

# Performance Evaluation of Newer Types of Silk Surgical Sutures



N Gokarneshan\*<sup>1</sup> and U Dhatchayani<sup>2</sup>

<sup>1</sup>Professor and Head, Department of Textile Technology, Park College of Engineering and Technology, India

<sup>2</sup>Associate Professor, Department of Textile Technology, Park College of Engineering and Technology, India

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\*Corresponding author: N Gokarneshan, Department of Textile Technology, Park College of Engineering and Technology, Coimbatore, Tamil Nadu, India, Email: advaitcbe@rediffmail.com

## Abstract

The effectiveness of newer types of silk surgical sutures have been critically evaluated and their influence in the surgical operations studied. A variety of suture materials are available for primary wound closure following oral surgical procedures. The aim was to review the tissue reactions to the various suture materials used in oral surgical interventions. Closing the surgical incision is an important step in the surgical procedures, the success of surgery is sometimes compromised by the defective suturing techniques or improper suturing materials, black silk sutures are more or less most often used materials in the day today surgical procedures, but these suture materials demand more time and effort from the surgeon and there is a need to substitute these materials with more user friendly and more successful wound closing materials such as cyanoacrylates. This study intends to compare effectiveness of the black silk sutures with cyanoacrylate adhesives in closing the surgical incisions. Trachoma causes blindness through an anatomical abnormality called trichiasis (lashes touching the eye). Trichiasis can recur after corrective surgery. We tested the hypothesis that using absorbable sutures instead of silk sutures might reduce the risk of recurrent disease among patients with major trichiasis in a randomized trial. The purpose of the study was to treat silk sutures with natural fungal pigment namely Thermomyces of different concentrations 1.5%, 2.0% and 2.5%, and to analyze its effect on the properties of silk sutures such as tenacity, knot strength, friction and antimicrobial activity.

Drug loaded antimicrobial silk suture have been developed for use in both wound closure and wound healing with an intention to prevent surgical site infections. The material has been analysed for various suture properties such as tensile strength, elongation, knot strength, bending properties and diameter. The suture material is coated with chitosan (biopolymer) and incorporated with herbal drug. Cold maceration technique is used to extract Cynodon dactylon drug for the study. The findings of the various studies mentioned herein are discussed in the subsequent sections of the article.

**Keywords:** Antimicrobial property; Silk; Tissue reaction; Cyanoacrylate glue; Absorbable; Fungal extract

## Introduction

In many surgical interventions there is a need to close the primary wound with a previously raised flap. Hence, different types of suture materials are available that can be categorized based on their origin (organic and synthetic) or based on their durability in host tissues (absorbable and non absorbable) [1,2]. Healing requires that the surgical wounds are properly closed. It requires close approximation of wound edges using suitable means and techniques. Healing complications arise following surgery due to one or more of the following reasons:

- a) Inadequate preoperative assessment.
- b) Faulty or traumatic surgery.
- c) Inadequate post-operative care.

Normally the wounds create problems relating to reinfection/infection during the process of healing. It is more so with oral wounds due to the increased problem appearing as

plaque and food and impaired wound healing. Globally, trachoma is identified as the major contributing factor in blindness [3]. Chronic inflammation of the conjunctivitis results from repeated incidents of ocular Chlamydia trachomatis infection in early childhood. Such inflammation results in scarring of conjunctival tissue that could lead to the rolling in of eyelids and scratching of the lashes on the surface of the eye (trachomatous trichiasis [TT]). In the end, continued abrasion of lashes and secondary bacterial infection lead to blinding corneal opacification (CO). A crucial aspect of the surgical process is the wound closure with suture materials. Sutures are natural or synthetic textile biomaterials widely used in wound closure, to ligate blood vessels and to draw tissues together [4]. Sutures consist of a fibre or fibrous structure with a metallic needle attached at one of the fibre ends and they can be classified into two broad categories namely absorbable and non-absorbable sutures. The most crucial requirements of suture materials are physical and mechanical properties, handling properties, biocompatibility,

