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A thread: A new modality in treatment of atrophic scars

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Abstract

An atrophic scar is a prevalent cosmetic condition. It happens as a result of diminished production of connective tissue, and inadequate compensation of dermal collagen that happens throughout the process of tissue regeneration following injuries. Various techniques may be employed for dealing with atrophic scars, including subcision, peeling with chemicals, dermabrasion, punch grafting, and the application of filler materials to improve depressed areas. Subcision, or subcutaneous incisionless operations, is a kind of surgery that targets various skin issues such as atrophic scarring from acne, wrinkles, depressed scarring, and cellulite. The subcision technique for scar healing involves the release of fibrotic strands that are located underneath the scars, the organization of blood inside the resulting dermal pocket, and the development of connective tissue in the scarred region. Threads insertion has become a common trend in soft tissue and facial skin suspension. The threads function by being inserted into the human body's tissues, which prompts the development of a fibrous capsule around them. This capsule may serve as a supportive structure inside the soft tissue matrix. Additionally, the presence of inflammation leads to an increase in collagen.

Keywords: Acne, wrinkles, depressed scarring, and cellulite

Introduction

The skin is a constantly regenerating organ that envelops the body's surface and acts as a barrier between the body and the external environment, while maintaining an interactive relationship with it. It serves as a defensive shield against external factors including physical and chemical harm, infections, high temperatures, water, and electromagnetic waves ^[1]. When this barrier is disrupted due to any cause such as trauma, burns, ulcers and neoplasms; these features are no longer sufficiently executed, so it is crucial to promptly reinstate this barrier ^[2].

Cutaneous Scarring

Scars are formed when normal tissue is replaced by fibrous tissue as a result of traumas, wounds, or certain illnesses ^[3]. Scars are often benign, although they may lead to significant cosmetic, functional, or social issues ^[4]. Hypertrophic, Atrophic, and keloid scarring are the 3 most prevalent forms of scars ^[5].

Clinical features of scars

The impact on patients' life quality is greatly influenced by factors such as where it is located, sizes, and the quality of the scar. The quality of a scar may be determined by its availability or lack of visual, sensory, and tactile characteristics ^[6, 7].

- **Texture:** Scar surface imperfections, such as roughness or relief, usually appear following burn therapy that requires skin transplantations. In these cases, a meshed split thickness skin grafting is given to the burnt region ^[6].
- **Color:** Pigmentation disorders occur due to differences in melanin production and melanocytes concentration. Erythema is considered a good indicator in the early maturation phase of scar activity. Young and active scars usually exhibit redness and a rapid capillary refill, In contrast, older scars are paler in color and have normal capillary refilling ^[6].

- **Thickness:** Scar thickness like atrophy and hypertrophy which is common and aesthetically displeasing consequence of scarring [6].
- **Surface area:** Change in the surface area of the scar may occur, as scars may either expand or contract horizontally. Scar expansion or widening is observed usually in linear scarring, while scar contraction often is seen in burn scars [6].
- **Pliability:** Scars become hardened and stiff as a result of increasing in the synthesis of collagen in the dermal layer [6].
- **Pain:** The sensation of scar pains is mostly characterized as a feeling of "pins and needles," and with some instances of "burning or shooting" [8].
- **Pruritus:** Given the extensive coverage of burned scars on the body, it is crucial to recognize the significant impact that itchy scars might be having on the patient. Hypertrophic scars frequently comes with itching [9].

Types of cutaneous scars [10, 11]

A diverse array of scar forms has been documented, spanning from typical fine line scars to extensive hypertrophic and severe keloid scarring.

