

Suture Glossary



A B C

Sutures

Introduction

Suturing can be variously defined as follows:

Suturing is an integral part of surgery technique in all medical specialities.

Suturing consists of ensuring good adaptation of body tissues for proper wound healing.

Suturing is a skill that requires good technique and the right material.

B. Braun Surgical, a key player in surgery with its Aesculap division, offers customised devices and services for operating theatres.

Renowned for its know-how and expertise, B. Braun Medical participates in the development of surgical techniques by taking into account practitioners' needs and offering a continuous training programme.

B. Braun Surgical has been making sutures for over 100 years and has contributed to advancement in this field by providing users with state-of-the-art material.

Its European excellence centre in Barcelona is in charge of the R&D, production and distribution of these products.

B. Braun Surgical's wide range of products caters to all the uses, needs and requirements of all the surgical disciplines and also to surgeons' preferences.

This brochure, which is presented in the form of an alphabetical glossary, provides useful information to help you choose a suture material and discover what we at B. Braun have to offer in terms of sutures and the very latest innovations.

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Absorbable

Absorbable sutures were introduced some forty years ago, in the seventies.

Absorbable sutures are available in monofilament or braided (multifilament) form. The absorbable sutures used nowadays are mainly of synthetic origin.

Their Absorption time varies from short-term (approx. 50 days) through mid-term (60 to 90 days) and long-term (180 to 210 days) to extra-long-term (390 days).

Examples of use according to resorption profile

Absorbable sutures	Examples of use
Short-term	Fast-healing tissues (skin, mucosa), episiotomy.
Mid-term	Soft tissue approximation: general surgery, orthopaedics, urology, ophthalmology, gynaecology, maxillofacial, plastic, neurosurgery.
Long-term	Vascular surgery, abdominal wall closure, orthopaedics.
Extra-long-term	Abdominal wall closure, difficult healing.

B. Braun offers a large choice of absorbable sutures (monofilament and braided).

Improvements have been made within the range of synthetic monofilament sutures with regard to increased physiology and tolerance.

For abdominal wall closure, B. Braun has created Monomax[®], a special, extra-long-term absorbable suture thread. The special requisites involved in abdominal wall healing were taken into account when developing this innovative thread.

In cases where removal of the stitches may be painful or difficult, or when only short-term support is required, fast-absorption sutures such as Monosyn[®] Quick or Safil[®] Quick are indicated.²

Non-Absorbable

Historically, non-absorbable sutures have played an important role in the development of surgical procedures.

The severity of local reactions generated by some of them, has hastened the development of absorbable sutures.¹³

They are, nevertheless, still used in some cases, particularly in cardiovascular surgery. As they remain in the body permanently, non-absorbable sutures offer long-term support.

They are made from physico-chemically stable materials.

If used in superficial tissue these sutures have to be removed. Non-absorbable sutures can be of natural, metal or synthetic origin.

Armed

A suture is a device that combines a thread attached to one or more needles, and there are variations on this theme depending on the configuration of the combination.

The classic combination consists of a thread and a single needle; this is called simply a single-armed suture.



A double-armed suture consists of a thread with a needle at each end; this type is used for special indications (e.g. vascular anastomosis).



Bending strength

One of the essential characteristics of surgical needles is bending strength.

The needle should not become twisted when passing through the tissues. If it does, this could damage the wound and the surrounding tissues.

Control of the needle's trajectory when it is passing through the body tissues depends on the capacity of the needle to conserve its original characteristics (see ductility).

Body

Along with the point (see term), the body is the other part of a needle. It can have different shapes (triangular, round, etc.) each of which serves for a particular use.

The body of the needle is the part that is held in the needle-holder² according to the 1/3 – 2/3 rule for a good, stable grip.⁷

There are a large number of curvature/body/point combinations to cover all tissue and surgery requirements.

Each type of needle body has a corresponding letter and symbol.

S = triangular



R = round



L = lancet



Triangular needles are normally used for piercing hard tissues such as the skin, round needles are most often used for suturing soft tissues, and lancet (or spatula) needles are used in ophthalmology.

Braided

Sutures can be made from a single filament (monofilament, see term) or from several filaments (multifilament) which are braided or twisted.

Compared to monofilament sutures, braided ones have a greater risk of promoting infection due to capillarity, as the interstices between the fibres can facilitate the spread of pathogens along the fibre and thus direct to the placement site.

Braided sutures have a relatively rough surface which causes a «saw effect» when the thread passes through the tissues.¹¹

All B. Braun Braided sutures are coated to reduce this effect.

Properties of braided sutures and monofilament sutures (according to 16)

	Braided	Monofilament
Strength	+	+
Tolerance	+/-	+
Capillarity	+	-
Glide	+/-	+
Flexibility	+	- (memory)
Élasticity	-	-
Knot fixation	+	-

Nevertheless, braided sutures are widely used in practice.

In the B. Braun range, Safil®, Safil® Quick and Premicron® are very widely used braided sutures.

