Original Article

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Dentistry Section

Oral Surgical Site Infections and Wound Healing Associated with Silk Fibroin Sutures versus Alternative Suture Materials: A Systematic Review

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ABSTRACT

Introduction: Delayed or improper wound healing can lead to Surgical Site Infections (SSIs), which are associated with increased mortality, morbidity, readmission rates and healthcare costs. Dental sutures are routinely used to close wounds, promote haemostasis and prevent infection. Although non absorbable sutures are preferred for promoting wound healing and preventing infection, Silk Fibroin (SF) sutures are still used due to their affordability and favourable properties. However, their multifilament structure makes them susceptible to higher bacterial adherence.

Aim: To compare the effectiveness of SF sutures in reducing SSIs and promoting wound healing with other suture materials used in dental procedures.

Materials and Methods: A systematic review was conducted following the Preferred Reporting Items for Systematic Reviews and Meta-analyses (PRISMA) 2020 checklist. PubMed, University of Toronto libraries and the Web of Science (WoS) were searched using specific keywords until January 4, 2025. Data were extracted and a risk of bias assessment was performed using the Risk of Bias 2 (RoB 2) and Risk of Bias In Non randomised Studies - of Interventions (ROBINS-I) tools. Nine studies were included.

Results: The study demonstrated that non resorbable multifilament SF sutures show high microbial adherence and prolonged wound closure time compared to other materials, due to their multifilament and braided structure. However, significant infections were rarely reported. Results regarding bleeding, pain and swelling varied across studies and were mostly non significant on day 7.

Conclusion: Antiseptic or antibiotic coatings on SF sutures can reduce bacterial adherence and lower the risk of infection, especially given their significantly higher adherence compared to other sutures.

Keywords: Bacteria, Oral surgical procedures, Surgical wound infection

INTRODUCTION

Wound closure is critical after oral surgery since the oral cavity is home to numerous microbes that can cause diseases such as gingivitis, dental caries, dysbiosis, periodontal disease and even oral cancer if wounds remain open for too long [1,2]. Wound healing follows sequential and overlapping phases: the haemostatic, inflammatory, proliferative and maturation phases [3].

The haemostatic phase starts within minutes after suturing and involves vessel constriction and fibrin clot formation [3]. The inflammatory phase, which lasts for about 72 hours, is characterised by pain, heat, swelling and redness [3]. The proliferative phase lasts for days to weeks, during which the fibrin clot is replaced by granulation tissue and immature type III collagen [3]. The final maturation phase can last from months to years, during which granulation tissue and type III collagen are replaced with type I collagen [3].

Despite these well-defined healing phases, bacterial colonisation at the surgical site remains a significant challenge, potentially leading to SSIs. SSIs are a considerable clinical concern, affecting approximately 10% of healthy individuals and over 25% of immunocompromised individuals [3,4]. SSIs may cause symptoms such as swelling, bleeding, pain, abscess, fever, or dry socket [4].

Sutures are conventionally used in oral surgeries to close wounds, promote haemostasis and prevent infection [3,5,6]. Sutures vary by material—natural or synthetic, monofilament or multifilament, braided or twisted and absorbable or non absorbable-each with different susceptibilities to microbial adherence and biofilm formation [7,8]. Absorbable sutures, such as Vicryl and Monocryl, are primarily preferred because they naturally dissolve within a month, reducing the risk of new wound formation during suture removal and promoting faster healing [3]. Monofilament sutures are associated with less inflammation but can be challenging to handle and may irritate the oral mucosa with their sharp ends. Consequently, multifilament sutures like SF are still commonly used for their low cost, ease of use, knot security and workability [9-11].

The SF is a natural, non absorbable, multifilament suture [12-14]. However, its multifilament [15] and braided nature results in higher bacterial accumulation [9,16-25] due to increased surface area and the wicking effect, raising concerns about potential infection risks. Nevertheless, SF-based biomaterials have proven to be ideal for a range of applications, including 3D scaffolds [26,27], drug delivery [26,28,29], tissue regeneration [30,31], bone tissue scaffolds [31,32] and even cancer studies [26,33]. Given SF's broad applications and biocompatibility, a clearer understanding of its use in post-surgical oral wound healing is required, especially regarding bacterial accumulation and infection risk compared to other sutures. Some studies have shown lower bacterial accumulation on SF compared to resorbable or antibiotic-coated sutures [34,35], thus necessitating a reanalysis of SF suture applications.

