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Suture materials

CLINICAL REVIEW

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Suture materials are of crucial importance for most surgical procedures, and knowledge about these is useful for all doctors. This clinical review article gives an introduction to the most common suture materials and their properties. Lastly, recent trends in suture technology are presented.

Suture materials have been used in surgical procedures for thousands of years (1). Both the materials and their usage have changed over time (2). Previously, needles were made of bone, and sutures were made of silk, tendon and hair (3). Today, we largely use metal needles and synthetic suture materials. However, the objective remains the same: to suture or ligate tissue.

Despite the wide range of available materials today (4), the perfect suture material does not exist, i.e. a suture material that is absorbable, easy to handle, can be used on all types of tissue, has good mechanical strength, has an acceptable price, provides good knot security, is non-carcinogenic and prevents infection, inflammation (including granuloma formation) and allergic reaction. Even though such a perfect suture material does not exist, knowledge about the properties of suture materials can make it easier to select one that is suitable. We would like to use this clinical review to give an introduction to the various properties of commonly used suture materials. The article is based on a discretionary literature selection and the authors' own clinical experience. Basic surgical principles and instrument handling have been described previously and are not included in this review (5).

Absorbability

Key properties of suture materials are absorbability, thickness and the number of filaments. Suture materials are classified into four main groups based on whether they are absorbable or non-absorbable, and whether they are monofilament or multifilament.

Sutures are defined as absorbable if they lose 50 % of their strength within 60 days (4). Non-absorbable sutures retain at least 50 % of their strength for more than 60 days (4). Synthetic sutures break down by hydrolysis, and sutures produced from natural materials (for example silk or animal gut) undergo proteolytic degradation (6). Non-absorbable sutures usually need to be removed when used in the skin. The time of removal depends on the wound's anatomical location, anticipated healing time and how well the subcutaneous closure of the defect has been performed. The general recommendation is to remove sutures after five days on the face, after seven days in the upper limbs, anterior trunk and scalp, after ten days in the lower limbs, and after 10–14 days if the sutures are on the back, palms of the hands, fingers or soles of the feet (7).

Number of filaments

Monofilament sutures consist of one filament (6). Multifilament sutures consist of several filaments that are either twisted or braided together (6). Multifilament sutures are generally stronger with better knot security than monofilament sutures made of the same material, but are associated with a higher risk of infection because they provide better physical conditions for colonisation by micro-organisms (6). Monofilament sutures generate less tissue friction (pass smoothly through tissue) compared to multifilament sutures, but have a tendency to spring back to the way they were packaged (memory), which can make handling during suturing more difficult (6). In our experience, this can be improved by stretching the thread after removing it from the packaging before use. Some monofilament suture material can have small barbs for anchoring in tissue, eliminating the need to secure the suture with knots (8). These sutures are particularly useful in endoscopic procedures and long wound lines (9). Another advantage of this suture material is better distribution of tension along the suture (9). The aforementioned types of suture materials are illustrated in Figure 1.

