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Vishaka GV

Basic Tasar Silkworm Seed
Organisation, Central Silk Board,
Bilaspur, Chhattisgarh, India

Rathore MS

Basic Tasar Silkworm Seed
Organisation, Central Silk Board,
Bilaspur, Chhattisgarh, India

Chandrashekhraiah M

Basic Tasar Silkworm Seed
Organisation, Central Silk Board,
Bilaspur, Chhattisgarh, India

Hasansab Nadaf

Basic Tasar Silkworm Seed
Organisation, Central Silk Board,
Bilaspur, Chhattisgarh, India

Sinha RB

Basic Tasar Silkworm Seed
Organisation, Central Silk Board,
Bilaspur, Chhattisgarh, India

Studies on Silk as a suture in medical science

Vishaka GV, Rathore MS, Chandrashekhraiah M, Hasansab Nadaf and Sinha RB

Abstract

Silk is an untangled mass of fibers woven by silkworms called as queen of textiles with beautiful lustre and unique properties. Silks are a group of fibrous proteins with high mechanical strength, antibacterial properties, biocompatibility, versatility in processing, the ease of sterilization, thermal stability and controllable degradation features making silk as promising biomaterial for many clinical functions. With this background, a study was conducted to assess the utilization of silk as a suture in clinical or biomedical science. A structured questioner was developed to collect the data from respondents. Data was collected from 60 professional working in medical field with having surgery experience. The salient finding of the study was 90.00 percent of the respondents were found to be using silk as a suture in different surgical operations. Further, they perceived that the silk as a suture is ligature for permanent, removal of fixtures and cardiovascular surgeries for suturing the grafts and can be used for closing of wounds and as sutures in holding the insertions. However, they also perceive that the percent use of silk was low compared to nylon and cotton but the trend for using silk was in the increasing order due to the very unique advantages like silk is very slow absorbable nor it is subjected to degradation or weakening by the action of tissue enzymes and it is natural material and elicits minimal inflammatory reaction on skin or tissue. The result of the study signified that silk suture facilitate easy passage through tissues and exhibit a good knotting strength and secure knot placement. The study indicated that the trend is changing from synthetic sutures to natural sutures to reduce the environmental impacts and apart from that, silk is on the way to bioengineering.

Keywords: Silk, suture, surgery, medicine

Introduction

The word Silk spells luxury and class. Even today, no other fabric can match silk in luster and elegance. The touch of silk evokes the very thread of history, a shimmering fabric of unparalleled grandeur. It has reigned undisputed as the queen of textiles over the centuries. Mankind always loves silk. It is the yarn of life, extruded by that unassuming caterpillar in a continuous filament as long as about one and half kilometers. Silk is a way of life in India. Over thousands of years, and with turn of centuries, it became an inseparable part of Indian culture and tradition.

Sericulture in India has proved to be an ideal avocation for inclusive development of rural populace especially the weaker sections of the society addressing equity distribution from urban rich to rural poor. With its ecofriendly production, process and high potentialities became an ideal tool for biotechnological development.

Silks are a group of fibrous proteins with unique properties with high mechanical strength, antibacterial properties, biocompatibility, versatility in processing, the ease of sterilization, thermal stability and controllable degradation features making silk as promising biomaterial for many clinical functions.

Since the time immemorial, surgical sutures have been in use. Sutures take important part in wound healings, enables reconstruction and reassembly of tissue separated by a surgical procedure or a trauma, and at the same time facilitates and promotes healing and haemostasis [1, 7]. Suture materials are made use in oral surgery and are considered substances that are most commonly implanted in human body.

Sutures should Posses characteristics viz., ease in handling, sterility, good tensile strength, uniform tensile strength and freedom from irritants, which helps for an uneventful and rapid healing. Among these characters, tensile strength plays an vital role in determining sutures appropriateness for specific situations. Tissue biocompatibility and ease of handling, with a focus on minimal knot slippage, also influence on thread to be selected.

Various materials ranging from human hair to the presently used silk sutures have been tried in

Corresponding Author:

Vishaka GV

Basic Tasar Silkworm Seed
Organisation, Central Silk Board,
Bilaspur, Chhattisgarh, India

the process of achieving a hassle free closure of wounds. Silk Suture is a natural, multifilament and non-absorbable material. It is composed of two proteins called fibroin and Sericin. Derived from the domesticated species *Bombyx mori* L. of the family Bombycidae. Fibroin is covered by protein called sericin which is a sticky material. It has a smooth flow through the tissue while maintaining the knot security. Silk material has an excellent strength and handling property, it is flexible, Coated with wax for smooth passage, and it has no tissue reactions [4, 5]. Silk has been used as biomedical suture material for centuries and it provides important clinical repair options for many applications. With this background, a study was conducted to assess the utilization of silk as a suture in clinical or biomedical science.