The present systematic review aims to compare the effectiveness of SF sutures in reducing SSIs and promoting wound healing with other suture materials used in dental procedures. It addresses this gap by analysing randomised and non-randomised clinical trials and

studies published since 2014, focusing on the use of SF and other sutures in dentistry for postsurgical infection and wound healing.

MATERIALS AND METHODS

The systematic review was registered with International Prospective Register of Systematic Reviews (PROSPERO) on the Centre for Reviews and Dissemination (CRD) York website (registration number: CRD42022320591). Findings were reported according to the Preferred Reporting Items for Systematic Reviews and Meta-analyses (PRISMA) 2020 checklist. No ethical approval was required, as the original studies had obtained it.

The Population, Intervention, Comparison, and Outcome (PICO) framework was used to define the research question and guide the study design:

Population (P): Patients undergoing oral surgeries;

Intervention (I): SF sutures;

Comparator (C): Non SF sutures;

Outcome (O): Assessment of wound healing and incidence of SSIs.

Inclusion criteria: Until January 4, 2025, articles were searched that evaluated the effectiveness of SF sutures compared to other sutures for post-surgical wound healing. No restrictions were applied regarding patients' age, gender, diagnosis, or country. Articles were included if they: (i) were randomised and non randomised clinical trials and studies; (ii) involved patients undergoing dental surgery; (iii) used SF and other sutures at the surgical site; (iv) assessed wound-related parameters, including bacterial adherence, bleeding, inflammation, wound healing, wound infection, pain, plaque and swelling; (v) were published in or after 2014; (vi) were published in English; (vii) had direct access to the full text; (viii) reported ethical clearance or approval; and (ix) were published in journals indexed in Scopus, Web of Science (WoS) or PubMed.

Exclusion criteria: Studies were excluded if they: (i) were non comparative; (ii) compared SF sutures only with antibacterial SF sutures; (iii) were abstracts, animal studies, book chapters, books, corrigenda, corrections, discussions, editorials, errata, in-vitro or in-silico studies, letters to the editor, patents, retracted articles, retrospective studies, or review articles; (iv) did not involve sutures; and (v) compared SF sutures with non suture materials.

Study Procedure

Search strategy: Articles were retrieved from PubMed, WoS and the University of Toronto (UoT) Libraries using the following keywords: "silk" AND "dental materials," "silk" AND "dentistry," "silk" AND "oral diseases," "silk" AND "oral infection," "silk" AND "oral surgery," "silk" AND "oral surgical site," "silk" AND "oral wound healing," and "silk" AND "silk proteins." The filter for articles published between 2014 and 2025 was applied in each database and for WoS and UoT, articles were retrieved specifically with filters for article type and English language.

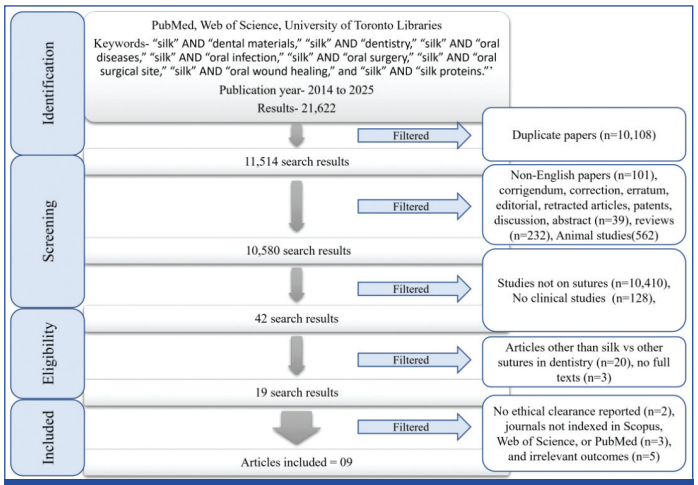
Selection process: All database results were downloaded as Comma Separated Values (CSV) files, compiled and filtered to remove duplicates. Duplicates were deleted and papers were sequentially filtered based on non English articles, not randomised or non randomised clinical trials and studies, animal studies, non suture-related research, non dentistry studies and lack of direct access to the full text. Full-text articles were then assessed for relevance and further excluded if they did not report ethical clearance, were published in journals not indexed in Scopus, WoS, or PubMed, or if outcomes were not clearly reported or relevant. Three reviewers (KKRE, NK and ER) independently screened titles and abstracts according to inclusion and exclusion criteria. Discrepancies were resolved through reanalysis and discussion.