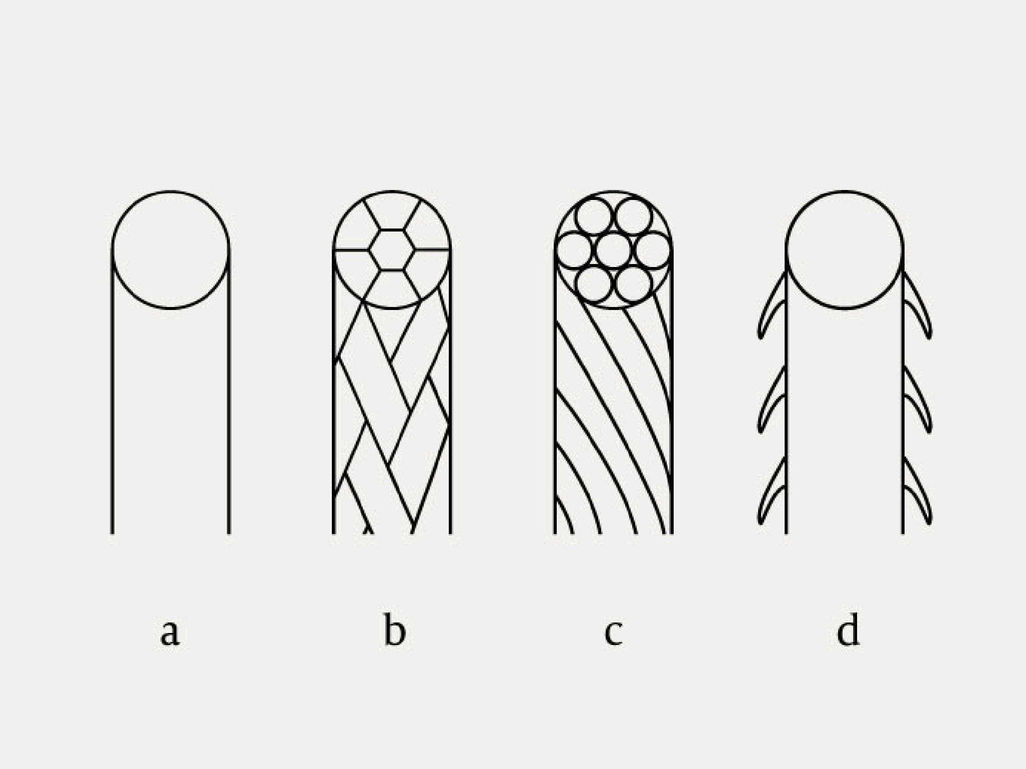

Figure 1 Illustration of the differences between a monofilament suture (a), braided multifilament suture (b), twisted multifilament suture (c) and knotless barbed monofilament suture (d).

Other properties of suture materials

In addition to the properties described above, other factors can also influence the selection of suture material, such as elasticity, strength and how well the thread holds the surgical knot (knot security) (4). The friction generated when the suture material is pulled through tissue also affects how much injury is caused to surrounding tissue. Tissue reactivity can also vary between the different materials (4). The suture colour can increase its visibility and so facilitate the surgeon's work. The different properties of suture materials are summarised in Box 1 (4, 9, 10).

Box 1 Properties of suture materials.

Friction

How much friction is generated when the thread is pulled through the tissue? Higher friction is associated with greater local tissue damage. Monofilament sutures generate less tissue friction than multifilament sutures (9).

Strength

Suture strength is defined by the energy required to rupture the suture (10). Strength is generally proportional to suture diameter.

Knot security

Surgical knot security depends not only on whether the knot has been correctly tied, but also on the suture material (4). Multifilament sutures typically allow for better knot security than monofilament sutures (4).

Elasticity

The ability of a material to retain its length following stretching is of clinical relevance because suture materials are subject to tensile stress due to movement and inflammation of tissue (4).

Memory

Memory is the tendency of the suture material to spring back to its packaged shape. This can affect its ease of handling.

Tissue reactivity

The suture material's ability to elicit local tissue irritation (9).

Some of these properties are also stated on the packaging. The thickness of the suture is defined in the United States Pharmacopoeia (11) and is specified from 12-0 (0.001 mm in diameter) to 10 (1.2 mm in diameter). Thinner sutures are usually used on the face, for example 6-0 and 5-0, and 4-0 or 3-0 on the back. Thicker sutures are chosen for skin areas subject to tensile stress, for example the front of the knee.

Needles

Suture materials come attached to the needles, which also have different properties. The needle can be straight, J-shaped or C-shaped. The curved needles are specified by what portion of a circle they make up, for example 1/2, 1/4, 3/8, 5/8 etc. The needle tip can be conical, triangular or blunt (Figure 2). Routine surgical practice indicates that conical tips are suitable for use in soft tissue, triangular tips for skin, and blunt tips for internal organs, for example the spleen. Furthermore, the needle shape has practical implications, for example conical needles rotate easily in the needle holder, which can lead to unnecessary trauma to tissue and also be disruptive for the surgeon.