1. **Mature (normal fine line):** Light-colored and flat.
2. **Immature:** Red, slightly elevated, and may cause occasional itching and discomfort. Many will develop a flat appearance and acquire pigmentation similar to the skin around them, although they may be somewhat lighter or darker.
3. **Widespread stretched:** It appears when the delicate lines of surgical scarring progressively stretched and expanded. Commonly, postoperative scars following shoulder or knee surgeries tend to be flat, soft, pale, and devoid of symptoms.
4. **Atrophic:** Flat and depressed into the adjacent skin. Typically, it is little frequently round in shape, including an inverted or indented center.
5. **Contracture:** It occurs when the scars aren't completely matured. It frequently displays hypertrophy and is typical for individuals to have disability and dysfunction following burn injuries.
6. **Linear hypertrophic:** The skin appears red, elevated, and sometimes causes itching. The condition emerges within a few weeks after the surgical procedure. Its growth may experience a fast rise in size over a period of three to six months, followed by a static phase, and then start to regress in size.
7. **Widespread hypertrophic:** It is a frequent occurrence following burns. A widespread scar that is red, elevated, and sometimes causes itching that remains within the borders of the original burn.
8. **Minor keloids:** Focally raised, itchy scars which extend over normal tissues.
9. **Major keloids:** Large, elevated scars that might cause pain or itching. They proliferate beyond the boundaries of healthy tissue and have the potential to progressively propagate over an extended period of time [10, 11].

Atrophic scars

Are flat or depressed below the surrounding skin due to deficiency of collagen and other fibrous tissues. Figure 1 [2, 12].

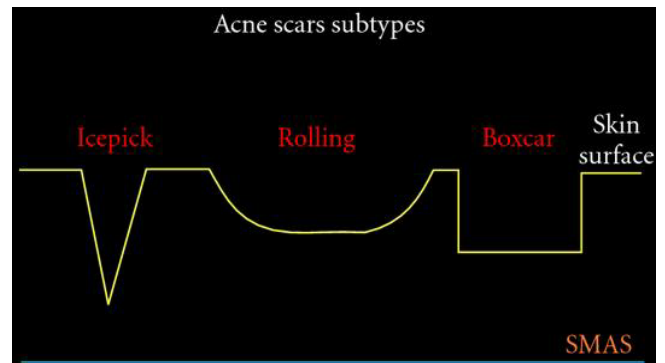


Fig 1: Acne scars subtypes [13]

Histopathology of skin in atrophic scar

There are some characterized features of the dermal scars which are thick epidermis with a flattened dermo-epidermal junctions, also the dermal matrix is organized abnormally into parallel bundles of collagen of the scarring tissues, as contrast to the normal weave basket pattern of dermal collagens. Scar collagen fibers exhibit reduced size, increased density, and elevated levels of collagen type 3 and fibronectin compared to the adjacent healthy skin. In scar elastic fibers there are fragmentation and abnormal organization in comparing with the normal surrounding skin dermis. In addition, inflammatory cell infiltrates were seen in most of atrophic scars dermis. Epidermal appendages like sebaceous glands and hair follicles are often absent in the scar. [14]. Figure 2. [15].

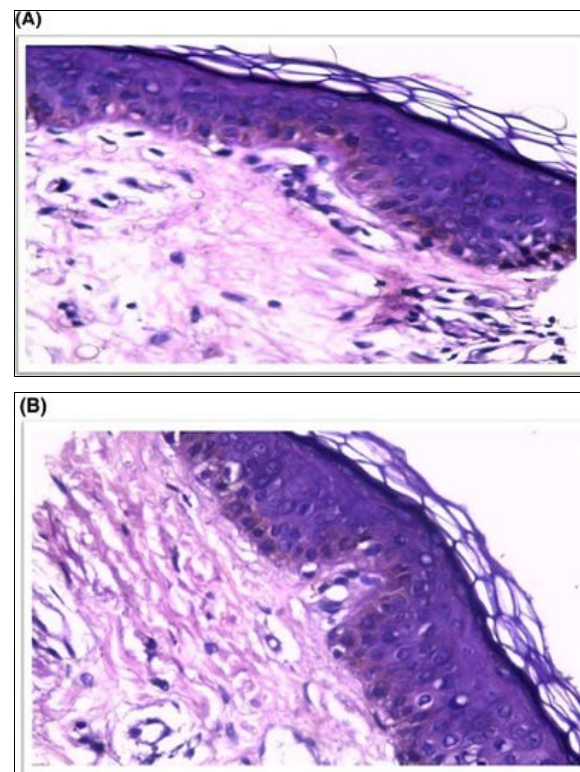


Fig 2: (A) Acne scar with flat rete ridges and a thin epidermis (H&E $\times 400$). (B) Following therapy, the acne scar has thicker epidermis with typical rete ridges (H&E $\times 400$) [15].