and antimicrobial nature [5]. Till date, there is no single suture material which can fulfill all the crucial requirements of sutures [6]. Sutures are natural or synthetic materials available in monofilament, multifilament, twisted and braided forms, used in wound closure, ligates injured blood vessels and to draw tissues together [7,8]. These comprise of absorbable and non absorbable types and attached with a metallic needle at one of the fibrous ends. The properties such as physical, mechanical, handling, biological, and biodegradation as considered crucial for suture materials, and are related to each other [9,10].

### Tissue Reactions to Silk Sutures

A suture material should comprise of the following critical parameters:

- a) Knot safety,
- b) Stretch capacity,
- c) Tissue reactivity, and
- d) Wound safety.

The selection of the suture material can also affect the healing of the incised soft tissues apart from the surgical and suturing method practiced [11]. Some cases have been reported relating to complications after the use of a sub epithelial connective tissue graft where an abscess occurred after the primary phase of healing [12]. The investigation has revealed that a probable cause of the abscesses could result from stitch abscess or reaction to the suture material used for the submerged sutures. Hence the choice of the suture material is to be taken into account during treatment planning for oral surgical interventions. An inflammation indicates the tissue reaction and occurs during the first two to seven days after the tissue has been sutured. Many investigations in the past have reported that synthetic materials show a better behavior to oral tissues with regard to tissue inflammatory reactions than non-synthetic suture materials [12-27]. Suture materials such as cotton, braided silk, polyester, nylon, and cat gut have been frequently studied with regard to tissue reactions. But, there are speculations over the outcomes of the investigations. Polyester sutures have been reported to cause a mild inflammatory reaction whereas cotton threads have been associated with an intense tissue inflammatory response. Other commercially available suture materials include polyglycolic acid (PGA) and polyglactin 910 (derived from copolymerization of glycosides and lactides) and have been labeled as “desirable suture materials” [28]; nevertheless, controversy persists over the efficacy of suture materials. It has been reported the bacterial count over the braided silk and PGA sutures to be similar; conversely, other studies have reported that silk sutures are more susceptible to bacterial invasion and severe tissue inflammatory reactions compared to other suturing products. However, in terms of cost-effectiveness, silk continues to enjoy its status as an “inexpensive” suture material as compared to other non-absorbable suture materials. As the selection of the suture

material used in oral surgical interventions may play a role in optimal post surgical wound healing, it has been focussed to review the tissue reactions to the various suture materials used in oral surgical interventions.

In the case of dental and medical surgeries a number of suture materials are being used. But, surgeons should understand the nature of the suture material, the mechanism of healing process, and the interaction between the suture material and the surrounding tissues. It is a serious problem since the surgeon should ensure that a suture would retain its strength until the tissues of the previously raised surgical flaps gain adequate strength to maintain the wound edges together. Till today the research details relating to the effectiveness of different materials are questionable and not consistent. Hence efforts have been directed to review the tissue reactions to various suture materials used in oral surgical interventions. In the case of dental and many other surgical procedures, silk has been the most traditionally used suture material [29]. Despite silk being economical and easier to handle than other non absorbable suture materials it should not be considered as a “material of choice” for oral surgical interventions [30]. Studies on oral tissue reactions to sutures have revealed constant inflammatory reactions, which are most prominent with silk and cotton and minimal with others including nylon, polyester, ePTFE, polyglactone 25 and PGA. A histological study compared the oral tissue reactions to various suture materials.

