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EFFECT OF DIFFERENT SUTURE MATERIAL ON WOUND HEALING

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Abstract:

Introduction:

Wound healing is a well-coordinated process which involves a series of stages such as king abdulaziz in jeddahinflammation, cell proliferation, matrix deposition, and tissue remodeling. Wound repair requires wound tissue approximation which is served and maintained by sutures until the wound attains adequate tensional strength to prevent dehiscence. It has been known from ages that sutures have been an effective and critical part of surgeries and trauma management. Variety of suturing material is derived from gold, silver, iron, steel wires, fried animal gut, animal hair, silk, tree bark, and plant fibers were used in the past, while some of them are still in use today. Various synthetic biomaterials such as polydioxanone are also used in recent past. Though there a wide variety of suture materials available but no single suture material that would be suitable for all types of surgical and medical requirements.

The aim of Work: *The purpose of the study is to understand the healing process of the wound using different suture material.*

Methodology: *We conducted this review using a comprehensive search of MEDLINE, PubMed, and EMBASE, January 1985, through February 2017. The following search terms were used: suture material, wound healing, poliglecaprone, monofilament, braided, glycomer, types of sutures, silk and nylon sutures*

Conclusion: *The selection of suitable suture material is of utmost importance. Regardless of advancements and innovation in materials, wound closures post-surgical procedures or trauma still largely involves uses of sutures. Ideally, a wound closure method should be cost-effective, time-efficient, easy to perform and produce the optimal cosmetic result. The primary goals of treating wounds in general and skin incisions, in particular, are rapid closure with the creation of a functional and esthetic scar.*

Keywords: *Suture material, Soft tissue healing, types of sutures.*

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INTRODUCTION:

Wound healing is a well-coordinated process which involves a series of stages such as inflammation, cell proliferation, matrix deposition, and tissue remodeling. Wound repair requires wound tissue approximation which is served and maintained by sutures until the wound attains adequate tensional strength to prevent dehiscence. It has been known from ages that sutures have been an effective and critical part of surgeries and trauma management. Variety of suturing material is derived from gold, silver, iron, steel wires, fried animal gut, animal hair, silk, tree bark, and plant fibers were used in the past, while some of them are still in use today. Various synthetic biomaterials such as polydioxanone are also used in recent past. Though there a wide variety of suture materials available but no single suture material that would be suitable for all types of surgical and medical requirements. [1] Egyptians dating back to 3500 BC described wound closure using suture material. In past centuries with more development, there have been many suture materials derived from animal tendons, horsehair, leather strips, vegetable fibers, and human hair. [2] In 1806, Philip Syng Physick developed absorbable suture made from buck skin essentially inventing the modern technique of suturing. [2]

METHODOLOGY:

• Data Sources and Search terms

We conducted this review using a comprehensive search of MEDLINE, PubMed, and EMBASE, January 1985, through February 2017. The following search terms were used: suture material, wound healing, poliglecaprone, monofilament, braided, glycomer, types of sutures, silk and nylon sutures

• Data Extraction

Two reviewers have independently reviewed the studies, abstracted data, and disagreements were resolved by consensus. Studies were evaluated for quality and a review protocol was followed throughout.

The study was approved by the ethical board of King Abdulaziz University Hospital.

Classification of Suture

Sutures can be broadly classified as Non-absorbable or absorbable, natural or synthetic and multifilament or monofilament.

A. ABSORBABLES:
   - Natural- surgical gut (plain and chromic), collagen, fascia lata, cargile membrane, kangaroo tendon.
   - Synthetic- polyglactin (Vicryl), polydioxanone (PDS), polyglycolic acid (Dexon-s).

B. NON-ABSORBABLE:
   - Natural- silk, cotton, linen, silkworm gut.
   - Synthetic-polyamide (poly or monofilament-braided), polyester (coated or uncoated), polypropylene (Monofilament). Metal-tantalum, stainless steel (Mono or polyfilament).

Ideal material and Handling Characteristics of Suture for skin repair.