Dermoscopic features of atrophic scars

Central whitish scar-like patch with yellow scales surrounded by pink-reddish coloration with peripheral pigment network [16]. Figure 3 [16]



Fig 3: Dermoscopic examination of an uncommon instance of atrophic dermatofibroma using dermoscopic observations: (A core white scar-like area with yellow scales is surrounded by a peripheral pigment network with a pink-reddish coloring (DermLite DL4, 3Gen, Inc, San Juan Capistrana, CA) ^[16]

Treatment options of atrophic scars

Atrophic scars can be treated by several modalities as follow (Topical treatment- Resurfacing modalities- Volume related “fillers”- Surgery related- Other modalities- Combined therapy) ^[17, 18].

Topical treatment

- 1. Retinoids:** Studies have shown that using higher doses of retinoids, like adapalene 0.3%/benzoyl peroxide 2.5%, may be more effective in treating acne scars that have already formed. This is because these retinoids promote the synthesis of new collagen and elastic tissue, which helps to rebuild the scars ^[19].
- 2. Platelet rich plasma:** Platelet rich plasma topical application after microneedling or CO₂ laser gives good results, due to the presence of multiple growth factors which play a role in healing augmentation ^[20].
- 3. Topical insulin:** Insulin was applied topically after microneedling and gave good results. It activates Phosphatidylinositol 3-kinase/ Protein Kinase B pathways to raise VEGF and then increase formation and maturation of collagen fibers ^[20].

Resurfacing modalities

Laser resurfacing is a very efficient therapy that is simpler to utilize compared to other methods. A variety of lasers, such as ablative and non-ablative lasers, are very effective in treating atrophic scars, with the exception of deep ice-pick scars ^[21].

Ablative lasers

Carbon dioxide laser: CO₂ resurfacing vaporizes tissue. The wound healing process is induced by dermal heating below the ablation zone which leads to heat-mediated tissue contraction and collagen remodelling. The process of re-epithelialization typically lasts between 5 to 10 days, but erythema, or redness of the skin, may continue for many months. Possible adverse effects involve infection, dyschromia (either excessive or insufficient pigmentation),

distinct boundaries between handled and untreated regions, and scars ^[22].

Erbium: yttrium -aluminum-garnet (Er: YAG): The laser produces a wavelength of 2940 nm, that's much more specific for water compared to a CO₂ laser, thanks to its shorter wavelength. This characteristic leads to a significant reduction in residual harm to the skin ^[23].

Non ablative lasers

Non ablative skin remodelling systems (Diode laser and Nd: YAG) have gained popularity for treating atrophic acne scars due to their ability to reduce the need for post-operative care and also decrease the side effects ^[24].

Dermabrasion

It is used to excise the epidermis, either with or without a portion of the dermis and then induction of remodeling of the skin structural proteins. This procedure helps to define scar edges, so it is used for treating broad-based scars that have unclear boundaries, although it is not suitable for deep boxcar or ice pick scars. The adverse consequences of this approach include substantial pain, modification of pigmentation, scarring, and the growth of milia ^[25].

Microdermabrasion: Is a more superficial dermabrasion variation which alone eliminates the outermost layer of the epidermis and therefore speeds up the normal process of shedding dead skin cells ^[26].

Both treatments are very successful in the treatment of scars and may result in noticeable changes in the skin's look ^[26].

Micro needling

Micro needling, also known as collagen induction treatment, involves the application of tiny needles to pierce the skin repeatedly, therefore creating micro-clefts which extend into the dermis. Damage to the dermis triggers the release of growth factors and the process of wound healing, which results in the manufacture and accumulation of collagen in the top layer of the dermis. An essential benefit is the preservation of the epidermis, and so most of laser resurfacing and chemical peeling risks are eliminated ^[27].