Data items and Synthesis method: Two reviewers (NK and ER) independently collected data on the outcomes of SF use in dentistry for post-surgical infection-related parameters from the included studies. Data were extracted using a custom template, capturing details such as: (a) authors and year; (b) country; (c) type of study; (d) field of use; (e) materials under study; (f) number and characteristics of patients (number, age and gender); (g) group(s); and (h) assessment parameters.

Risk of bias assessment: To validate study eligibility, two reviewers (NK and ER) assessed the risk of bias during data extraction. For randomised trials and studies, the Cochrane Collaboration's RoB 2 tool [36] was used to assess the risk of bias arising from: (i) the randomisation process; (ii) deviations from the intended interventions (effect of assignment to intervention); (iii) missing outcome data; (iv) measurement of the outcome; and (v) the selection of the reported result. For non randomised studies, the ROBINS-I tool [37] was used to assess the risk of bias arising from: (i) confounding; (ii) participant selection into the study; (iii) classification of interventions; (iv) deviations from intended interventions; (v) missing data; (vi) measurement of outcomes; and (vii) selection of the reported result.

RESULTS

Data extraction was conducted according to the inclusion and exclusion criteria described earlier. Following that, papers were further filtered to refine the search results. A total of 21,622 papers were initially compiled (8,596 from PubMed, 8,690 from WoS and 4,336 from the UoT Libraries), from which 10,108 duplicate papers were removed. Additional papers were excluded based on the following criteria: non English language (101); corrigenda, corrections, errata, editorials, retracted articles, patents, discussions and abstracts (39); review articles (232); animal studies (562); studies not related to sutures (10,410); studies that were neither randomised nor non randomised clinical studies or trials (128); studies that did not compare SF sutures with other sutures (20); and papers with no direct access to the full text (3). Papers were further excluded if they did not report ethical clearance (2), were published in journals not indexed in Scopus, WoS, or PubMed (3) and where outcomes were either not clearly presented or relevant (5). In total, nine papers were included in the study [Table/Fig-1].



[Table/Fig-1]: PRISMA flowchart. The flowchart depicts the search strategy and the number of articles screened, filtered and included in this study.

Study characteristics and synthesis: Data on the use of SF sutures in dental applications for post-surgical infection management and wound healing were available across all nine trials, with a total of 270 participants. Due to the heterogeneity of interventions and comparators across studies, a meta-analysis was not possible, leading to a qualitative synthesis to summarise and interpret the findings.

The included studies provided insights into the use of SF as a suture material in various dental and surgical applications, including periodontal surgery [19], molar extractions [9,16,18,38,39], odontectomy [21,40] and intraoral wound healing [22]. The key characteristics of each study are summarised in [Table/Fig-2]

[9,16,18,19,21,22,38-40]. Briefly, the study included four randomised clinical studies [16,18,38,39], one randomised clinical trial [19] and four non randomised clinical studies [9,21,22,40] conducted across multiple countries, including Türkiye [38], India [9,22], Iran [19], Indonesia [21,40], Serbia [39] and Italy [18]. Sample sizes ranged from 12 to 40 participants, primarily adults aged 16 to 63 years, with balanced gender distributions.

The studies compared SF sutures with various other suture materials, including Catgut [21,40], Caprosyn [39], Monocryl [9,16, 19], Monocryl Plus [16,19], Nylon [18,19], Polyglycolide [18], Polyethylene Terephthalate (PET) [38], Prolene [9,39], Polysorb [39] and Vicryl Plus [9,22]. The primary parameters studied were bacterial adherence [9,16,18,19,21,22,39], followed by wound healing [39,40], bleeding [16], infection [16], inflammation [39], pain [38], swelling [38] and plaque accumulation [38].

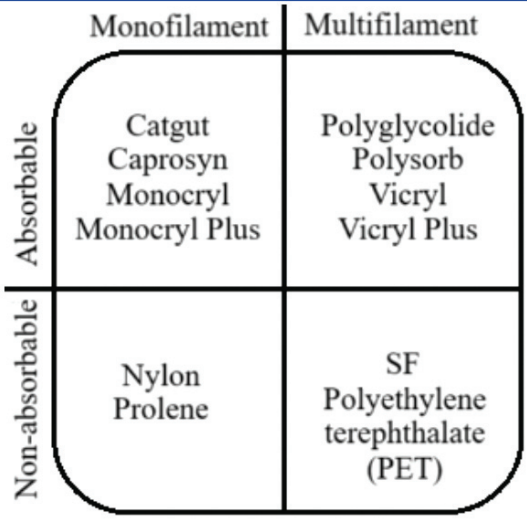
The sutures included in the study [Table/Fig-3] comprised both monofilament and multifilament types, as well as absorbable and non absorbable sutures. Among them, SF and Catgut sutures are naturally derived, while the remaining sutures are synthetic.