The results showed the presence of a large number of neutrophilic polymorpho nuclear leukocytes in the premises of silk sutures which were less intense in oral tissues farther from silk sutures. Another finding was that fibroblasts and new capillaries formed at a slower pace in the oral tissues in the vicinity of silk sutures compared to tissues farther from the silk sutures. This may be a justification for the delayed healing and severe tissue reactions associated with silk sutures. Another factor that may instigate tissue reactions is the capability of bacteria to adhere to various suture materials. In an in vitro study, the capability of bacteria to adhere to various types of sutures to cause tissue reactions has been investigated. The results showed that bacterial adherence to braided silk sutures was five- to eight folds higher as compared to nylon to which the least numbers of bacteria adhered. In another study, colonization on various intraoral suture materials from patients microbial having undergone dentoalveolar surgery was investigated. The results showed a larger numbers of bacteria on silk as compared to polyglactone 25. In an experimental study, the inflammatory responses in oral tissues sutured with silk and ePTFE by recording the presence or absence of bacterial plaque along the suture track has been investigated.

The results showed that bacterial plaque was present in 10 out of the 11 silk and four out of the 11 ePTFE suture channels. These studies may act as possible explanations to the minimum tissue reactions evoked in nylon and polyglactone

25 as compared to braided silk sutures. Thus, the different rates of bacterial adherence to various suture materials support the hypothesis that bacterial adherence to sutures plays a significant role in the induction of tissue reactions. Since sutures are immediately contaminated as soon as they contact the oral cavity, it is recommended that sutures should be opened just before being passed through the gingival tissues in order to minimize complications such as stitch abscesses. It is well known that systemic conditions such as poorly controlled diabetes mellitus and cardiovascular disease are directly associated with oral inflammatory conditions [31-35]. Therefore, it may be hypothesized that the massive inflammatory response induced by such confounding factors may "mask" the tissue reactions provoked by the suture material. Data from the clinical studies, included in the present review, revealed that all participants were systemically healthy; therefore the influence confounding parameters (such as those mentioned previously) may be overruled. Diabetic rats have been investigated for tissue reactions to silk, catgut, and Polyglecaprone 25. The study of diabetic and control groups reveals similar activities of silk and catgut. There is no clarity regarding whether this similarity in tissue reactions between the two suture materials be attributed to diabetes control or to the properties of the suture material. The use of tobacco products and smoking are other confounding factors that can also support oral mucosal [36-38]. Owing to inadequate data relating to tobacco habits in such investigations, further clinical trials would be required to study the role of tobacco habits as a confounding factor in suture-induced tissue reactions.

### Silk Sutures vs Cyanoacrylate Adhesive in Human Mucosa – A Clinical Trial

Suitable material like sutures or tissue adhesives needs to be used for the area to be healed through proper wound closure method. Over the years surgical sutures have been used and different materials ranging from human hair to the recently developed silk sutures are attempted so as to attain a safe closure of wounds. However, despite advanced suture materials and methods situations do arise when the wound closure is not satisfactory and can lead to complications like fistulation and granuloma formation, that could arise mainly due to incompatibility of suture materials per se. Also, the suture materials have innumerable setbacks like cutting through the debris. Thus there is a necessity for an increased focus in prevention of occurrence of infection by way of maintaining an aseptic environment and careful manipulation of tissues during surgical process to prevent or minimize the post-operative complications parenchymal and inflammatory tissues during suturing.

The capillary action of braided or twisted black suture materials, result in increased risk of wound infection, prompting the requirement for suture removal on the seventh day following

surgery with non-resorbable suture materials, which creates discomfort to the patient and possibility of early/delayed resorption of suture material with absorbable sutures leads to wound dehiscence or wound re-infection. Besides these, the manipulation of tissue margins with such suture materials necessitate 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 as otherwise would lead to tearing of the wound margins/necrosis with excess forces or else, slackness in suture leading to gaping between the wound margins leading to partial healing or re-infection/scarring. Further the appearance of diseases such as AIDS, Hepatitis etc. That involve great risk of transmission through needle prick also apprehends the surgeons in implementing this process. It has resulted in the introduction of easier method of wound closure through use of tissue adhesives that are meant to minimize the effort and also avoids the risk of needle prick and tissue tears while closing the wound margins. Thus the use of such tissue adhesives is growing and currently there is a growing necessity to critically assess and test such tissue adhesives to find out their effectiveness, merits and setbacks over the currently used contemporary techniques 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.