Chemical peeling

Chemical peeling is the application of chemicals to the skin in order to eliminate the outermost layers that are damaged, hence speeding up the natural process of shedding dead skin cells. Chemical peels may be classified into four categories based on the histologic amount of necrosis they induce, since various agents have varying degrees of penetration. The four categories are characterized as superficial, medium depth, and deep peeling, with varying levels of depth ^[28].

Radio frequency (RF)

A novel technique called fractional bipolar (RF) has been developed to enhance the effectiveness and minimize the adverse effects of fractional bipolar (FB) treatment. This technique, known as "sublative rejuvenation," achieves significant remodeling of the dermis while causing little damage to the epidermis. The FB RF device shown notable efficacy in considerably improving atrophic acne scars ^[29].

Volume related (fillers)

Soft tissue fillers are a useful treatment for people with

rolling acne scars. Scarring fillers can be used in two ways. First, direct injection of fillers under scars for immediate improvement. Second, volumizing fillers [29].

Surgery related

- 1. Punch excision and punch elevation:** Punch excision is recommended for the treatment of boxcar and icepick scars. Choose a punch tool that is roughly the same size as the scar, and then proceed with excising the subcutaneous layer. The sutures ought to be used to repair the defect in alignment with the relaxed skin tension lines [30]. Punch elevation is most appropriate for treating wide boxcar scars that do not have underlying fibrosis [31]. The scar is surgically removed using a punch device that matches the size of the depressed scar, reaching down to the layer of tissue just below the skin. The tissue is then lifted and stitched in position at a little higher level compared to the skin that surrounds it, taking into consideration the natural contraction that occurs throughout the healing of the wound [32].
- 2. Subcision:** Subcision is a surgical procedure that is utilized for treating various skin diseases by releasing fibrotic strands that are located underneath scars, and formation of new connective tissue. [33]

Other modalities (Fat transplantation- Stem cell therapy- Epidermal growth factor- Plasma exeresis)

- 1. Fat transplantation:** This form of therapy is recommended for highly atrophic scars that have experienced significant damage to the deeper layers of tissue [34].
- 2. Stem cell therapy:** Stem cells which are found in our body, are nonspecific or undifferentiated cells, so they possess the capacity to regenerate themselves and undergo differentiation into specific types of cells [35].
- 3. Epidermal growth factor:** The ability of EGF to stimulate neo-collagenesis and dermal thickening lead to reduction in wrinkles, fine lines and increase firmness, also when applied topically, it helps in acne scar improvement [36].
- 4. Plasma exeresis:** it is a novel noninvasive treatment that is gaining popularity in the field of aesthetic medicine that sublimates the treated area without surrounding tissues damaging [37].

Combined therapy

Threads

Antiaging and skin rejuvenation have become a very popular aspect in dermatology field. The primary emphasis of esthetic manipulation has been on ensuring safety, maximizing efficacy, simplifying the technique, and minimizing the danger of adverse effects. Thread lifting has gained popularity as a prevalent practice for suspending soft tissue and face skin. This approach involves the temporary immobilization of sustaining tissues, like the malar fat pad and/or platysma. Initially, non-absorbable cogged threads had been employed to optimize the skin lifting effects. However, absorbable threads have been created as a substitute because to concerns about foreign body responses [38].

Mechanism of threads in tissue augmentation

The threads function by being inserted into the human body,

which leads to the development of a fibrous capsule surrounding the thread. This capsule may serve as a scaffold inside the soft tissue matrix. Additionally, the presence of inflammation stimulates the production of collagen [39].

Types of threads

Mode of absorption

- 1. Absorbable threads:** Including Polydioxanone threads (PDO), Silhouette Soft threads are composed of Poly-L-lactic acid or Sculptra in a solid state, combined with delicate threads that contain absorbable cones that can be absorbed in two directions. [40].
- 2. Non-absorbable threads:** Including Aptos threads, Contour threads, Silhouette lift threads, Woffles threads (Polypropylene) [40].