Risk of bias in studies: The risk of bias was evaluated for each study and is outlined in [Table/Fig-4] and [Table/Fig-5] for randomised and non randomised studies, respectively. Among the randomised studies [Table/Fig-4], three studies showed a low risk of bias [16,38,39], while two studies showed some concerns [18,19]. In the non randomised clinical studies, Kandathil AM et al., (2023) demonstrated a low risk of bias, while Krishna S et al., (2023) and Syaflida R et al., (2019 and 2021) showed moderate risks [Table/Fig-5] [9,21,22,40].

Results of individual studies: The results of individual studies are summarised in [Table/Fig-6] [9,16,18,19,21,22,38-40]. Briefly,

S. No.	Author (year)	Country	Type of study	Field of use	Sutures	Number and characteristics of patients	Group (s)	Assessment parameters
1.	Dilan OZ et al., (2023) [38]	Türkiye	Randomised clinical study	Impacted lower third molar surgery	SF and Polyethylene Terephthalate (PET)	40 (21 females and 19 males. Aged ≥18 years. Mean age 26.1±7.25 years. Similarly positioned impacted third molars for extraction)	Two	Pain, swelling, plaque accumulation
2.	Kandathil AM et al., (2023) [22]	India	Non-randomised clinical study	Intraoral wound healing	SF, Vicryl Plus and pomade-coated SF sutures	36 (Aged 18-45 years. Required intraoral multiple interrupted sutures for wound closure on the mandibular arch, mandibular vestibule and floor of the mouth)	One	Bacterial adherence
3.	Krishna S et al., (2023) [9]	India	Non-randomised clinical study	Impacted lower third molars surgery	SF, prolene, vicryl plus and monocryl	40 (Aged 20-40 years. Required surgical extraction of impacted lower third molar)	Four	Bacterial adherence
4.	Naghsh N et al., (2023) [19]	Iran	Randomised clinical trial	Periodontal surgery	SF, nylon, monocryl and monocryl plus	12 (11 females and 1 male. Aged 20-40 years. Required periodontal flap surgery in four quadrants)	One	Bacterial adherence
5.	Syaflida R et al., (2021) [21]	Indonesia	Non-randomised clinical study	Odontectomy surgery	SF and catgut	30 (Aged 17 to 59 years. Underwent odontectomy)	Two	Bacterial adherence
6.	Dragovic M et al., (2020) [39]	Serbia	Randomised clinical study	Four impacted molar teeth extraction	SF, Prolene, Polysorb® and Caprosyn®	32 (21 females and 11 males. Aged 18-25 years. Required surgical extraction of four impacted wisdom teeth)	One	Bacterial adherence, wound healing, inflammation
7.	Syaflida R et al., (2019) [40]	Indonesia	Non-randomised clinical study	Odontectomy surgery	SF and Catgut	30 (20-45-year-old with impacted third molar)	Two	Wound healing
8.	Bucci M et al., (2017) [18]	Italy	Randomised clinical study	Third molar extraction	SF, nylon, polyglycolide	30 (18 males and 12 females with ages ranging from 16 to 63 years undergoing third molar extraction)	Three	Bacterial adherence
9.	Sala-Pérez S et al., (2016) [16]	Spain	Randomised clinical study	Mandibular third molar extraction	SF and monocryl plus	20 (10 males, 10 females. Aged 16-45 years. Undergoing removal of four third molars)	One	Bleeding, infection, bacterial adherence

[Table/Fig-2]: Study characteristics [9,16,18,19,21,22,38-40].



[Table/Fig-3]: Suture types in the study. The top left quadrant represents monofilament, absorbable sutures. The top right quadrant represents multifilament, non absorbable sutures, the lower left quadrant represents monofilament, non absorbable sutures and the lower right quadrant represents multifilament, non absorbable sutures. SF and catgut are natural, while the others are synthetic.

Parameters	Dilan OZ et al., (2023) [38]	Naghsh N et al., (2023) [19]	Dragovic M et al., (2020) [39]	Bucci M et al., (2017) [18]	Sala-Pérez S et al., (2016) [16]
Risk of bias arising from the randomisation process	Low	Low	Low	Some concerns	Low
Risk of bias due to deviations from the intended interventions	Low	Low	Low	Low	Low
Missing outcome data	Low	Low	Low	Low	Low
Risk of bias in the measurement of the outcome	Low	Some concerns	Low	Low	Low
Risk of bias in the selection of the reported result	Low	Low	Low	Low	Low
The overall risk of bias	Low	Some concerns	Low	Some concerns	Low

[Table/Fig-4]: Risk of bias evaluation for randomised clinical trials and studies using the RoB-2 tool [16,18,19,38,39].