The ideal suture material should be inert, induce no foreign body reaction, have fine caliber and a smooth surface and easy to handle. Suture material should have pliability and flexibility for better handling characteristics to be effectively used such as suture strength, infection risk, tissue-holding power, incision type, and suturing technique are deciding factors for wound closure.[3] The choice of suture material also depends on a number of tissue layers involved in wound closure, tension across the wound, depth of suture placement, the presence of edema, expected time of suture removal.[4] Also, ease I knot placement, high knot security, free from irritating and infectious substances are other features taken into consideration for better wound healing.[5-7]

The choice of suture material for a particular procedure should be based on its known physical and biological properties. The principle feature for different sutures to function are filament structures, size, degradation property, tensile strength, stiffness, surface texture and flexibility of the material. The size and tensile property of suturing material are responsible for resisting tissues induced stress and

repair capability. For better healing process the tensile strength of suture material should balance the tensile strength of tissue which in turn depends on number of filaments (monofilament or multifilament). Multifilament possess higher mechanical property than monofilament sutures. [4,5,7] Multi-filament or braided sutures are easy to handle and have favorable knot-tying qualities. However, bacteria can enter the braided interstices and escape phagocytosis, potentially leading to suture infection, granulomas and sinuses. By contrast, monofilament sutures cause significantly fewer tissue reactions and glide easily through tissue. Their disadvantages include high retention of package shape, difficult handling, knot insecurity, and potentially cutting through tissue. [3,9]

Various physical and biological properties of different suture material as follow:

Absorbable sutures

Suture	Configuration	Tensile Strength	Ease of Handling	Knot Security	Tissue Reactivity	Uses
Surgical gut (Plain)	Virtually Monofilament	Poor at 7-10 days	Fair	Poor	Moderate	Rarely used in skin
Surgical gut (chromic)	Virtually Monofilament	Poor at 21-28 days	Poor	Poor	Less than plain	Skin grafts, surface sutures for mucosa
Surgical gut (fast-absorption)	Virtually Monofilament	50% at 3-5 days	Fair	Poor	Low	Skin grafts, surface sutures
Polyglycolic acid (Dexon)	Braided	20% at 21 days	Good	Good	Low	
Polyglactin(vicryl)	Braided	75% at 14 days	Good	Fair	Low	Subcutaneous closure , vessels ligature
Polydiaxanone	Monofilament	70% at 14 days 50% at 30 days 25% at 42 days	Poor	Poor	Low	Subcutaneous Closure (high-tension areas)
Glycolide and Trimethylene(Maxon)	Monofilament	81% at 14 days 59% at 28 days	Fair	Good	Low	Subcutaneous Closure (high-tension areas)
Polyglecaprone	Monofilament	50-60% at seven days	Good	Good	Minimal	When minimal tissue reactivity is essential
Glycomer	Monofilament	75% at 14 days 40% at 21 days	Good	Poor	Minimal	Subcutaneous Closure (high-tension areas)

Table 1: summary of the common types of absorbable sutures [8]

Absorbable sutures lose their tensile strength within 60 days after placement and are absorbed with little or no tissue reactions at a predictable rate. They are primarily used as buried sutures to close dermis and subcutaneous tissue to reduce wound tension. Absorbable sutures derived from animal protein, plain and chromic gut are degraded through proteolytic enzymes produced by inflammatory cells, tensile strength is lost in a short time. For plain gut 7-10 days, chromic gut 10-14 days with absorption rates as long as 90 days. [10] Sutures derived from synthetic material provide more tensile strength and less tissue reaction.