In a number of materials attempted, Butyl cyanoacrylate satisfies most of the properties expected of a tissue adhesive. Though such materials' adhesive properties have been identified earlier when initially the alkyl forms and ethyl forms were tried as tissue adhesives, but have been discontinued due to their toxic reactions with the tissues and in their place N-butyl-2-cyanoacrylate (Histoacryl) has been attempted as it showed merits such as achieving immediate haemostasis, and apart from being easy to use it also possessed bacteriostatic properties and rapid adhesion to hard and soft tissues [39]. The use of cyanoacrylates 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 cyanoacrylate, it has been reported that butyl and isobutyl cyanoacrylates are non-carcinogenic and non-toxic in living organisms unlike ethyl and methyl cyanoacrylate compounds, evaluate and test these tissue adhesives to find out their effectiveness, advantages and drawbacks over the presently used contemporary methods and materials [40-55].

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By means of suitable approximation of the wound corners and appropriate separation of the wound the wound healing can be improved after its closure. There is superficial contamination of the wound following surgery which generally results in delayed epithelialization of the wound surface and the production of excessive granulation tissues. Such factors result in surgical failure in yielding the desired outcome and result in lead to greater pain and discomfort after surgery. The healing is hindered by plaque, food debris and excessive manipulation of tissues during surgery. The incidence of infection can be reduced by careful attention to asepsis and gentle handling of the tissues to prevent the implantation of foreign material into them. Postoperatively the immediate concern is the protection of the tissues and to control the infection while healing. Healing is improved by immobilization of the healing area. Immobilization of healing area can be achieved by suture or tissue adhesive.

Post-operative clinical evaluation of the cases in this study clearly revealed that the sites which were closed with silk sutures showed longer duration and more dense inflammation when compared to the sides treated with the cyanoacrylate, this is possible because of the irritation and trauma from the sutures and collection of food particles on the sutured area, moreover the blood coagulum which fills the defects to protect the incision from outside influence probably gets effected by the fibrinolytic effect of the saliva during the healing period 18 whereas the adhesion of the two margins of the incision by the cyanoacrylate leaves no space for salivary interference during healing, thus the isolation of the wound margins from the saliva and food debris/plaque appears to be added advantage provided by the use of adhesive materials like cyanoacrylate for closing the incision margins post operatively, it is also observed that cyanoacrylates has antimicrobial activity, bacteriostatic effects against gram positive microorganisms of n-butyl-2cyanoacrylate have been also reported by Tse [56]. Schmaisner reported that it had bactericidal activity against 10 test bacilli [57]. This study showed that the amount of inflammation on the sutured and glued incision line was different because the epithelialization on the sutured side was not uniform and there was significant scar formation. Besides the soft tissue applications, cyanoacrylates have also been used for the hard tissues. The use of n-butyl-2-cyanoacrylate adhesives in the surgical treatment of fractures

is found to hold great potential and it is found that n-butyl-2cyanoacrylate was nontoxic, non-mutagenic and non-carcinogenic [51]. In certain investigations use of agar overlay tissue cultures has revealed that fibroblast cell death around a disc of n-butyl-2-cyanoacrylate advanced at a slow rate showing its moderate toxicity on fibroblasts in vitro [58,59]. Investigation by means of clinical and electron microscopic study has not shown any evidence of such kind. Thus this investigation favours the use of cyanoacrylate as an effective technique for closing the incision margins.