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Capillarity

The capillarity of a suture describes the ease with which fluids can be wicked along the suture thread. This property is inherent to multifilament (see term) sutures as a result of the loose interstices of their fibres.³

Capillarity is also related to the suture's capacity for carrying and transmitting bacteria, and plays an important role in the spread of infection.²

This risk of contamination is worth taking into account as suturing is performed in surgical scenarios where there is a high risk of infection.

This disadvantage is real, since the idea of adding an antibacterial agent to the suture material has been considered, although to date there is insufficient evidence to warrant recommending the routine use of this type of thread.⁴

That is why, when choosing a suture thread, low capillarity is of paramount importance.

Only monofilament sutures have no capillary action.

Coating

Coating is a surface treatment that can be used for the needle as well as for braided sutures.

It consists of coating these elements with a material (e.g. silicone, glyconate, etc.) for the purpose of modifying their surface.

With the needles the aim is to improve precision and penetration (e.g. Easyslide needles).

With the thread the aim is to optimise its passage through the tissues and at the same time make it less traumatic; in fact, without a coating, braided sutures (see term) have a rough surface that can have a saw effect on the tissues.

Coating improves glide (see term) and reduces irritation and capillarity (see term) while still maintaining good knot security (see term).

However, this surface coating is thin and friction during manipulation can rub off the protective coating.⁵

For atraumatic passage through tissues it is better to choose a monofilament suture, which, by its very structure, ensures excellent results in this aspect.

Colours

The suture threads, whether natural or synthetic, absorbable or non-absorbable, monofilament or braided (see relevant terms), are available dyed (violet, green, blue, black, etc.) or undyed.

The colour acts as an indicator, which can be particularly useful in certain cases (e.g. vascular surgery) for distinguishing the different anatomical structures. The colour enhances their visibility, even if they are steeped in blood, making stitch removal easier.²

The colours used in production are mainly those certified by the FDA (Food and Drug Administration) under "D&C" («Drug & Cosmetics») colours.

In contrast, undyed threads have the advantage of being less visible and more discreet, and thus better for use in eye surgery or skin suturing, for example.

Dyed sutures are rarely used on the outer surface of the body, to avoid a tattoo effect.

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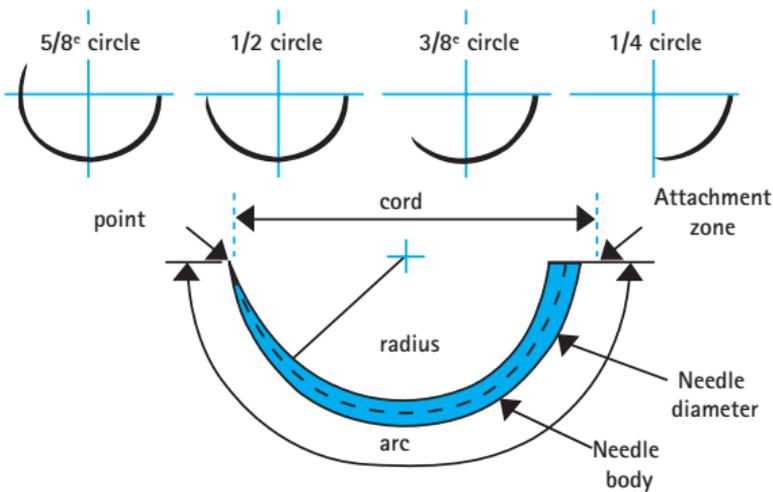
Curvature

Curvature is one of the characteristics of the needles (see term).

There are straight needles and curved needles.

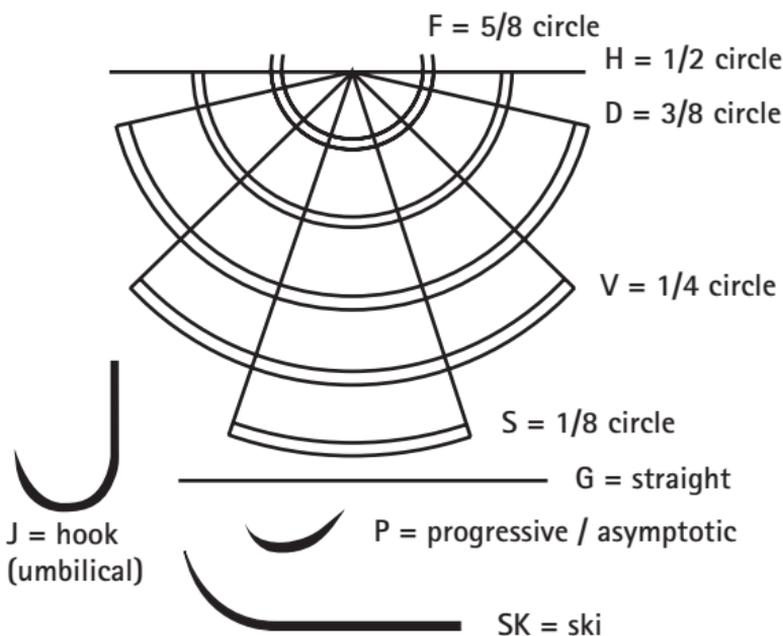
Straight needles can be used without a needle-holder and are more often used for superficial planes.

