1. Introduction

Surgical removal of impacted third molar is the most frequently performed procedure by a maxillofacial surgeon (de Almeida Barros Mourão et al., 2020). Wound closure following removal of impacted third molar is generally achieved by suturing. The various objectives of suturing include re-approximation of wound edges to facilitate wound healing and haemostasis in the postoperative phase.

Conventional suturing requires placement of knots to secure the suture material (Paul, 2009; Guide, 2015) to the tissues and to maintain adequate tension at the approximated wound margin. Suturing after mandibular third molar surgery presents with the following technical difficulties: restricted access, difficulty in instrumentation, difficulty in securing knot (Kasi Ganesh et al., 2018). In addition, numerous knot related complications have been documented in literature such as accumulation of food debris leading to infection and soft tissue irritation (Kasi Ganesh et al., 2018; Bui et al., 2003). Literature also reveals that knots over the wound can cause ischemia due to additional pressure which predisposes the wound to infection. Improper suturing leads to complications such as wound dehiscence, infection, and post-operative pain (Sisk et al., 1986; Leknes et al., 2005).

Various alternatives to suturing have been used to eliminate the disadvantages associated with conventional suturing and suture materials. Novel materials including staples, tapes, cyanoacrylates (Oladega et al., 2019), and fibrin sealant (Gogulanathan et al., 2015) have been utilized as potential substitutes for sutures to achieve optimal surgical outcomes.

Knotless suturing is an innovative method of wound closure used in the fields of bariatric surgery (Ferrer-Márquez et al., 2016), abdominoplasty (Warner and Gutowski, 2009), facial rejuvenation procedures (Rachel et al., 2010), arthrotomy (Nett, 2011), laparoscopic myomectomy (Iavazzo et al., 2015), partial nephrectomy (Metcalfe et al., 2010), and in various minimally invasive procedures. The first report of knotless suture in oral cavity has been published by Kasi Ganesh et al. (2018), which discussed its potential merits. The aim of this study was therefore to assess the clinical utility of knotless suture for wound closure after third molar surgery.

2. Materials and methods

2.1. Study design

The study was designed as a randomized controlled clinical trial comparing 3-0 knotless suture (30 × 30 cm) with 4-0 polyglactin 910 (vicryl) for wound closure, for patients undergoing bilateral extraction of mandibular third molars. The study was done using the 'split-mouth method', where one side was assigned for knotless suture (study group) and the contra-lateral side for polyglactin 910 (control group). Removal of the impacted molars in the opposite arch was done one month after the first surgery. Approval for the study was obtained from the institutional review board (SRMU/M&HS/SRMDC/2018/F/003) and was performed in accordance with the Consolidated Standards of Reporting Trials (CONSORT) statement.

2.2. Patient selection

Patients who required surgical removal of bilateral mandibular third molars with similar difficulty index (Gogulanathan et al., 2015) were recruited for this clinical study based on pre-operative assessment of orthopantomogram. Consent was obtained from all patients after detailed explanation of the procedure.

The inclusion criteria consisted of patients belonging to ASA 1 (American society of anaesthesiology) category and who required surgical removal of bilaterally impacted mandibular third molars. Patients with impacted teeth of similar difficulty index and willing to undergo the surgical procedure were included in the study.

Patients with any pre-existing systemic disease or condition, history of medication with anti-coagulants and those with known history of lignocaine allergy were excluded from the study.

2.3. Surgical procedure

Surgical removal of the impacted teeth was performed under local anaesthesia. Preoperative inter-incisal opening was noted for each patient in millimeters. The surgical procedure was standardized as follows; 5% povidone–iodine solution was used for site preparation and 2% lignocaine hydrochloride with 1:80,000 adrenaline bitartrate was administered as inferior alveolar and buccal nerve blocks. Conventional Ward's incision was placed to raise a mucoperiosteal flap (Ashiq Ali et al., 2019). Bone removal was done using a surgical drill under cold saline irrigation for surgical exposure and delivery of the tooth. Haemostasis was achieved and wound closure was performed with 4–0 polyglactin 910 suture (Ethicon Inc., Somerville, NJ, USA) (dyed) for the control group and 3-0 knotless suture (Quill knotless® tissue-closure device, Surgical Specialties México, Tijuana-Rosarito) for the study group respectively.

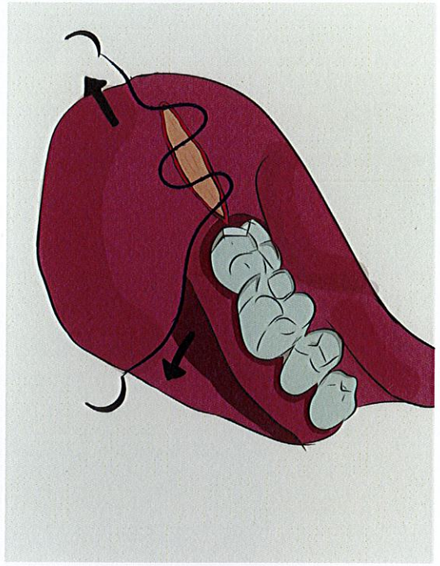

Fig. 1. Schematic diagram.