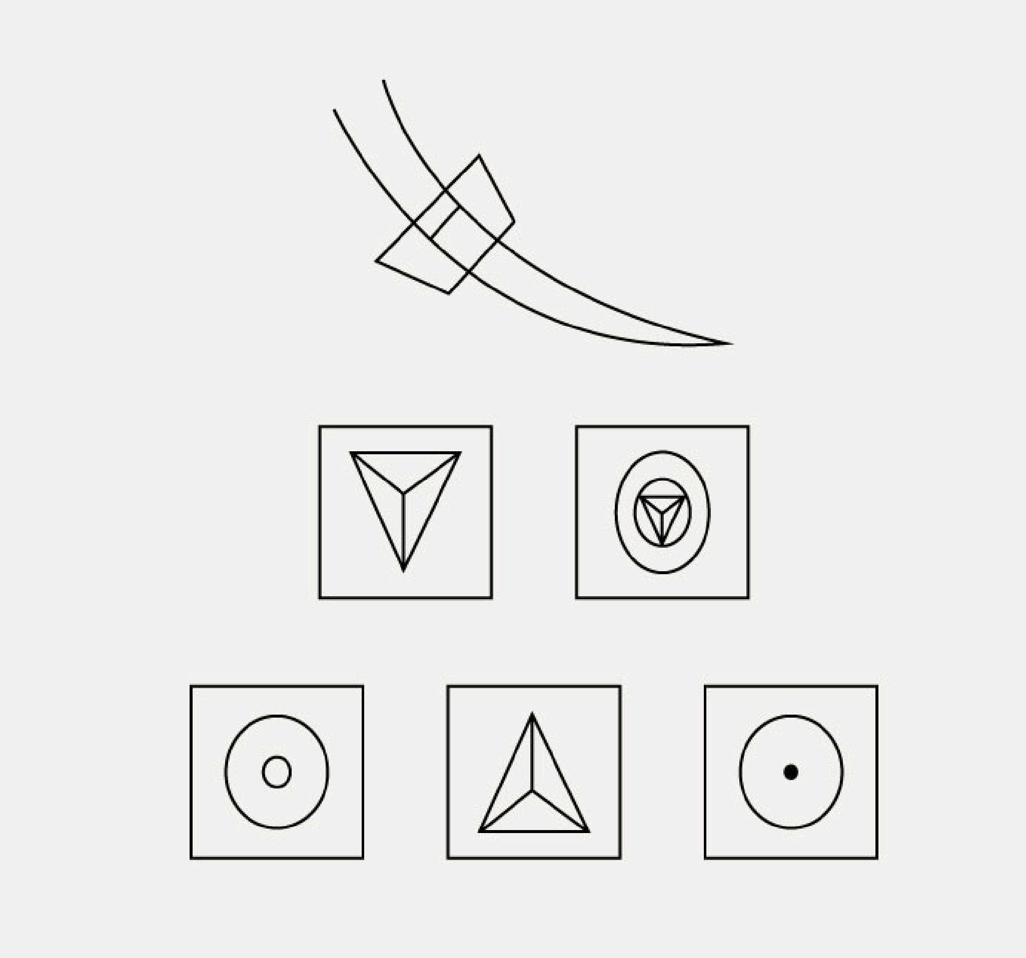

Figure 2 Suture materials come with various shapes of needle tips.

Alternatives to sutures

The most common alternatives to mechanical closure of tissue defects with sutures are healing by secondary intention, skin glue, surgical strips and staples.

In healing by secondary intention, the wound edges are not physically approximated but are left to heal by themselves. Granulation tissue covers the wound bed, with epithelisation taking place from the edges (approx. 1 mm/day). Some wound contraction occurs, i.e. myofibroblasts pull the wound edges towards each other so that the wound becomes smaller than the original defect (10). This healing process requires appropriate conservative wound management until the wound has healed.

Skin glue (cyanoacrylate) and surgical strips can be used alone or in addition to sutures (12, 13). Surgical strips are often used to support the wound after suturing, but can be sufficient on their own for superficial wounds. Staples are metal clips (or polymer clips) which are applied with an appropriate device and allow rapid wound closure. They have good strength, cause little tissue irritation and are associated with a low risk of infection (14).

Latest suture technology

Developments in suture technology in the last few decades have mainly focused on adding new properties to existing suture materials to combat infection and promote the healing process (15, 16). Suture materials that have an antibacterial or bactericidal action, such as triclosan-impregnated sutures, already exist on the market and have been demonstrated to be effective in some meta-analyses (17, 18), while other authors have concluded that their effect is uncertain (19).

Sutures seeded with mesenchymal stem cells, which are called biological sutures, can be beneficial in the wound healing process by reducing fibrosis and inflammation (20). Work is also in progress to develop smart sutures which have a built-in self-tightening and expanding function to enable optimal tissue approximation (21). It is hoped that further research and development can improve existing suture technology.

Conclusion

Knowledge about the properties of various suture materials can be important to achieve the best possible result in a surgical procedure. Although the main objective of the various suture materials has remained unchanged for many years, developments in suture technology in recent years may help to improve surgical treatment in the future.

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