The curvature is expressed as eighths of a full circle, for example 5/8 or 3/8, with 4/8 corresponding to a semi-circle (1/2) and 2/8 to a quarter circle (1/4).



In practice, the deeper the layer, the more curved the needle should be.

Certain curvatures have special shapes: hook, progressive/asymptotic, or even ski-shaped.



Examples of use according to the curvature²

Curvatures	Examples of use
1/4 circle	microsurgery
3/8 circle	easily-accessible flat structures (e.g. the skin)
1/2 circle	deep layers and narrow spaces.
5/8 circle	nasal cavity
1/2 curve or ski	endoscopy procedures
Straight	easily accessible tissue that can be stitched directly by hand

B.Braun has decided to simplify needle curvature identification by means of letters.

S = 1/8 circle
V = 1/4 circle
D = 3/8 circle
H = 1/2 circle
F = 5/8 circle

P = progressive / asymptotic
J = hook (umbilical)
G = straight
SK = ski

Decimal

The European Pharmacopoeia (EP) decimal classification is used as the standard for defining the thread gauge (from 0.1 to 10).

For example, a decimal 2 corresponds to a thread of 0.20-0.29mm in diameter.

However, the most widely used system of classification is that of the United States Pharmacopoeia (USP) in which the gauge varies from 12/0 to 4, going from thinnest to thickest and according to the origin (see term) of the suture and its resorption (see term) profile.

There is an equivalence between these two standards.

USP	Decimal	Thread gauge in mm
12-0	0.01	0.001-0.009
11-0	0.1	0.010-0.019
10-0	0.2	0.020-0.029
9-0	0.3	0.030-0.039
8-0	0.4	0.040-0.049
7-0	0.5	0.050-0.069
6-0	0.7	0.070-0.099
5-0	1	0.10-0.149
4-0	1.5	0.15-0.199
3-0	2	0.20-0.249
	2.5	0.25-0.299
2-0	3	0.30-0.349
0	3.5	0.35-0.399
1	4	0.40-0.499
2	5	0.50-0.599
3+4	6	0.60-0.699
5	7	0.70-0.799
6	8	0.80-0.899
7	9	0.90-0.999
8	10	1.00-1.099
9	11	1.10-1.199
10	12	1.20-1.299

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Diameter

The diameter of a suture is one of the criteria involved in its selection, and applies both to the needle and the thread.

The diameter, or gauge, is expressed differently depending on the reference pharmacopoeia (see term) (EP or USP).

There is a broad spectrum of diameters available.

The thread gauge used in ophtalmic - or plastic surgery cannot be used for sternal closure surgery, for example.

That is why the B. Braun range of sutures offers thread gauges from USP 11/0 to USP 4, to cover all surgical disciplines.

Ductility

This term designates the capacity of a material to be deformed without breaking.

Such a material is said to be ductile.

Ductile is the opposite of fragile or brittle, which defines a lack of bending strength and the resultant potential breakage of a material.

It is a property that is highly sought after in surgical needles.

B. Braun surgical needles are made from a 300 stainless steel alloy for ductility and bending strength, allowing optimal security when suturing.

Elasticity

Elasticity is the capacity of a material to regain its initial length after stretching.

A suture's elasticity properties depend on:

- the material from which it is made
- the suture diameter
- the suture structure
- how the suture is made

A suture with poor elasticity will break more easily at the knot.

Elasticity enables the suture to stretch with oedematous tissue but also to regain its original length and shape on remission of the oedema.

Good elasticity has obvious clinical benefits: a highly elastic suture is less likely to cut into oedematous tissue and will keep the wound edges approximated throughout the healing process.²

Monomax[®] is a monofilament known for its elasticity and is, in fact, the suture of choice for abdominal wall closure because it adapts well to the often considerable variations in intra-abdominal pressure.

Elongation

See plasticity.

Flexibility (Pliability)

Flexibility is highly appreciated by surgeons as it makes suturing easier and improves precision. Knot-tying is easier and less traumatic with a flexible suture thread.

Braided threads are more flexible and, in general, have less memory than monofilament sutures, making them easier to handle.

Safil[®], our suture made from polyglycolic acid, is known for its considerable flexibility.⁸

Monosyn[®], our monofilament suture made of glyconate have a flexibility comparable to a braided suture.

Glide

Suture glide is the capacity of the suture thread to pass smoothly through the tissue during placement, and is a function of its coefficient of friction.

