COMPARATIVE ANALYSIS OF TENSILE STRENGTH OF MULTIFILAMENT SILK AND VICRYL SUTURES USED IN SURGERY

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ABSTRACT

Sutures made with different materials are used in surgery for multiple reasons. These materials may be monofilament or multi filaments based on either natural or synthetic content. Mechanical and physical properties of sutures are crucial requirements to make an informed decision for their appropriate use in surgery. This study was aimed at determining and comparing the tensile strength of sutures made with silk and vicryl materials in straight and knot pull. An experimental study was conducted. Samples of sutures made with silk and vicryl used for surgery were collected from various pharmaceutical companies of Lahore. These were evaluated for their tensile strength by using DX Instron tester with two configurations. The results depicted that multifilament suture made with silk fiber had better tensile strength as compared to the vicryl in both straight and knot pull type.

KEYWORDS: *Tensile strength, Suture, Silk, Vicryl, Straight pull, Knot pull*

INTRODUCTION

The use of sutures in the field of surgery dates back to the earliest human beings. These sutures were used for closing and suturing the wounds. In the olden days, sutures were made from animal hairs and ligaments, plant fibers such as flax and hemp and some grass species (Swanson and Tromovitch, 1982). Very little advancements were seen in the use of materials for sutures since Renaissance till 1940. Nylon and polyester yarns were the first synthetic materials to be used in this field in early 1940's. Later on, in 1970 other materials such as polyglycolic, polyglactine and vicryl came to the market (Mirkovic *et al.,* 2010)

It is necessary to choose the right material to manufacture sutures, adequate technique of suturing, surgical needle, its diameter and suture knot for better healing of wounds (Silverstein *et al.,* 2009) Suture materials are divided into natural and synthetic. These materials are further categorized as monofilament or multifilament, absorbable or non absorbable, dyed or undyed. They have certain mechanical characteristics such as tensile strength, elasticity, flexibility, breaking strength or capillarity (Kudur, 2009). There are many natural and synthetic materials available from which sutures are made for various medical and dental works. So, it is necessary for the surgeon to know the type of material of suture, as it has to surround with the tissue and affects the healing process. Most importantly the strength of suture can not be neglected as adequate strength is always needed to keep the wound edges together (Mirkovic *et al.*, 2010 ; Javed *et al.,*2012).

Monofilament suture presents low knotting resistance, less tissue dragging, less raveling and increased resistance against infection as there is less chance of colonization by certain microorganisms. Multifilament sutures are rather easy to manage due to their low bending strength. It helps in making a stable knot. However their structure often attracts the growth of bacteria (Kim *et al.,* 2007).

Nonabsorbable suture material is usually preferred by most surgeons as it can tie easily and has good breaking strength. It also has a less inflammatory reaction. Some researchers and surgeons prefer absorbable suture as they do not need to be removed and save time. It also reduces patients stress (Parell and Becker, 2003). Absorbable materials have a strong connection with tissues in their degradation process through hydrolysis or phagocytosis. This degradation depends on pH value and tissue temperature surrounded by suture (Kim *et al.,* 2007).

Knotting is the ability of a suture to maintain and retain knot strength without slippage from its place. It affects the working ability of a suture in a particular procedure. Suture with high memory are considered as less pliable and can produce difficulty during the work. Examples include monofilament based fibers such as polypropylene and nylon (Kudur *et al.,* 2009).

Choice of suture materials is based on the biological

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needs of the tissues and their relevancy with the mechanical properties of yarns to make a connection with each other. Technology is kept on growing at phenomenal pace but still no material is considered as the perfect one with excellent characteristics (Neto, *et al.,* 2018).

Tensile strength is the extent of a suture to withstand longitudinal stress without breaking[1]. Low tensile strength of suture may result in breaking of thread and leads to poor results in surgical procedures (Vasanthan *et al.,* 2009). Very little research has been conducted to measure the tensile strength of suture materials. Therefore, this study compares the tensile strength of natural and synthetic materials.

MATERIALS & METHODS

An experimental study was designed to evaluate the tensile strength of sutures made with natural and synthetic materials. These sutures were collected from famous pharmaceutical companies in Lahore. All sutures were new and their expiry date was also checked before purchase. The selected sutures were categorized into two groups based on their fiber content. Their specifications are given in Table 1.

