taut (Fig. 1). The ligature is run up tight, and is locked by a third half-knot tied with the short end held taut (Fig. 2). This knot does not slip,

FIG. 1

FIG. 2

and I have used it in the ligation of large vessels, including the femoral artery. Long ends should not be left, and assistants are trained to cut them close to the knot. Tension sutures are not employed, for I am not convinced that they contribute materially to the strength of the wound, and they produce unsightly scars across it and delay healing.

It is not suggested that there is no place for catgut. I still employ it for the mucosal sutures in most bladder and stomach operations, because non-absorbable sutures may cause trouble in these sites. Nevertheless, for nearly all sutures and ligatures nylon has definitely established its superiority in my cases. An additional consideration is the fact that the cost of nylon for surgical work is only one-eighth that of catgut.

Summary

The presence of catgut in a wound leads to increased inflammation and induration, greater exudation of serum, delay in healing, and an increased incidence of wound infection and breakdown.

Silk, linen, and cotton threads are free from these disadvantages, but may cause great delay in healing if infection is present.

Nylon causes a minimum of tissue irritation, and its use as a buried suture material in 300 operations has shown its superiority to the materials in common use. Wounds healed rapidly and with no complications.

I wish to express my thanks to Prof. Burn, of the Pharmacology Laboratory, Oxford, for providing the facilities for the animal experiments.

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Medical Memoranda

Parotitis due to Unusual Foreign Body in Parotid Duct

References in the literature to foreign bodies in the salivary ducts are few. Mittermaier (1929) mentions "bristles, fish-bones, hair, grain and seeds, splinters of wood, etc."; Illingworth and Dick (1941) state that "on rare occasions a foreign body, such as a piece of straw, a fruit seed, or mycelia of actinomycetes, may form a nucleus for stone formation"; and Tramer (1938) reported a case in detail. The following account may therefore be worth recording.

CASE HISTORY

The patient was a girl aged 6 years who complained one evening of pain in the right side of the neck, which within a few hours had become swollen below the ear. On examination next day the right parotid gland was moderately enlarged and tender, and thin purulent fluid was seen escaping from the orifice of the right parotid duct. The mouth and throat were otherwise normal, and nothing could be felt on palpation of the duct; the temperature and pulse were 100.5° F. and 120 a minute respectively.

The following day the temperature was 98.4° F. and the pulse 100, but the local swelling and tenderness were more marked. After cleansing the mucosa round the duct orifice with spirit before taking a swab of the pus, slight pressure was made on the duct. Purulent fluid appeared from the opening, and was followed by what seemed to be a bristle, one portion (the last to leave the duct) of which was coated with pus. Chewing-gum was given to help drainage by stimulating the salivary flow, and a course of sulphapyridine was started. The fluid seen flowing from the duct next day was indistinguishable from normal saliva, and as it seemed unnecessary the sulphapyridine was stopped after a total of 6 g. had been given. Two days later the gland was no longer enlarged; the temperature was normal, and, except for slight local tenderness, which disappeared after a further five days, recovery was complete.

Dr. J. B. Penfold examined the pus and the foreign body and reported as follows: "Film: Many pus cells, few epithelial cells, and numerous mixed organisms. Culture: Mixed growth of normal mouth organisms. Foreign body: Husk of seed 6 mm. by 1.5 mm. diameter, with tail 4 mm. long." He submitted the husk to Dr. E. J. Salisbury, Director of the Royal Botanic Gardens, who identified it as "a floret of one of the cultivated forms of the common rye grass, *Lolium perenne*. This form has a fairly long finely barbed awn, which was no doubt responsible for setting up irritation."

Foreign bodies are more common in the submandibular duct on account of its larger size and the position of its orifice on the floor of the mouth (Mittermaier, 1929). Both the site and the nature of the foreign body are unusual in this case. Tramer (1938) describes the case of a child 6 years old who developed parotitis lasting, with fluctuations in its severity, for well over one month: on the forty-first day an incision was made into the parotid, from which pus (giving a mixed growth of organisms) discharged for 31 days. A foreign body was seen in the wound on the thirty-first day and removed; at the end of a further six days the wound was healed completely. The foreign body proved to be a fragment of grass seed, consisting of a husk and a piece of stalk, but was too incomplete for exact identification.