Parameters	Kandathil AM et al., (2023) [22]	Krishna S et al., (2023) [9]	Syaflida R et al., (2021) [21]	Syaflida R et al., (2019) [40]
Bias due to confounding	Low	Low	Low	Low
Bias in the selection of participants for the study	Low	Low	Low	Low
Bias in the classification of interventions	Low	Low	No information	Low
Bias due to deviations from intended interventions	Low	Low	Low	Low
Bias due to missing data	Low	Low	Low	Low
Bias in the measurement of outcomes	Low	Moderate	Moderate	Moderate
Bias in the selection of the reported result	Low	Low	Low	Low
The overall risk of bias	Low	Moderate	Moderate	Moderate

[Table/Fig-5]: Risk of bias evaluation for non-randomised clinical studies using ROBINS-I tool [9,21,22,40].

Parameters	Sutures	Results		p-value
Dilan OZ et al., (2023) [38]				
Pain (Hours: 3, 6, 12, 24. Days: 2, 3, 4, 5, 6, 7)	SF	Hour 3 Mean: 4.85 Hour 6 Mean: 4.93 Hour 12 Mean: 3.90 Hour 24 Mean: 3.23 Day 2 Mean: 2.85 Day 3 Mean: 2.33 Day 4 Mean: 1.18 Day 5 Mean: 1.08 Day 6 Mean: 0.58 Day 7 Mean: 0.80	Hour 3 SD: 2.43 Hour 6 SD: 2.13 Hour 12 SD: 2.35 Hour 24 SD: 2.30 Day 2 SD: 2.52 Day 3 SD: 2.52 Day 4 SD: 1.99 Day 5 SD: 2.21 Day 6 SD: 1.75 Day 7 SD: 2.20	p>0.05 for all except for 12th hour and 24th hour. Hour 12: 0.011 Hour 24: 0.042
	PET	Hour 3 Mean: 4.23 Hour 6 Mean: 3.95 Hour 12 Mean: 2.55 Hour 24 Mean: 2.13 Day 2 Mean: 2.33 Day 3 Mean: 1.30 Day 4 Mean: 0.83 Day 5 Mean: 0.48 Day 6 Mean: 0.43 Day 7 Mean: 0.43	Hour 3 SD: 2.7 Hour 6 SD: 2.39 Hour 12 SD: 2.37 Hour 24 SD: 2.37 Day 2 SD: 2.41 Day 3 SD: 1.73 Day 4 SD: 1.52 Day 5 SD: 1.36 Day 6 SD: 1.53 Day 7 SD: 1.66	
Swelling (Day 2 and 7)	SF	Day 2 Mean: 3.58 Day 7 Mean: 0.68	Day 2 SD: 6.32 Day 7 SD: 2.32	Day 2: 0.763 Day 7: 0.477
	PET	Day 2 Mean: 3.53 Day 7 Mean: 0.28	Day 2 SD: 4.44 Day 7 SD: 0.93	
Plaque (Day 2 and 7)	SF	Day 2: 50% sutures Day 7: 20% sutures	NA	Day 2: 0.005 Day 7: 0.366
	PET	Day 2: 25% sutures Day 7: 15% sutures	NA	
Kandathil AM et al., (2023) [22]				
Bacterial adherence (Day 3 and 7)	SF	Day 3 Mean: 9.21 Day 7 Mean: 11.50	Day 3 SD: 3.41 Day 7 SD: 4.07	SF vs Pomade-coated SF: 0.0001 SF vs Vicryl Plus: 0.0001 Pomade-coated SF vs Vicryl Plus: >0.05
	Pomade coated SF	Day 3 Mean: 6.5 Day 7 Mean: 7.64	Day 3 SD: 1.94 Day 7 SD: 2.11	