Barbed and non-barbed threads (smooth threads)

Barbed threads: There are 3 types of barbed threads [41]:

- **Bi-directional threads:** (long sutures) are introduced into a hollow needle and subsequently positioned inside the treated region.
- **Uni-directional barbed threads (long sutures):** Are intended to be securely attached to a stable framework, like the deep temporal fascia.
- **Cogged threads (short sutures):** Some examples of cogged threads are PDO uni-directional cogged threads, PDO bi-directional cogged threads, and PDO multi-directional cogged threads.

Non-barbed threads (smooth threads) [41]: Two varieties of non-barbed threads exist:

- **Monofilament Plain:** Some examples of threads used in cosmetic procedures involves Miracu plain threads and TR lift threads.
- **Monofilament Screw or Spiral:** Examples involve the K2 and T screw lifting threads.

Length of threads

Additional research categorized the thread based on its length, with varying lengths utilized for distinct lifting strategies, like the short suture procedure (less than 90 mm in length) and long suture procedure (more than 90 mm in length) [42].

Indications: Threads are used in treatment sagging, the mandibular line, eyebrow ptosis, The skin in the middle third of the face and the loss of volume in the cheek area, particularly in mild and severe cases, are often seen in individuals with less pronounced subcutaneous tissue [43].

Additional indications include facial asymmetry resulting from irreversible facial paralysis and individuals who are unable to undergo surgical treatments due to contraindications [44]. Also, it was found that scalp threading has a role in hair loss treatment, as it provides the scalp with enough growth factors to enhance hair growth [45].

Contraindications: Allergy to foreign bodies, documented or suspected sensitivities to instruments or implants, autoimmune diseases, active infections, lactating, or being pregnant, or patients with restricted capacity to adhere to post-treatment instructions [46].

Advantages: A thread lift is a less invasive procedure used to revitalize the face. Patients express high levels of

satisfaction with the brief length of the operation, minimum scarring, fast recovery, and low occurrence of problems, making it a favorable substitute for more invasive operations [47].

Complications: Threads may cause some complications such as ecchymosis, pain, discomfort, dimple formation, thread rupture during insertion, thread extrusion, migration and expulsion of threads, as well as the presence of leftover threads following a surgery, infection, swelling and hematoma. Rare complications like asymmetry, Static or dynamic traction lines, granuloma formation, chronic foreign body sensation, Formation of scars at the locations of entrance and exit, rupture of Stensen's duct, and injury to nerves [46].

Aptos threads

The first trials included the use of a polypropylene thread that had unidirectional barbs, which were affixed to a lengthy guiding needle. Several strands were inserted into the subcutaneous a tiny incision was made in the temporal region, and the remaining portion of the thread was trimmed and gently tugged [46]. Figure 4

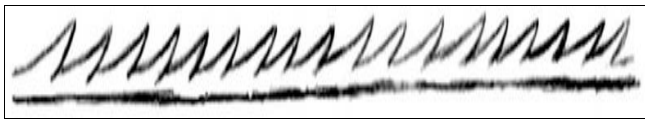


Fig 4: Aptos threads [48]

This thread included convergent barbs and was designed to be inserted into the subcutaneous tissue using a guiding needle Figure 5, so it doesn't become necessary to perform a previous incision. This method initially applied to all facial regions, but with extensive experience, it was shown to be more effective in enhancing the shape of the center facial area and lifting the mental area [49].

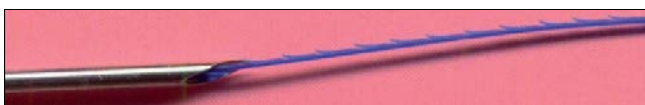


Fig 5: Aptos thread enlarged - needle - conductor with the thread [49]

This thread's pointed tips formed a single whole at this place because of a transient weld that connected them. In this approach, there was no need for a preexisting incision. The two needles have been inserted into the skin via the same opening and then moved apart inside the skin after they were correctly positioned, before being pushed in opposing directions. A greater lifting power is made by this new thread [46].