The lower the coefficient of friction, the less the thread gets stuck and injures the tissues. Conversely, threads with a high coefficient of friction can have a saw effect as they pass through the tissues. Ideally, therefore, surgical thread should have a low coefficient of friction. However, knots tied in low-friction-coefficient threads tend to slip and come undone, which is a major disadvantage where suturing and haemostasis ligatures are concerned.

Because of their very texture, monofilament threads usually glide very well, whereas braided threads with their uneven surface have a higher coefficient of friction. To minimise tissue trauma caused by braided threads, they are usually «coated».

Absorbable monofilament sutures have good glide characteristics and cause minimal tissue damage because of the smooth structure of the thread and its gradual bio-absorption. The glyconate in Monosyn® combines good glide with good knot security.

Glyconate

Glyconate is a copolymer made of 72% glycolide, 14% trimethylene carbonate and 14% Σ -caprolactone. This copolymer is degraded by hydrolysis. As it is the material used in Monosyn® and Monosyn® Quick, it gives these monofilament sutures flexibility, elasticity and strength, properties that are highly appreciated in plastic surgery.

Healing

Tissue healing (of a surgical or traumatic wound) is a natural phenomenon involving processes of repair and regeneration.

The quality of the healing and the length of time involved depend on numerous factors, both local and general (aetiology, site, type of tissue, patient's general state of health, infection, etc.).

The role of a suture is to assist healing by supporting the tissues throughout the critical stage.

That is why it is important to know how long the different body tissues take to heal. This crucial information should be contrasted with the suture absorption time so that, by matching the two, the appropriate suture can be chosen, thus ensuring optimal conditions for successful healing.

TISSUE	HEALING TIME
Skin	1 to 2 weeks.
Subcutaneous tissue	2 weeks.
Peritoneum	4 to 10 days.
Abdominal fascia	5 to 6 weeks. Regains 75% of initial strength in 9 months.
Digestive tract	2 to 3 weeks.
Uterus	8 days.
Vagina / perineum	8 to 10 days.
Bladder.	5 days. Regains 75 to 90% of initial strength in 2 weeks.
Ureter	7 days.
Joint capsule	5 to 6 weeks.
Ligaments/tendons	6 weeks. Regains 50 to 70% of initial strength after 1 year.

The B. Braun range of sutures offers a variety of resorption profiles, thus enabling us to provide made-to-measure, indication-specific sutures.

In addition, we know that after incision and suturing the length of time necessary for tissues to regain their initial tensile strength varies a great deal depending on the type of tissue involved.

The tensile strength of healing tissue is always weaker than the initial strength of the injured tissue.

This parameter too is a determining factor when it comes to choosing a suture material.

For example, fascia takes several months to heal. In fact, this poorly vascularised tissue, which is subject to variations in pressure, heals slowly, yet secure closure of the abdominal cavity⁵ depends precisely on the fascia, although the latter will only regain 70% of its initial strength after laparotomy.⁶

This particular situation requests a customised suture material.

B. Braun offers surgeons an innovative thread for abdominal wall closure: Monomax[®]. This thread has unique properties that meet the specific requirements of laparotomy surgery.

Hydrolysis

Hydrolysis is the mechanism of resorption (see term) of absorbable synthetic sutures, and leads to the gradual disappearance of the thread. It is a chemical reaction in which a water molecule is used to break a covalent bond by dissociating into OH⁻ and H⁺. This breakdown is more regular and more predictable than enzymatic reactions (as in the case of catgut), which partly explains the increase in use of synthetic sutures.

Knot security

Knot fixation is a determining factor with surgical thread as it guarantees the security of the suture. Knot fixation capacity depends on certain parameters: the thread stiffness, coefficient of friction, elasticity and plasticity. In addition to these parameters, knot fixation differs according to whether the thread is monofilament or braided. Monofilament sutures are usually stiffer than braided ones, especially in the larger gauges. Their perfectly smooth surface also means they have a lower coefficient of friction and better glide. These two characteristics, stiffness and glide, are the reason why, in general, knot fixation is weaker with monofilament sutures than with braided ones. This concept, however, needs qualifying, especially in view of the plasticity of certain monofilament sutures.

Indeed, certain monofilament sutures such as Monosyn[®] have the property of bending when the knot is being tied, which increases its fixation.

For greater security, a knot should have at least 3 loops with 3 mm-long ends.

Soft surfaces reduce knot security and this must be offset by extra loops.²

Knots

The knot or stitch is what holds the suture in place. It consists of several loops.

Each type of suture and each thread gauge have their own means of knot-tying, which should be taken into account for the purpose of ensuring greater knot security.



It is commonly accepted that 4 knots are necessary for securing a braided suture and 6 to 8 knots are required in the case of a monofilament suture.

Length

Suture threads are available in different lengths for use in different-sized incisions. The most frequently used lengths are: 45 cm, 70 cm and 90 cm.

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Ligature

Ligatures, with their characteristic ribbon shape and form of application, serve for identifying or differentiating anatomical structures and for clamping blood vessels or ducts.