### Comparison of Absorbable and Silk Sutures in Surgical Therapy

The major cause of infection leading to blindness in the world could be attributed to Trachoma [60]. Active trachoma or chronic conjunctival tissue could result from recurrent events of ocular Chlamydia trachomatis infection in early childhood. This inflammation results in scarring of conjunctival tissue, resulting in rolling of the eyelids to roll in (entropion) and scratching of the lashes on surface of the eye (trachomatoustrichiasis [TT]). Finally it leads to blinding corneal opacification (CO) arising due to the continual abrasion of lashes and secondary bacterial infection. Many nations have reported on the prevalence of blinding trachoma. Above 40 million people, majority of them being children have been found to have active trachoma at a given time, 8 million people have trichiasis and a further 8 million are estimated to be blind or visually impaired from the disease [61]. The maximum cases of active trachoma and trichiasis in the world have been found in Ethiopia, with a large number of unoperated cases of TT. Endemic countries are striving to control this disease through the implementation of the SAFE strategy: surgery for trichiasis, antibiotics for infection, facial cleanliness and environmental improvements to reduce transmission [62].

Surgery has been performed to rectify the entropion, lifting the eyelashes off the cornea in order to prevent blindness from trichiasis. Ophthalmic services are normally restricted in trachoma endemic settings. Hence, specially trained nurses usually perform the surgery in the community. Many varied procedures have been attempted during the past century [63]. However, trichiasis often recurs either due to certain intrinsic restriction or quality of the surgery, or due to progressive scarring. Studies of trichiasis recurrence rates following surgery conducted under "operational" conditions have consistently shown disappointing outcomes, with usually at least 20% recurrence by 1 y and up to 62% at 3 y [64-70]. Moreover, these poor surgical outcomes undermine other efforts to prevent blindness from trachoma. Context-appropriate interventions to improve results are urgently needed. Several factors contribute to recurrent trichiasis, which can be divided into early surgery-related and later disease-related factors. Data from prospective studies suggest that the majority of recurrent trichiasis develops within 6 mo of surgery, indicating the importance of how the surgery is performed [71-73].

Randomized controlled trials (RCTs) of alternative procedures indicate that bilamellar tarsal rotation (BLTR) and posterior tarsal rotation (PLTR) procedures are associated with the lowest recurrence rates, leading to the World Health Organization's (WHO) recommendation of their use [74,75]. However, recurrence rates for both procedures are quite high [76-78]. The quality of surgery is important, indicated by significant variation in the results of different surgeons. Suture type, positioning, and tension are likely to be important aspects of surgical technique that contribute to TT recurrence. Silk sutures are used as standard in trichiasis surgery and need to be removed 7-10 d postoperatively. At this stage the incision may not have reached a state of stable wound healing, because of the scarred nature of the diseased tissue. The use of absorbable suture materials, such as polyglactin-910, which is commonly used in ophthalmic and other surgery, may provide more prolonged and stable fixation of the tissue in the desired position while healing is taking place [79]. Study of surgical outcomes has shown that recurrence rates were significantly lower in individuals who had received long-lasting absorbable sutures (0.8%) compared to those with silk sutures (43.5%). Test has been carried out on the hypothesis of using absorbable polyglactin-910 sutures can reduce the postoperative trichiasis recurrence rate than the existing standard silk sutures, in a randomized trial.

The investigation has many merits including the large size, high follow-up rates, good balance of clinical and demographic characteristics between the randomization groups, the fact that observations at each time point were made by a single observer, and that outcome measures were determined by masked individuals. There were slightly more individuals in the polyglactin-910 group who were lost to follow-up at 12 mo. But, majority of the participants were out of the study circle and hence the small difference cannot be ascribed to effect of treatment. Even after following careful standardization procedures, certain variation has still been found between the findings of the various surgeons, showing the importance of how the surgery is performed. These may include subtle variation in the length of the incision or the tension on the sutures. Individuals with minor trichiasis were excluded from this trial and enrolled into a separate trial evaluating the efficacy of surgery versus epilation [80]. However, we are unaware of any reason to think that these findings could not be generalized to the full range of trichiasis severity. It would be interesting to know if there were significant differences in the participants' experience of the different sutures used in this trial and their perspectives on the potential benefit of not needing to have the absorbable sutures removed; however, we did not formally investigate this.