	Vicryl plus	Day 3 Mean: 5.67 Day 7 Mean: 6.89	Day 3 SD: 2.23 Day 7 SD: 2.12	
Krishna S et al., (2023) [9]				
Bacterial adherence (Day 7)	SF	Mean: 36,640	NA	0.001
	Prolene	Mean: 12,225		
	Vicryl plus	Mean: 19,370		
	Monocryl	Mean: 23,715		
Naghsh N et al., (2023) [19]				
Bacterial adherence (Day 7)	SF	Mean: 9.9	SD: 4.38	<0.001
	Nylon	Mean: 5.91	SD: 2.65	
	Monocryl	Mean: 4.3	SD: 2.36	
	Monocryl plus	Mean: 4.62	SD: 2.8	
Syaflida R et al., (2021) [21]				
Bacterial adherence (Day 7)	SF	Mean: 207.38	SD: 173.605	0.186
	Catgut	Mean: 115.15	SD: 158.905	
Dragovic M et al., (2020) [39]				
Bacterial adherence (Day 7)	SF	Mean: 6.87×107	SD: NA	For all, p<0.05, except between SF and Polysorb, p=0.243
	Prolene	Mean: 0.0591×107		
	Polysorb	Mean: 5.43×107		
	Caprosyn	Mean: 0.574×107		
Wound healing (Day 3 and 7)	SF	Day 3 Mean: 3.78 Day 7 Mean: 4.09	Day 3 SD: 0.61 Day 7 SD: 0.69	p=0.000 for all, except between polysorb and caprosyn on day 3=0.499 and day 7=0.480
	Prolene	Day 3 Mean: 4.75 Day 7 Mean: 4.94	Day 3 SD: 0.44 Day 7 SD: 0.24	
	Polysorb	Day 3 Mean: 4.41 Day 7 Mean: 4.66	Day 3 SD: 0.61 Day 7 SD: 0.54	
	Caprosyn	Day 3 Mean: 4.50 Day 7 Mean: 4.72	Day 3 SD: 0.57 Day 7 SD: 0.46	
Inflammatory cells (Day 7)	SF	Mean: 109.94	SD: NA	For all, p<0.05, except between SF and Polysorb, p>0.05
	Prolene	Mean: 2.13		
	Polysorb	Mean: 82.87		
	Caprosyn	Mean: 20.2		
Syaflida R et al., (2019) [40]				
Wound healing (Day 1 and 7)	SF	Day 1 Mean: 2.67 Day 7 Mean: 1.40	Day 1 SD: 0.488 Day 7 SD: 0.507	0.073
	Catgut	Day 1 Mean: 2.93 Day 7 Mean: 1.07	Day 1 SD: 0.258 Day 7 SD: 0.258	0.015
Bucci M et al., (2017) [18]				
Bacterial adherence (Day 7)	SF	Mean: 185.6	SD: 24.1	0.01
	Nylon	Mean: 138.4	SD: 41.0	
	Polyglycolide	Mean: 159.5	SD: 33.7	
Sala Pérez S et al., (2016) [16]				
Bacterial adherence (Day 3 and 7)	SF	Day 3 Mean: 125 cfu/cm/mL Day 7 Mean: 80 cfu/cm/mL	Day 3 SD: 179 Day 7 SD: 169	Day 3: 0.013 Day 7: 0.197
	Monocryl plus	Day 3 Mean: 28 cfu/cm/mL Day 7 Mean: 45 cfu/cm/mL	Day 3 SD: 42 Day 7 SD: 116	
Bleeding (Day 3 and 7)	SF >Monocryl plus			Day 3: 0.752 Day 7: 0.113
Infection (Day 3 and 7)	Only one case of infection on day 3 with SF suture			NA