Sutures were evaluated for their tensile strength with the help of hydraulic DX Instron tester. Each suture was fixed to the mount by tying it around the cross bar

Table 1: Construction specifications of collected sutures

Code	Nature of Material	Fiber Content	Structure	Degradation	Needle type	Needle size
Group I:	Natural	Silk	Multifilament	Non-absorbable	3/8 circle, reverse cutting	19mm
Group II:	Synthetic	Vicryl (Polyglactin)	Multifilament	Absorbable	3/8 circle, reverse cutting	19mm

and leftover suture was wrapped around the shaft. The test speed was 120mm per minute as specified in the test procedure. The temperature was kept at 27.1 ± 2.3 ºC and humidity 32.9 ± 5.2 (Naleway *et al.,* 2015). A total of ten sutures from each group were tested in two configurations such as straight pull and knot pull. For a straight pull test, each suture was cut in a specific length that covered both grip faces and these grips were tightly closed with a clamp. In order to conduct a knot pull test, a suture was tied around a cylindrical rod to make sure that it remained in the center of the test zone around the grip and test was made to compare the strength of silk suture with vicryl suture.

RESULTS AND DISCUSSION

A total of ten tests from each group were made, five with straight pull and other five with knot pull configuration. The mean values and standard deviations were calculated.

Knot security is used as a key indicator in determining the strength of sutures. The firmness of knot without raveling in a particular time determines the quality and performance of suture (Mirkovic *et al.,* 2010). It was depicted that various components of tensile strength varied with the type of suture tested. Less strength loss was observed with the silk material in both configurations as compared to the vicryl (Table 2). Silk yarn has high elasticity and good knot stability to be used as suture (Koshak, 2017). It has been extensively used for suture manufacturing since many decades for all types of surgical procedures, because it is cost effective and easy to manage as compared to many other non absorbant materials (Ananthakrishnan *et al.,* 1992 ; Javed *et al.,* 2012) Whereas, some studies reflected that many inflammatory reactions are observed with silk and cotton and less with polyester, ePTFE, and polyglecaprone (Yilmaz *et al.,* 2010).

The suture must surround the wound edges completely until it has recovered enough strength to keep the edges from separating with each other. Progressive degradation of silk fiber was observed which resulted in deterioration of tensile strength (Hochberg *et a*l., 2009). Knotting of sutures is one of the essential considerations during

Table 2: Tensile measurement of silk and vicryl

Code	Pull type	Elongation		Load		Load reduction	Failure stress		Failure strain	
		Mean	SD	Mean	SD		Mean	SD	Mean	SD
Group I: Silk	Straight	20.2	0.09	25.3	0.02	35.2	1432.5	0.52	0.35	0.02
	Knot	13.7	0.59	19.2	0.00	35.2	794.3	0.71	0.297	0.01
Group II: Vicryl	Straight	39.2	0.91	47.4	0.75	45.2	1725.3	0.83	0.845	0.04
	Knot	27.5	0.05	33.7	0.62	45.2	1103.5	0.75	0.517	0.01

surgery (Brown, 1992). The results depicted that failure stress was more in straight pull for vicryl than knot pull. Vicryl had the highest rate of breaking strength when measured in the knot condition as compared to silk (Outlaw *et al.,* 1998). Similar results were produced in the current study. In another study (Outlaw *et al.,* 1998) researchers observed that polyglycolic acid maintained 89%, 63% and 17% of its strength at 7, 14 and 21 days respectively.

Absorbable sutures made with synthetic materials provides temporary support to the wound until it recovers. As body tissues heal, the suture made with degradable material slowly gets weaken. The designing and manufacturing of an absorbent suture is a challenging task, as it surrounds the tissue to heal it soon (Huang et al., 2010)

It was studied that vicryl showed low tensile strength when reacted with fluids / liquids such as salvia, milk or soya (Ferguson et al., 2007). This study also showed the similar results when vicryl was compared with silk. It has been observed that absorbable sutures demand less medical and dental attention as compared to non absorbable sutures. One of the reasons is that non absorbable sutures have better tensile strength which results in improved and quick healing of wounds (Selvi *et al.,* 2016).

CONCLUSION

This study illustrated the data based on stress and strain ratio of selected sutures. It concludes that natural multifilament that was nonabsorable material had better tensile strength to use as suture than synthetic materials. Findings of this study can provide a framework that will assist surgeons to make their decision in selecting mechanical characteristics suitable for a particular surgery. It will also help textile manufacturers to review and alter their construction parameters of making sutures with various materials.

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