Research methodology

Sixty numbers of doctors (surgeons) of Bengaluru in Karnataka state and Hyderabad in Telangana states were selected for the study based on their professional and surgery experience. A structured questioner was developed to collect the data from the respondents by thorough understanding of the existing literature and discussion with the experts. The developed structured questionnaire was mailed to 87 respondents but 60 of them were replied. Respondents were asked whether they have adopted silk as suture during surgeries on the binary response yes or no. Those who responded yes, again they were requested to put their response on a three point continuum, namely continued the adoption, discontinued the adoption and want to continue the adoption in future with the score of 3, 2, and 1 on a prelisted adaption strategies

The data collected from selected doctors were coded and tabulated by keeping in view the objective of the study. The respondents were grouped into three categories (low/medium/high), keeping the mean and standard deviation as check.

In this study 10 patients between age group of 15-30 years with satisfactory general health were taken into consideration by the surgeons, in each patient the apicoectomy with silk suture was used for the closure of the incision, the evaluation of the treated sites was done and the grading of the swelling was done and graded as 1) Mild-when there is only local swelling 2) Moderate-when swelling extending superiorly and laterally, 3) Severe-when swelling extending superiorly up and extending towards the different angles.

Accordingly pain was graded 1) Mild only when there was dull intermittent pain, 2) Moderate when there was throbbing intermittent pain, 3) Severe when there was continuous throbbing pain. Grading for swelling and pain was done at 1st, 2nd, 3rd and 7th postoperative days.

Correlation

A Pearson’s product moment correlation co-efficient was used to calculate ‘r’ value, which facilitated the relationship between dependent and independent variables. Multiple regression was used to find out the amount of contribution made by the independent variables in explaining the variation in the dependent variable.

Results

The binary response of surgeons in adoption of silk as suture was analyzed. 91.33% of respondents found to be using silk as a suture and the binary response was yes, whereas 8.67% of respondents were not adopted silk as a suture (Fig.1).

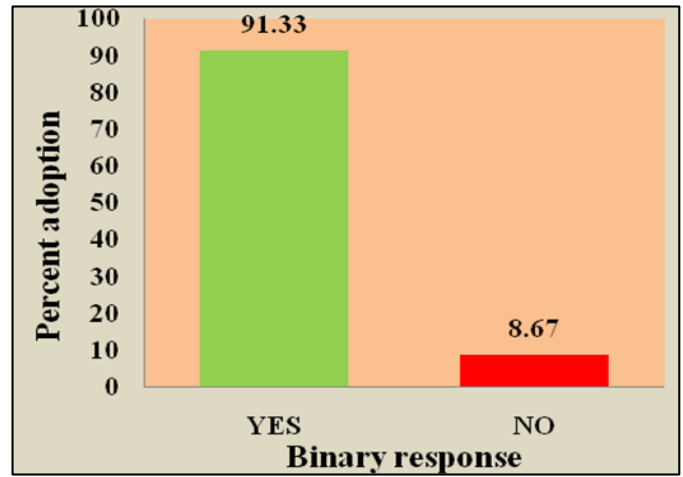


Fig 1: Binary response of surgeons in adoption of silk as a suture

Adoption of silk as a suture

According to the three point continuum scale it was found that most of the respondents were found to continue the adoption of silk compared to other sutures like nylon and cotton. And also silk suture scored good in case of the adoption. However, the least scores were found in case of non-adoption or discontinue the silk suture adoption in comparison with other sutures. The results of table 1 clearly indicate that there is a scope to continue silk as a suture and there is increase trend for silk suture in comparison with the other sutures (Table 1).

Table 1: Adoption level of silk as a suture compared with other sutures by the respondents

	Adoption level		
	Silk Suture	Nylon Suture	Cotton Suture
Adoption	2	3	2
Want to continue adoption	3	2	1
Non-adoption	1	1	3

Silk suture was used for the closure of the incision, the evaluation of the treated sites was done and the grading of the swelling was done and graded as 1) Mild-when there is only local swelling 2) Moderate-when swelling extending superiorly and laterally, 3) Severe-when swelling extending superiorly up and extending towards the different angles. Accordingly pain was graded 1) Mild only when there was dull intermittent pain, 2) Moderate when there was throbbing intermittent pain, 3) Severe when there was continuous throbbing pain. Grading for swelling and pain was done at 1st, 2nd, 3rd and 7th postoperative days.

Results showed that all the operative areas healed uneventfully by the seventh postoperative day (Table 2), on the first postoperative day, moderate swelling was observed in 10 cases and in 2 cases severe swelling on sutured side was seen. On the second postoperative day, moderate swelling was observed in 8 cases and in 1 case severe swelling on sutured side was observed. However, on third postoperative day mild swelling was seen in 8 cases and 2 cases found to be moderate swelling. Interestingly no severe swelling was found in any case of third postoperative day. On seventh postoperative day, very mild swelling was observed in 2 cases and no moderate or severe swelling was seen in any of the silk sutured patients. The grades for the pain showed that on the first postoperative day, 10 respondents were found to be with mild pain, 2 respondents with moderate pain and one respondent with

severe pain was observed. Whereas, on second postoperative day 8 cases with mild pain, 1 case with moderate pain were found. However, on third postoperative day only 1 case was seen with mild pain and on seventh postoperative day no mild, moderate or severe pain was noticed in none of the respondents (Table 2).