[Table/Fig-6]: Study results [9,16,18,19,21,22,38-40].

bacterial adherence was measured as the primary outcome by Kandathil AM et al., Krishna S et al., Naghsh N et al., Syaflida R et al., (2021) and Bucci M et al., Kandathil AM et al., (2023) found that SF showed higher bacterial adherence compared to Vicryl Plus; however, pomade-coated SF sutures showed no significant difference compared to Vicryl Plus [22]. Similarly, Krishna S et al., (2023) reported significantly higher bacterial adherence on day 7 for SF compared to Prolene, Vicryl Plus and Monocryl Plus [9]. Naghsh N et al., (2023) observed that SF sutures showed significantly higher bacterial adherence on day 7 compared to Nylon, Monocryl and Monocryl Plus [19]. Syaflida R et al., (2021) found no significant difference in bacterial adherence between SF and Catgut sutures [21]. Bucci M et al., (2017) found that on day 7, SF had significantly higher bacterial adherence compared to Nylon and Polyglycolide [18].

Dilan OZ et al., (2023) assessed pain, swelling and plaque accumulation on SF and PET sutures. They found significantly higher pain scores for SF compared to PET at the 12th and 24th hours. Additionally, plaque accumulation was significantly higher in SF on day 2 (p=0.005) [38]. Dragovic M et al., (2020) studied bacterial adherence (day 7), wound healing (days 3 and 7) and the number of inflammatory cells (day 7) in SF, Prolene, Polysorb and Caprosyn sutures. They found significantly higher bacterial adherence and inflammatory cells in SF compared to Prolene and Caprosyn, but not Polysorb. Wound healing was significantly lower with SF compared to the other sutures [39]. Syaflida R et al., (2019) found no significant differences between SF and Catgut in wound healing [40].

Sala-Pérez S et al., (2016) measured bacterial adherence, bleeding and infection on days 3 and 7 for SF and Monocryl Plus sutures and found no significant differences between the two, except for higher bacterial adherence in SF on day 3 (p=0.013) [16].

DISCUSSION

In oral surgery, achieving successful wound healing while minimising the risk of SSIs is crucial. Sutures play a significant role in wound closure; however, their potential for bacterial colonisation remains a concern. The present systematic review evaluated the performance of SF sutures, a natural, non absorbable, multifilament material, compared to other dental sutures. The results showed that silk sutures exhibit maximum bacterial adherence but pose no or low risk of SSIs. Other parameters, including bleeding, wound healing, pain, swelling, were variable yet comparable to those of other sutures.

Suturing can induce bleeding due to tissue puncture and the suture material affects both the amount and duration of bleeding. Sala Pérez S et al., (2016) reported that SF sutures had slightly higher, though not statistically significant, bleeding than Monocryl Plus on both Day 3 and Day 7 [16]. The amount of bacterial accumulation on a suture often depends on its origin, structure and chemical composition [15]. Notably, SF sutures showed the highest bacterial adherence across studies; however, by Day 7, the difference in adherence between SF and other sutures, such as Monocryl Plus [16], Polysorb [39] and Catgut [40], was not significant.

Bacterial adherence can lead to plaque formation, as demonstrated by Dilan OZ et al., (2023), where SF sutures showed significantly higher plaque on Day 2, though this difference diminished by Day 7 [38]. Accumulated bacteria can also stimulate inflammatory responses, attracting inflammatory cells to the surgical site to initiate healing. This leads to increased pain and swelling. Since a suture should not incite any inflammatory reaction [18], its selection must be carefully considered based on the patient's overall health. Dragovic M et al., (2020) found that by Day 7, SF sutures showed the highest inflammatory cell accumulation compared to Polysorb (p>0.05), Caprosyn and Prolene. Additionally, SF sutures were associated with greater, though non significant, swelling compared to PET sutures on both Days 2 and 7 [39].

Despite bacterial accumulation and inflammation posing risks of infection, studies did not report significant infection rates with SF sutures, except for one case on Day 3 in the study by Sala-Pérez S et al., (2016), where SF sutures were used in 20 participants [16]. This suggests that in healthy patients, bacteria already present in the mouth do not provoke infection due to overaccumulation. However, for immunocompromised patients, excessive bacterial proliferation can lead to infection. Inflammation and swelling, irrespective of infection status, result in postoperative pain at the surgical site. Although SF sutures were associated with higher pain levels than PET sutures, the difference was significant only within the first 24 hours post-surgery [38].

Effective wound healing requires the management of inflammation, swelling and pain. In the study by Syaflida R et al., (2019), SF sutures showed slower initial healing than Catgut on Day 1 but improved significantly by Day 7 [40]. Healing outcomes with Polysorb, Caprosyn and Prolene were generally better than those with SF sutures on both Days 3 and 7 [39].

The higher bacterial adherence on SF sutures is primarily due to their braided structure, which increases the surface area available for colonisation. Monofilament sutures, in contrast, have a simpler structure with less surface area, resulting in lower bacterial adherence [24,25]. In the assessment of bacterial adherence, monofilaments showed the lowest adherence compared to multifilaments and performed better in reducing bleeding, inflammatory cells and enhancing wound healing.

When comparing SF's natural, multifilament, non absorbable and non antiseptic properties to other types, monofilaments generally performed better. Among resorbable and non resorbable sutures, non absorbable sutures demonstrated better results in bacterial adherence, inflammatory cell reduction and wound healing [9,18,19,39]. Natural sutures are generally more susceptible to bacterial adherence and inflammatory reactions than synthetic sutures, which was confirmed in the reviewed studies where SF exhibited the highest bacterial adherence [9,16,18,19,22,39], increased pain [38] and lower wound healing [39] compared to synthetic sutures. Bleeding [16] and swelling [38] were comparable between the two.