The material was reconfigured by using the abilities of Aptos thread 2G in conjunction with Aptos needle (Aptos needle 2G). The Aptos needle 2G threads consist of many barbs connected to two double-pointed needles, similar to the original Aptos needle design. By using this novel substance, they successfully attained enhanced stability and a more robust upward force. This procedure is mostly recommended for lifting the central-facial zone. The application process is almost same to that utilised with Aptos thread 2G [49]. Figure 6

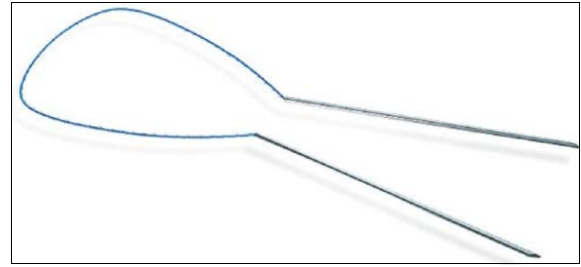


Fig 6: Aptos thread 2G [49]

Silhouette threads

The suture consists of an 8-inch (20-cm) straight needle connected to a 14.7-inch (37.3-cm) polypropylene sutures of sizes 2-0 and 3-0. There are 8 (2-0) or 9 (3-0) knots located at the far end of the suture. These knots cover a distance of 8 cm, with intervals of roughly 10 mm between them. Each knot is inserted with an absorbable cone to form a sequence of 8 or 9 interacting components Figure 7 [50]. The cones possess a hollow structure, characterised by an outer diameter of 1.27 mm at the base and 0.46 mm at the top, along with a length of 2.53 mm. The cones are created using a polymer consisting of glycolic and L-lactic acid [51].

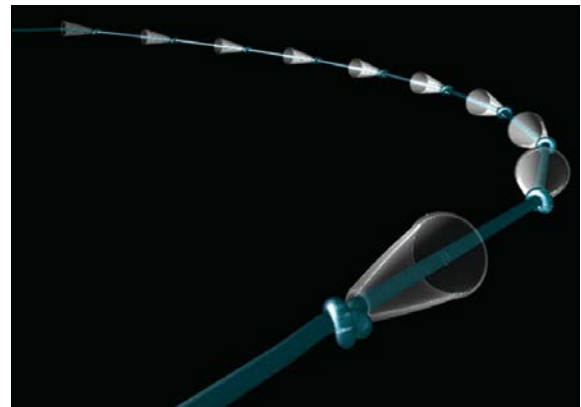


Fig 7: Silhouette threads [50]

The silhouette suture's physical and chemical structure enables the instant repositioning of face tissue by exerting traction and promoting the production of new collagen fibres. This provides additional support to the tissue versus the force of gravity. The initial traction is generated by the preexisting cones and then strengthened by the creation of new collagen. Following the absorption of cones, collagen is generated around the nodes in the thread to maintain tissue tension [52].

Polydioxanone threads (PDO)

Are a kind of artificial absorbable sutures which have been utilised for surgical procedures for a considerable period of time. The suture material undergoes total absorption by the body after a period of 4 to 6 months. The reabsorption process occurs by hydrolysis, that stimulates the generation of fibroblasts. These fibroblasts then make more collagen specifically in the region being targeted. Upon insertion of the thread, the body initiates the generation of granulation tissue and synthesises several kinds of collagens that are naturally present in the human skin. The presence of type 1 and type 3 collagen in the human dermis contributes to its tensile strength. Fibroblasts and myofibroblasts are

produced inside this newly formed granulation tissue. Myofibroblasts are involved in wound contraction, healing, and contribute to the elasticity and tightness of the treated region throughout the process of regeneration of the skin [52].

Types of polydioxanone (PDO) threads: [48, 52] Figure 8

- The Mono-PDO thread:** is a single-strand, smooth, and thin thread measuring 0.07-0.15 mm in thickness.
- Spring or twin thread:** composed of either a twisted single monofilament or 2 monofilaments interwoven, has greater tensile strength compared to mono-PDO thread.
- The Cog PDO thread:** is equipped with barbs that securely attach to tissues upon insertion, resulting in lifting effects.

Monofilament threads

These threads possess a smooth texture, devoid of any barbs or cogs, and are inserted utilising a "free-floating" method. The dimensions of the smooth thread, namely its length and diameter, exhibit variation. The needle gauge ranges from 18 to 31, with thickness varying, and the length is determined by the specific treatment area. Upon inserting smooth threads into the subdermal plane, the thread will remain in position after the needle or cannula is removed [46].