Detecting differences in changes in both corneal disease and visual acuity would probably require a longer follow-up period. Polyglactin-910 absorbable sutures had a similar risk of trichiasis recurrence to silk sutures for PLTR TT surgery

and comparable secondary outcomes. But, when viewed from a programmatic point of view, polyglactin-910 presents the major merit in which patients do not have to be seen soon after surgery for suture removal. The postoperative review can be delayed for 3-6 months, which could permit to better determine who needs additional surgery and offset the slightly higher cost of absorbable sutures. It is necessary to take into account the logistical merits of using absorbable sutures as far as the selection of suture material is concerned.

### Antibacterial Silk Sutures with Natural Fungal Extract

A number of options are available for the surgeon today regarding selection of suture material and he can select them depending upon their availability and his familiarity. Owing to its beneficial properties silk which is a natural non-absorbable suture material has been used over many years as biomedical suture. But, the low microbial resistance property is one of the major setbacks related to the silk. Various antimicrobial agents have been used on silk sutures by many research workers for imparting antimicrobial properties. Silver doped bioactive glass powder has been used to coat silk surgical suture [81]. Recently, investigations on the influence of chitosan coating on the properties of silk sutures have been carried out [82]. In another investigation tetracycline coating on silk sutures has been attempted the influence of tetracycline treatment on silk suture characteristics has been studied [83]. Recently, antimicrobial finishing of textiles using microbial dyes have received greater attention as they require less labour, land, and cost effective solvents for extraction as opposed to higher plant materials. In this study, silk sutures are treated with *Thermomyces*, a natural fungal extract and its effect on the properties of silk sutures such as antimicrobial activity, friction, tenacity and knot strength are studied.

Silk suture produced was treated with natural fungal extract at optimum concentration and the effects of natural fungal treatment on the suture properties were studied. The result showed that the tenacity and knot strength of silk braided sutures increased compared to the untreated silk suture. The frictional properties of both the fungal treated silk suture and the untreated silk suture were determined by the dynamic coefficient of friction and there is a slight reduction in frictional value found in the treated silk suture compared to the untreated silk suture. The uniform deposition of natural fungal pigment on to the surface of the silk braided suture was confirmed by Scanning Electron Microscopy [84]. The antibacterial activity of fungal treated silk braided suture at optimum concentration against *S. aureus* and *E. coli* is found to be good compared to the untreated silk suture. The result suggests that the silk suture treated with optimum concentration of the natural fungal pigment is appropriate to retard the exponential growth of *S. aureus*, a gram-positive bacterium and *E. coli* a gram-negative bacterium and hence silk sutures can be developed with the required characteristics for healthcare applications.

## Herbally Treated Silk Suture

Most infections that take place in the surgical area arise from sutures, within a month following a surgery or before a year in case of an implant being left in place after surgery affects the incision or deep tissues in the operated area [85]. Since the suture is a foreign material in a surgical wound, it renders the surrounding tissues of wound prone to infections [86]. Presence of bacteria in the surgical wound contaminates the tissues as well as the suture material, and thus results in ineffectiveness in decontaminating the wound [87]. Bacterial attachments and colonization occur in all suture material and leads to surgical site infections [88]. Implants have non-shedding surface, skin or other bacteria to form an extra cellular matrix (biofilms), protecting the bacteria from host defense factors [89,90]. Such biofilm bacteria are not easily treatable and they do not respond so well sensitive to antibiotics and antiseptics. It is necessary to remove the implant, and antibiotic treatment is essential if biofilms infection is formed [91]. In order to overcome this, many antimicrobial sutures were developed by incorporating suitable antibiotics, antiseptics or their combination. Triclosan, commonly used in the antimicrobial sutures, was found to have some demerits such as prematurely change of tadpoles into frogs and reduced sperm production in male rats [92].