A comparative study done by Williams, on catgut, a natural absorbable suture to a synthetic absorbable suture material shows, synthetic sutures to degrade at a slower rate than natural suture with less tissue

reaction and offered more consistency in performance

According to Choudhary, the use of synthetic absorbable suture designed to degrade rapidly to lessen scar formation. The absorbable suture provided better outcome as the need for painful suture removal was eliminated. The material visible on skin was able to wipe off 7-10 days postoperatively. [12] The transition from natural to synthetic absorbable sutures started in the 1970s with the introduction of polyglycolic acid sutures. Braided, coated, polyglactin suture has 75% strength retention in two weeks and 50% in 3 weeks. It is completely absorbed between 56 and 70 days. [11]

Non-absorbable sutures

Suture	Configuration	Tensile strength	Ease of Handling	Knot Security	Tissue Reactivity	Uses
Silk	Braided	None in 365 days	Gold Standard	Good	Moderate	Mucosal surface
Nylon:						
Ethilon	Monofilament	Decrease 20% per year	Good to fair	Poor	Low	Skin closure
Dermolan	Monofilament	Good	Good to fair	Poor	Low	
Surgilon	Braided	Good	Good	Fair	Low	
Nurolon	Braided	Good	Good	Fair	Low	
Polypropylene	Monofilament	Extended	Good to fair	Poor	Minimal	Running Subcuticular Suture
Polyester	Braided	Indefinitely	Very Good	Good	Minimal	Mucosal Surface
Polybutester	Monofilament	Extended	Good to fair	Poor	Low	

Table 2: Summary of commonly used non-absorbable sutures [8]

Silk sutures are old standbys, natural, non-absorbable material produced by silkworm. Silk sutures are typically not used in the presence of infection. Non-absorbable sutures are most useful in percutaneous closures and is characterized by resistance to degradation by living tissues. According to pecha, the silk suture migrated toward the intestinal lumen, causing ulcerations and bleeding up to six months postoperatively. Silk tends to cause more tissue reaction; braided silk suture can harbor bacteria or foreign material which reacts with body tissues especially in bacteria-rich environment such as the bowel.

Synthetic non-absorbable suture such as polydioxanone are monofilament sutures that are soft and pliable developed to decrease tissue reaction, though they have slight tissue reaction and low affinity for microorganism therefore its indicated to close fascia in pediatric cardiovascular and ophthalmic procedures, orthopedic patients and patients with compromised wound healing. They are known to provide extended wound support up to 6 weeks.

Polyester sutures are braided , multifilament sutures and Polypropylene is monofilament suture. The former is stronger than natural fibers and do not weaken when wetted while the later is inert as steel and is unaffected by tissue fluids, retains tensile strength in vivo long term. Surgical stainless steel is available both as monofilament and multifilament suture and has indefinite tensile strength , causes minimal tissue reaction but should be cautiously used in patient with known metal sensitivities to stainless stell , chromium or nickel and is most commonly used in sterna and abdominal wound closure. For obese patients , the technique of retention sutures using large gag wires has been demonstrated to help support deep tissues while the more superficial fascia and skin tissues heals. [12]

Experimental study on Animals

20 male rats were randomly allocated, four longitudinal incision wounds, each 1 cm in size were created on the dorsum of each animal and primarily closed with four different types of sutures. Sutures

used were:

- Polyglecaprone, absorbable, synthetic, monofilament suture
- Silk, non-absorbable, natural, braided suture
- Polypropylene, non-absorbable, synthetic, monofilament suture
- Polyglactin, absorbable, synthetic, braided suture

A period of seven days was selected as the experimental interval. No statistically significant difference was observed between the coated polyglactin, polypropylene, silk, and polyglecaprone regarding the cell density, the presence of cells of chronic infection. However, at 7^{th}-day cells of chronic infection was found to be higher in propylene and silk suture group. In all the group's the presence of fibrosis was higher at 7th day. There were no significant complications during and post-operatively regarding the suture materials. Polypropylene as being a non-absorbable monofilament suture showed slightly less foreign body reaction. [13]

CONCLUSION:

Many factors are involved in the choice of skin closure material, including the type and place of the wound, available materials, physician expertise, and preferences, patient age and health provide the main uses of different skin closure materials for helping surgeons choose the appropriate material for different wounds according to the best available evidence. Demands for sutures materials are on the rise due to an increase in some surgical procedures performed worldwide, regardless of the availability of sutures substitute such as surgical staples, glues, and strips in the market. These products do on occasions fall short of the stability and flexibility rendered by sutures in wound management.

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