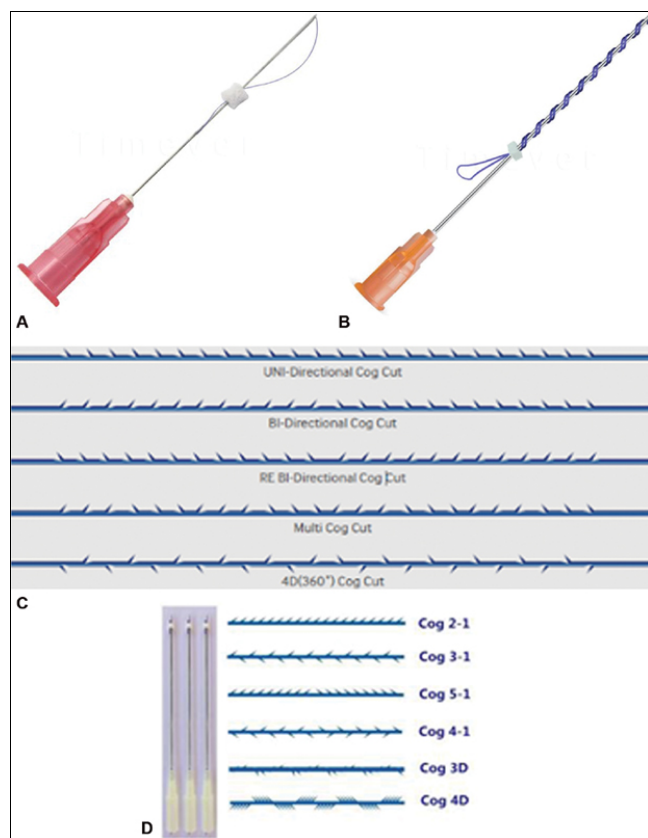


Fig 8: Polydioxanone threads come in two types: smooth threads and barbed threads. (A, B) Smooth threads may exist as single or many entities, or they might possess a structure that is like that of a screw. Their primary role is collagen synthesis. (C, D) The barbed threads may have either a unidirectional or bidirectional orientation. They possess either barbs or cones. These are the factors responsible for the lifting of the structures. The choice of references is contingent upon their availability in various countries, resulting in variations. [52]

Cog polydioxanone (PDO) threads

The classification of cog PDO thread is based on the orientation of the spikes, which may be categorised as uni-directional, bi-directional, or multi-directional. The barbs included on each suture serve as interlocking mechanisms that securely hold the skin and facilitate tissue suspension in various facial regions. Threads that are bidirectional and feature barbs on 4 to 6 sides exhibit superior tissue grip compared to unidirectional threads. An important benefit of these novel barbed sutures is that they don't require attachment to a deeper anatomical tissue such as the periosteum or deep temporalis fascia. The many barbs that support the lifted tissues aid in the enhancement of skin laxity and ptosis [52].

Poly-L-Lactic Acid threads (PLLA)

Newer threads possess enhanced durability and have the capacity to stimulate a greater production of collagen compared to other thread varieties. These threads are derived from the same components as the absorbable stitches produced from polydioxanone materials. They are efficacious in enhancing wrinkles, diminishing sagging, minimising pore size, and inducing lifting. The presence of threads in the body causes small injuries that activate cells that include macrophages, mast cells, and lymphocytes. These cells then stimulate the production of new collagen (specifically type 1 and type 3) as the sutures are absorbed. This process enhances collagen stimulation, leading to a gradual and natural increase in facial volume and restoration of facial contour smoothness [53].

The threads undergo degradation into water and CO₂, and this process takes around 3 months, although it may vary from 9 to 30 months. This length is greater compared to the estimated 6-month lifespan for PDO. As a result, the patient's natural collagen synthesis is stimulated, leading to results that can continue for 12-18 months. PLLA threads have been utilised for the purpose of lifting sagging skin, augmenting volume as a substitute for fillers, and promptly reducing acne scars by making them smoother and plumper [53].

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