They are made from synthetic materials (polyester, polyglycolic acid, etc.) or natural materials (silk) and vary in length.

B. Braun offers a full range of ligatures.

Loop

The loop consists of a suture thread in the shape of a flexible ring attached to a needle; this device, which is stronger than the classic device, is used for particular suture techniques (e.g. abdominal wall closure).



Memory

Thread memory is the capacity of the suture thread to return to its former, packaged shape. Thread memory has little effect on the quality of the suture, however it does affect manageability, as threads with memory tend to form knots spontaneously during use.

Sutures with a strong memory effect are not flexible and are difficult to work with, sometimes requiring extra knots to be tied (e.g. nylon).²

To reduce the memory effect, B. Braun has developed an innovative packaging: the Race Pack.

In the Race Pack the suture is positioned in such a way that when it is removed from the package it loses its initial shape.

Premilene® polypropylene monofilament, used mainly in vascular surgery, is packaged in the Race Pack.



Monofilament

The suture material may be made of a single filament (monofilament) or several filaments (multifilament or braided).²

Monofilament sutures are an attractive option because of their strength, low tissue drag and low propensity to spread infection.

It is accepted that the incidence of infection with a monofilament suture is significantly lower than with a braided one.²

Monofilament sutures are a surgical advancement because their structure facilitates passage through the tissues and prevents capillarity.

The table below summarises the advantages of monofilament sutures:

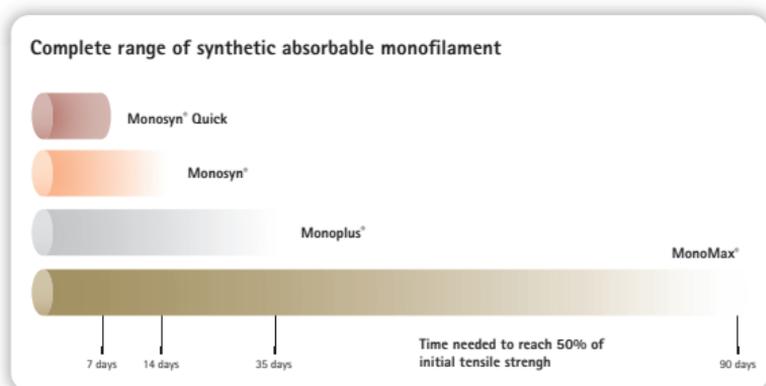
Monofilament sutures: characteristics, advantages and benefits

Characteristics	Advantages	Benefits
Smooth, even surface	Excellent passage through the tissue	Minimal tissue trauma
Lack of capillarity	No wick effect, Prevents spread of infection, Applicable sutures	Less risk of post-operative infection, Better healing, Time-saving, Even distribution of strain on the incision,
Elasticity	Better knot security	Suture security

B. Braun Medical offers a large selection of monofilament sutures to cover practitioners' requirements.

This range of sutures is the one in which innovation is making rapid advances.

B. Braun monofilament sutures:



B. Braun offers surgeons the most complete range of monofilament sutures on the market in terms of resorption, with Monosyn[®] Quick short-term absorbable, Monosyn[®] mid-term absorbable, Monoplus[®] long-term absorbable and Monomax[®] extra-long-term absorbable (unique on the market).

Natural

The very first sutures were made from natural materials – collagen (catgut), silk and linen – and were eventually replaced by synthetic sutures.

Needle

A suture usually comprises a thread and a single needle (see «armed»), which is the most conventional form.

The needle is an essential component as it is the first part to pass through the tissues and conditions the success of the suturing, to a certain extent.

The needle consists of 3 parts: point, body and curvature (see terms). Each of these features has to be carefully identified for the purpose of making the best choice, that is, for choosing the most appropriate needle for the patient and the type of surgery involved²

B. Braun Medical offers a wide range of needles made from 300 stainless steel (see term) alloy: more than 150 types that are indication-specific and also tailor-made to surgeons' preferences.

The main characteristics of the needles are given on the B. Braun suture packaging (see term) along with a full-size illustration of the needle, thus making the surgeon's choice easier.

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Origin

Suture threads may be of natural or synthetic origin.

Natural threads (collagen, silk and linen) were the first to appear on the market but they have gradually been replaced by synthetic threads made from polymers.

However, natural sutures are still used in certain cases (silk in eye surgery, for example) despite their disadvantages (strong capillary action, problems with tolerance, tissue reaction).

Non-absorbable synthetic suture thread appeared in the nineteen fifties, followed by absorbable synthetic thread which came onto the market in the seventies.

The majority (80%) of sutures used nowadays are of synthetic origin.

P4HB

B. Braun Medical is now marketing a new thread made from poly-4-hydroxybutyrate (P4HB).

This new material is an absorbable polyester that shows interesting properties for medical use⁹, which have been utilised in the development of an innovative suture thread, Monomax[®], for abdominal wall closure.