Table 2: Evaluation of swelling and pain in the silk suture operated areas at postoperative days

Grade of Event	Postoperative days			
	1 st	2 nd	3 rd	7 th
Patients with mild swelling	0	0	8	2
Patients with moderate swelling	10	8	2	0
Patients with severe swelling	2	1	0	0
Patients with mild pain	10	8	1	0
Patients with moderate pain	2	1	0	0
Patients with severe pain	1	0	0	0

Effectiveness of silk suture at first postoperative day showed 0 scars, 2 necrosis, 3 slackness and there was 0 healing. On 2nd postoperative day 0 scars, 2 necrotic spots, 2 slackness and 0 healing was observed. Whereas, on 3rd postoperative day 1 scar, 1 necrotic spot, 1 slackness and 0 healing was noticed. Interestingly no scars, no necrosis, no slackness and 100 per cent healing were observed (Table 3).

Table 3: Effectiveness of silk sutures in different clinical events

Postoperative days	Events			
	Scars	Necrosis	Slackness	Healing
1 st	0	2	3	0
2 nd	0	2	2	0
3 rd	1	1	1	0
7 th	0	0	0	3

Table 4: Evaluation of silk suture properties based on the different clinical characteristics

Clinical Characters	Characteristic Scores
Tensile strength	10
Shelf stability	7
Non-toxicity	8
Non-carcinogenic	9
Antimicrobial	8
Biodegradability	10
Spreadingness	8
Adhesion	9
Flexibility	10
Applicability	10

Silk suture was evaluated for the clinical characteristics. The results showed that the characteristics like applicability, flexibility, biodegradability and tensile strength scored 10. Whereas, Adhesion and non-carcinogenic scored 9. And the other characteristics like Spreadingness, antimicrobial and non-toxicity scored 8. However, only shelf stability scored 7 (Table 4).

Discussion

Healing by primary intension demands a proper closure of surgical wounds, this needs close approximation of wound edges with appropriate means and methods. The wounds in general pose a challenge of reinfection/infection during healing process. A carefully planned surgery needs proper immobilization of healing area and this can be achieved by proper wound closure technique with appropriate material such as sutures or tissue adhesives. Hence an increased

attention to prevent the incidence of infection is needed in the form of maintaining an aseptic environment and careful manipulation of tissues during surgical process to prevent or minimize the post-operative complications [10]. Risk of wound infection, adding to this, the need for suture removal on the 7th postoperative day in case of non-resorbable suture materials poses inconvenience to the patient and chance of early/delayed resorption of suture material in the case of absorbable sutures paves way for wound dehiscence or wound reinfection, apart from these, the manipulation of tissue margins using these suture materials demand a high level of clinical judgement, dexterity, time and patience from surgeon and exact control over the force application on the suture to avoid excess/inadequate tension in the suture while suturing which if not there will result in tearing of the wound margins/necrosis in case of excess forces or else, slackness in suture resulting in gaping between the wound margins resulting in incomplete healing or reinfection/scarring, more over the emergence of diseases like AIDS, Hepatitis etc. which carry high risk of transmission through needle prick also apprehends the operators in executing this process, this has led to the introduction of easier way of wound closure by means of using tissue adhesives which are supposed to minimize the effort and also avoids the risk of needle prick and tissue tears while closing the wound margins, hence the use of these tissue adhesives is gaining momentum and presently there is an increased need to critically evaluate and test these tissue adhesives to find out their effectiveness, advantages and drawbacks over the presently used contemporary methods and materials. The ideal tissue adhesive should demonstrate shelf stability, complete polymerization even in the presence of moisture (blood, saliva or water), it should permit adequate working time, should spread to cover the optimum area, should provide wettability and should not produce excess heat during the process of polymerization and it should provide strong and flexible bond, should be tissue compatible (non-toxic), biodegradable, easily applicable and non-carcinogenic [3]. According to study, silk sutures fulfils most of the properties required by a tissue adhesive, since it exhibited advantages like achieving immediate haemostasis, and apart from being easy to use it also possessed bacteriostatic properties and rapid adhesion to hard and soft tissues. The use of silk sutures in the repair of organs, skin, vessels, nerves, mucosa grafts, closure of laceration wounds and incisions has been done successfully in surgical applications and treatment of extraction sockets, fixation of mandibular fractures, healing of intra oral wounds, fixation of free gingival grafts, healing of periodontal flaps were also found successful with the application of this silk suture. It has been reported that silk sutures are non-carcinogenic and non-toxic in living organisms [4, 5]. Hence, the study favors and gives a future to non-textile application of silk and many applications in bio and medical field.

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