Silk is a natural biomaterial that is constituted of fibroin, and aids cell attachment and proliferation. It can also produce a knot of good quality [93,94]. Owing to its biodegradability, biocompatibility, nontoxicity, and anti tumour characteristics chitosan is considered as one of the most valuable polymers for biomedical and pharmaceutical applications [95,96]. As chitosan stimulates hemostasis and accelerates tissue generation, it proves beneficial to wound healing [97]. Suture materials are normally coated with silicon or wax was found to create inflammatory and thrombotic response to the tissues [98]. Coating with chitosan prevents inflammation as well as scar formation with and provides antimicrobial property since silk is easily prone to microbial infection [99].

Aqueous extract of *Cynodondactylon* ( a traditional herb), commonly called as Bermuda grass was evaluated for their antioxidant, anti inflammatory action while its fresh juice has shown the immunomodulatory and DNA protective activity [100-102]. The ariel part extract of *Cynodondactylon* was found to possess alkaloids, phenols, tannins, and flavonoids on preliminary screening. An antibacterial effect and wound healing property of the grass was investigated by many researchers [103-108]. The main focus has been to develop an antimicrobial silk suture preventing SSI by using natural materials having rich medicinal values, which includes biomaterials and medicinal plants.

Silk has been used as a suture material and fabricated using a circular braiding machine. The silk suture is coated with chitosan (a biopolymer) and incorporated with *Cynadolandactylon* (a natural drug). The coated suture is found to have good properties.

In order to obtain optimum antimicrobial efficacy, response surface optimization process using Box-Behnken experimental design is applied. It is found that 1.7% chitosan and 7% drug at 600C has optimum antimicrobial efficacy with effective bacterial reduction percentage against *S.Aureus* and *E.Coli*, when subjected to antimicrobial study.

## Conclusion

In the case of primary wound closures subsequent to oral surgery, many suture materials are available. Study has been done on the tissue reactions to the various suture materials used in oral surgical interventions. Various textile materials have been explored. Polyglactin 910 sutures were associated with the development of stitch abscess in one clinical study. Eight studies reported that tissue reactions are minimal with nylon sutures. Tissue reactions to suture materials used for oral surgical interventions may vary depending on the surface properties and bacterial adherence properties of the material. Comparative clinical and histological studies between silk sutures and cyanoacrylate adhesive has revealed that the use of cyanoacrylate glue has resulted in less postoperative inflammation and good clinical and histological healing when compared to the silk sutures. Silk sutures have been compared with absorbable polyglactin-910 sutures for post surgical effectiveness. There was no evidence over use of absorbable polyglactin-910 sutures was associated with a lower prevalence of trichiasis recurrence at 1 year post surgery than silk sutures. However, from a programmatic perspective, polyglactin-910 offers the major advantage that patients do not have to be seen soon after surgery for suture removal.

The postoperative review after surgery using absorbable polyglactin-910 sutures can be delayed for 3–6 months, which might enable us to better determine whether a patient needs additional surgery. The silk sutures have been treated with natural fungal pigment-*Thermomyces* of different concentrations to analyze its effect on the properties of silk sutures such as tenacity, knot strength, friction and antimicrobial activity. Silk suture treated with optimum concentration of the natural fungal pigment is appropriate to retard the exponential growth of *S. aureus*, a gram-positive bacterium and *E. coli* a gram-negative bacterium and hence silk sutures can be developed with the required characteristics for healthcare applications. Antimicrobial silk suture has been developed for analysis of wound healing and closure so as to avoid surgical site infections. The treated silk material has been investigated for a number of properties. The suture material has been coated with biopolymer chitosan (biopolymer) and incorporated with herbal drug. The drug loaded samples are subjected to antimicrobial study (AATCC 100) against *S. aureus* and *E.Coli* and found to have effective bacterial reduction percentage. Hence, the natural drug loaded suture material could prove a better alternative for synthetic drug loaded suture that is found to have certain disadvantages.

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