Packaging

B. Braun sutures are packaged in individual, Direct Dispense Pack (DDP); packed in boxes of 12, 24 or 36 units.

The packaging offers advantages in terms of practicality and information, for optimal use of B. Braun sutures in the operating theatre.

The main characteristics of the suture material (needle and thread) are given on the packaging labels (box and individual peel pack) to simplify the surgeon's choice, reduce errors and ensure requirements are met.

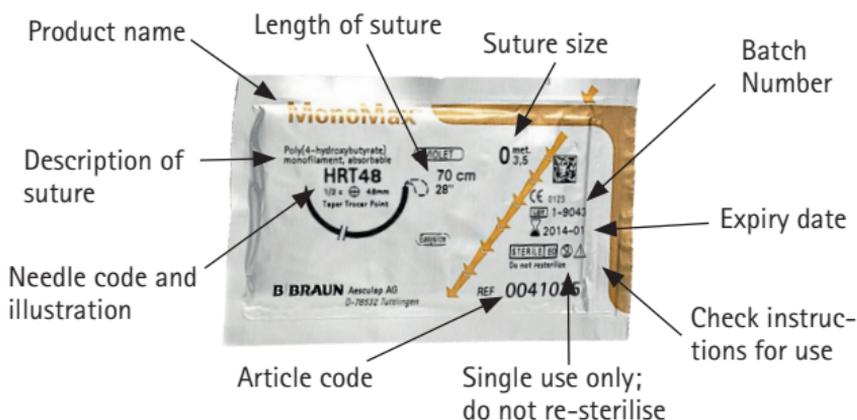
The box: ergonomic and lightweight, stackable and easy to open.

A label on the front gives all the essential information.

The peel-pack sachet: the sachet label shows the trade name and all the suture characteristics (needle and thread).

A full-size picture of the needle is shown.

B. Braun packaging



Pharmacopoeia

The European Pharmacopoeia (EP) and the United States Pharmacopoeia (USP) are the standard-setting authorities for suture material.

They define a certain number of criteria regarding suture gauge and also properties such as knot breaking strength, linear pull during the critical healing stage, and absorption time.

The European Pharmacopoeia uses the metric system, expressed in decimals (from 0.1 to 10), while the USP system is similar to that used for classifying catheter gauges.

Unlike the USP, the EP makes no distinction between natural and synthetic absorbable sutures.¹⁰

The USP standard is the most widely used.

In this system, zero (0) corresponds to the average basic size of a suture.

The smaller the gauge of a suture, the more zeros are used in sizing the thread; for example, a 6-0 suture is smaller than a 4-0 suture.¹

The more zeros there are, the weaker the thread.¹¹

There is an equivalence table for these two standards (see Decimal)

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Physical structure

Sutures can be made from a single filament (monofilament) or several filaments. Monofilament sutures have interesting qualities such as strength, low tissue drag and a low propensity to harbour bacteria.

The incidence of infection is significantly lower with monofilament sutures than with braided ones. However, monofilament sutures are not as manageable as braided ones.

Multifilament sutures (braided or twisted) are more manageable but it has been shown that they promote infection and tissue reaction. Increased tissue infection is the result of capillary penetration of bacteria and other foreign matter.

A braided suture can harbour bacteria in the interstices between its fibers, which keep the bacteria safe from phagocytosis.²

In addition, as they are generally larger in diameter than monofilament sutures, they make bigger holes in the tissues or prostheses.¹⁵

Plasticity

Plasticity is defined as the capacity of a suture to retain its length and strength after stretching. It means the suture can accommodate the stretch of oedematous tissue without regaining its original shape on remission of the oedema.

Therefore, sutures with high plasticity can become too loose when the oedema resolves, thus preventing correct approximation of wound edges.²

Point

The point, along with the body (see term), is one of the parts of a surgical needle.

It can be of different shapes (round, triangular, diamond, blunt, etc.) and each of these shapes has a certain impact on the tissues it passes through, making it indication- and tissue-specific.

Examples of use according to the type of point

Points	Characteristics	Examples of use
Round	non-sharp	visceral surgery
Triangular	penetrating	skin
Diamond	sharp on 4 sides	calcified and sclerous tissue
Blunt	atraumatic	parenchymal tissue

Round point: penetrates the tissues by separating rather than cutting the fibres. Does not tear soft, fragile tissues; its power of penetration is limited in dense tissue such as the skin. Used mainly in vascular, digestive and urinary surgery and for all friable tissues.

Triangular point: easily penetrates dense tissue (skin, aponeurosis) by cutting the fibres; type of needle used for the skin and ligaments or tendons.

Diamond point: a strong cutting tip honed on 4 sides, followed by a round, atraumatic body, ensures easy penetration through tissue with minimal trauma.

Blunt point: allows penetration through friable tissues or to reduce damages in surrounding tissues.

Spatula and lancet point: sharp but flat points, for use in microsurgery and ophthalmology.