Compared to Catgut, a natural suture, SF had slightly higher but non significant bacterial adherence [21], potentially due to the monofilament nature of Catgut. However, the monofilament nature of Catgut offered no benefit over multifilament SF in wound healing, where SF showed significantly less healing on Day 1 but significantly more by Day 7 [40].

When comparing antiseptic-coated versus non coated sutures, it was found that on Day 7, triclosan-coated absorbable monofilaments, such as Monocryl Plus [19] and multifilaments, like Vicryl Plus [9], exhibited more bacterial adherence than non absorbable monofilament sutures like Nylon [19] and Prolene [9]. In the study by Sala-Pérez S et al., (2016), SF differed significantly from Monocryl Plus until Day 3, with no significant difference by Day 7 (p=0.197) [16].

These results may arise from triclosan's 96-hour efficacy period [34], as it is metabolised and cleared from the bloodstream almost 99% within approximately 3.8 days [41]. This finding was consistent with another study by Nadafpour N et al., (2019), which found no difference in Enterococcus and E. coli accumulation between SF and Vicryl Plus sutures [34]. After Day 7, Vicryl showed fewer bacterial CFUs than Vicryl Plus [34], consistent with findings by Pelz K et al., (2015), suggesting triclosan's limited long-term efficacy in preventing bacterial accumulation [42].

Triclosan inhibits bacterial growth by disrupting cell membranes and interfering with fatty acid synthesis [43]. Several studies confirm that synthetic, resorbable sutures, like Vicryl Plus, reduce bacterial adherence and SSIs [44-46]. Despite this, the use of triclosan has raised concerns regarding the development of antimicrobial resistance [47,48]. However, Leaper D et al., (2011) reported that triclosan in sutures does not elicit antimicrobial resistance, possibly due to its low concentration [41]. Kandathil AM et al., (2023) found that coating SF sutures with Pomade, an antiseptic, reduced bacterial adherence compared to Vicryl Plus. Pomade, which contains iodoform (40.4%) and calendula oil (5%), showed efficacy [22]. However, iodoform is a known irritant and toxic to epithelial and macrophage cells [49,50], making it essential to consider safer alternatives. Studies investigating triclosan coating on SF sutures are currently unavailable, which may be a better option than Pomade. Given triclosan's limited half-life and the lack of benefits over non coated Vicryl sutures [34,35], antibiotics with longer half-lives, such as azithromycin (half-life: 68-79 hours) [51,52], could be considered, although antimicrobial resistance remains a concern [7].

Studies by Kandathil AM et al., (2023) and Layeequa L and Sequira J (2021) showed that antibiotic-coated SF sutures reduced bacterial adherence compared to non coated SF sutures [22,53]. Additionally, SF-based composites incorporating antimicrobial agents, such as silver nanoparticles [7,15,54-56], nano titanium dioxide [54,57], or copper nanoparticles [8], have been studied for wound dressings, exhibiting bacteriostatic activity against bacteria such as *Staphylococcus aureus, E. coli, Pseudomonas aeruginosa* and *Acinetobacter baumannii* [54,55,57], as well as *Porphyromonas gingivalis* and *Aggregatibacter actinomycetemcomitans* [8].

Further research to refine SF properties and explore alternative materials is essential for enhancing SF's effectiveness and safety in dental surgery. Furthermore, SF-based innovations, such as sutureless SF dual-layer adhesive [58], SF-based film-forming spray [59], or metal ions-infused SF hydrogels [60], could benefit oral surgical wound care.

Limitation(s)

The limitations of the present systematic review include variations in participant numbers, surgical procedures, patient demographics, dental settings, differences in materials compared with SF sutures and inconsistent outcome measurements across studies. These factors may have influenced the interpretation of the results and limited meta-analyses for a comprehensive assessment. However, the strength of this review lies in its comprehensive search strategy and rigorous risk of bias assessment using the Cochrane RoB 2 and ROBINS-I tools. Despite these limitations, the present review provides valuable insights into SF suture performance in dental surgery.

CONCLUSION(S)

In conclusion, the present review highlights that SF sutures, while cost-effective and user-friendly, exhibit high bacterial adherence and initially slower wound healing, which could pose risks for immunocompromised patients. SF sutures may be more suitable for procedures with a lower infection risk, such as extractions, rather than periodontal surgeries with high microbial exposure. Future research should explore antimicrobial coatings, such as silver nanoparticles or titanium dioxide, to enhance SF's infection resistance, potentially making it a safer choice for various dental applications.

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