Microtip triangular point: precision point with specific, fine-tip geometry and with the apex of the cutting edge on the outside of the curve. Ideal for plastic surgery.

Each type of point is designated by a letter and symbol which are clearly shown on the packaging for the purpose of immediate identification

Needle curvature	Body type	Point type	Length (mm)	Gauge
S 1/8 circle	R Round body	T Diamond	Distance in millimetres measured from the point end of the needle to the attachment end, following the body of the needle	f thin bodied needle
V 1/4 circle	S Sharp	N Blunt		s Strong needle
D 3/8 circle	L Spatula	S Tapercut		ss very strong needle
H 1/2 circle		C Round Microtip		v Break-off needle
F 5/8 circle		MP Triangular Microtip		b black needle
G Straight		Cm Taperstar		
P Progressive		m micro needle		
J Hook		SK Ski		

Example:

H	R	T	26	
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HRT 26 → 1/2 circle round body, diamond point, 26 mm.

Polyester

Polyester is a polymer which contains the ester functional group in its main chain. Premicon® is a non-absorbable, braided polyester suture, suitable for a number of uses, from anchoring wound drainage systems to anchoring cardiac valves.

Polyglycolic acid

The first synthetic absorbable sutures to come onto the market (in 1970) were made from polyglycolic acid.¹

Polyglycolic acid, commonly known as PGA, is a synthetic biomaterial composed of glycolide polymers.

This material is reabsorbed by hydrolysis in a predictable manner. Its tissue support is excellent and it causes minimal tissue reaction.

PGA sutures rapidly became popular as a result of their better tensile strength and good knot security.¹

In the B. Braun range the Safil® and Safil® Quick braided (see term) sutures are made from PGA and offer the well-known advantages of this class of sutures.

Safil® and Safil® Quick have different absorption times, making them suitable for a number of surgical indications.

These threads are recommended for approximating wound edges, especially in gastrointestinal, gynaecological or urological operations, as well as for subcutaneous sutures and ligatures.

Polymer

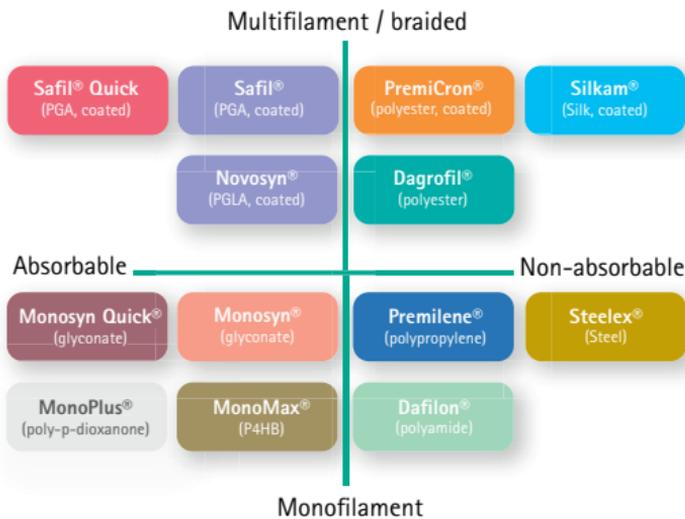
A polymer (from the Greek *pollus*, many, and *meros*, parts) is a system formed by a group of macromolecules of the same chemical nature. The terms «polymer» and «macromolecule» are frequently used interchangeably.

Polypropylene

Polypropylene, the chemical formula of which is $(-CH_2-CH(CH_3)-)_n$, is a semi-crystalline, thermoplastic polymer. Non-absorbable polypropylene monofilament sutures such as Premilene® are the sutures of choice for vascular surgery.

Range

Overview of the B. Braun range



At present, B. Braun offers the most complete range to fulfil practitioners' need.

Reels

Sutures also come in the form of reels of unattached thread, often used for ligating small blood vessels.



Resorption (Absorption)

Resorption is still called «loss of mass».¹¹

Once implanted, the suture material may either remain in the body or be broken down.

This difference in behaviour leads to sutures being classed under two categories: non-absorbable sutures and absorbable sutures.

- Non-absorbable sutures remain in the body permanently and offer long-term support; in the event of their being used superficially (on the skin or mucosa = e.g. episiotomy), they will have to be removed.
- Absorbable sutures disappear in the more or less long term; the degradation profile depends on the chemical composition of the threads.

There are absorbable sutures for use short-term (approx. 50 days), medium-term (60 to 90 days), long-term (180 to 210 days) and extra-long-term (390 days).

- The mechanism of degradation varies according to the origin (see term) of the material from which the suture is made. Absorbable synthetic sutures are broken down by hydrolysis (see term), which guarantees homogeneous, regular, predictable degradation and creates physiological metabolites (products of degradation). B. Braun offers an extensive range of non-absorbable and absorbable sutures.

Steel

Steel is used for making surgical needles but also for making a certain type of sutures.

The needle (see term) is one of the main elements of a suture and must have certain properties in order to ensure optimum results both functionally and aesthetically.

B. Braun Medical focuses special attention on the design and manufacture of its needles, for the purpose of providing users with very high quality products.

All our «Easyslide» needles are made from a 300 stainless steel alloy, a unique material that gives them excellent torsional and breaking strength.

This way, their initial quality is maintained throughout the operation.

Moreover, our «Easyslide» needles are silicone-coated for greater precision and smoother tissue penetration.

Stainless steel is also the material used as the basis for certain sutures, such as our non-absorbable monofilament and multifilament steel suture. This robust, resistant suture is used specifically in orthopaedic and thoracic surgery for bone approximation (e.g. Steelex), or tendon repair (e.g. Tendofil®)

prs

Sterilisation

The industrial sterilisation techniques mentioned below have been recognised and accepted worldwide following consideration of all their pros and contras:

- Gamma radiation, mostly for polyamide, polyester and silk.
- Ethylene oxide, mostly for absorbable synthetic materials such as polyglycolic acid or materials such as polypropylene and linen.¹⁴

Ionising radiation has the disadvantage of changing the structure of polymers by fractioning the molecular chain, which reduces the thread's tensile strength and accelerates hydrolysis.

Strands

Strands, or ligatures, are threads with no needle attached.

Synthetic

Nowadays, synthetic suture material is the type most widely used. Synthetic sutures have replaced natural sutures because they offer improved tolerance and a more predictable resorption profile in case of absorbable sutures..

Tensile strength

The stability of a suture is what enables it to withstand the forces connected with the healing process, and is better known as its "tensile strength".

This corresponds to the strain, in kilos, that the suture can withstand before breaking. The suture material must have and must maintain a tensile strength that is suitable for its specific use.²

In view of the fact that a suture usually breaks at its weakest point – for example, at the knot or at an area that has been accidentally damaged – the knot tensile strength is very important for the surgeon.

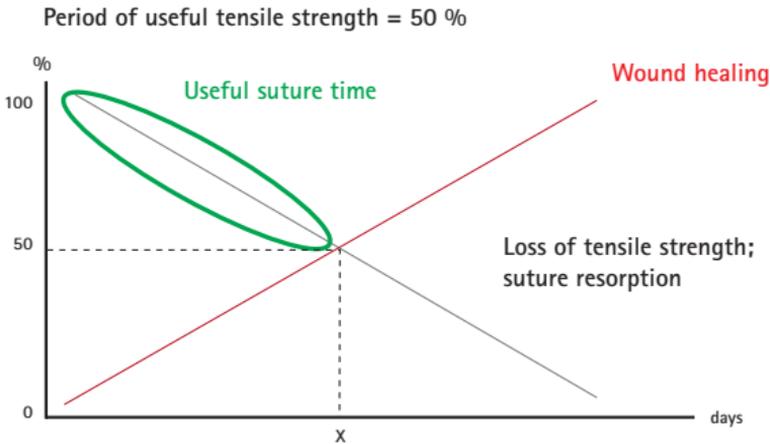
The knot tensile strength is usually 30 to 50% less than the linear tensile strength of a suture. The suture material and diameter are key factors where tensile strength is concerned.

The loss of tensile strength should not be confused with resorption (see term) of the suture material. A suture is only as functional as its tensile strength permits.

After healing has taken place, the stitch is of no more use and effectively becomes a foreign body. So, once healing is completed, it is best for the thread to be absorbed and disappear, or for it to be removed. While they may have the same decimal designation, suture threads differ in terms of how long they last depending on their composition and structure.

An absorbable suture should be chosen by ensuring that its decrease in strength is proportional to the increase in strength of the wound (see healing).

Cross-matching of suture strength and tissue strength during healing



Tissue reaction

Our immune system considers all suture threads to be foreign bodies and the inflammatory response that occurs is similar to the reaction against any foreign body. The severity and duration of the reaction depend on the type of thread, its texture, the degree of tissue trauma sustained, and the length of time the suture is in place. The inflammatory reaction is in accordance with the amount of material and therefore with the number and size of the knots.

One of the principles of surgical suturing, therefore, is to combine suture security with minimal amount of material. If the inflammatory response is intense, the suture may weaken or the surrounding tissues may become compromised. A certain amount of inflammation is necessary in normal healing. However, a suture that causes a severe, prolonged inflammatory reaction can delay healing and leave the wound open to infection.

USP

(see Pharmacopoeias).

Schock Z

Schock Z is a lab test that subjects the suture material to considerable pressure for the purpose of evaluating its elastoplastic properties.

It is performed on threads that are to be used for suturing tissues which have to withstand physiological variations in pressure, as is the case with the abdominal wall.

Monomax[®], a monofilament suture specially designed for abdominal wall closure, was tested under these conditions and resisted variations in pressure equivalent to the abdominal pressure, without becoming deformed, for a long period of time. The results of this test show that Monomax[®] has unique elastoplastic properties (in-house data).

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