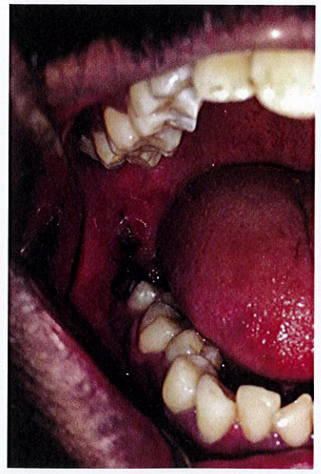

Fig. 2. Intra operative sutured socket-control group polyglactin 910 (vicryl).

The technique of suturing was two simple, interrupted sutures for the polyglactin 910 group (Fig. 2). For the knotless group, suturing proceeded from the distal end of the wound (2nd molar) to the proximal end, by utilizing a continuous suturing technique (Fig. 1). The suture was activated by holding the ends of the suture material and pulling them in opposite directions (Fig. 3). This engaged the barbs deeper into tissues and approximated the wound margins in a firm manner. The sutures were then cut closer to the tissues with no exposure of suture material in the oral cavity (Fig. 4).

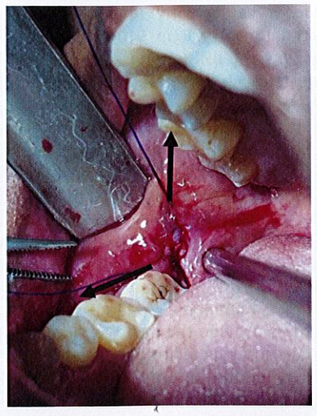

Fig. 3. Intra operative activation of knotless suture.

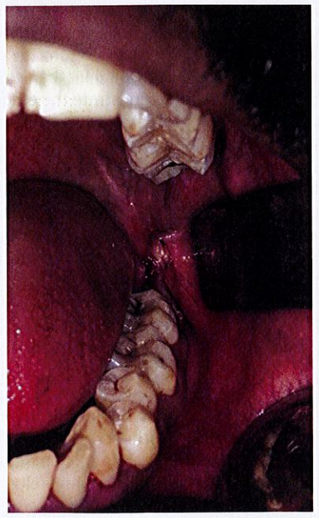

Fig. 4. Intra operative sutured socket – study group (knotless).

2.4. Parameters for outcome assessment

The four parameters assessed were wound closure time, maximum inter incisal opening, VAS pain score and facial swelling. Wound closure time was assessed from the start of suturing till the time of complete flap approximation. A numerical pain rating scale (VAS) was used to assess pain. The patient was asked to rate the severity of pain from 0 to 10, where 0 indicated no pain at all, and 5 indicated moderate pain, and 10 indicated the worst possible pain. Facial swelling was measured (in millimetres) and recorded by using the method described by (Gogulanathan et al., 2015). Facial swelling was measured (in millimetres) and recorded using the method described by (Gogulanathan et al., 2015). The points A, B, C, D and E were marked and 3 reference lines of AC,AD and BE were drawn using these points. Point A is the most posterior point on the tragus, point B is at the lateral canthus of the eye, point C is the most lateral point on the corner of the mouth, point D is the soft tissue pogonion and point E is the most inferior point on the angle of the mandible. The swelling was measured depending on the difference between the averages of pre and post-operative measurements [(Pre-operative AC + AD + BE) − (Post-operative AC + AD + BE)]. Maximum inter incisal mouth opening (MIO) was measured between the upper and lower incisors by a scale (in millimetres).

2.5. Review protocol

The patient was checked for pain, maximum inter incisal opening and swelling were assessed on 1st, 3rd and 7th post-operative days.

2.6. Statistical tests

Normality test results (Kolmogorov–Smirnov test and Shapiro–Wilk test) showed that the samples followed a normal distribution. Therefore parametric tests were used to analyse the data. As this was a split mouth study, the paired *t*-test was used to compare the mean values between the control and experimental groups. The paired *t*-test was also applied for comparison between time points. The level of significance was fixed as =0.05 (two-tailed). IBM SPSS Statistics for Windows, version 20.0 (IBM Corp., Armonk, NY, USA) was used for the data analysis.

3. Results

A total of 25 patients participated in the study (14 males and 11 females) with the mean age of 25.6 years. The study group showed a statistically significant reduction in the duration for achieving wound closure in comparison to the control group ($p < 0.0001$). The mean time taken for approximation of the wound with the knotless sutures was 2.45 min, whereas in polyglactin 910 sutures it was 4.1480 min (Table 1). The mean mouth opening on the first post-operative day in the study and control group were 33.02 mm and 28.27 mm respectively (p-0.015). The same difference was observed between the groups on the 7th post-operative day (39.4 mm in the study group vs 35.64 mm in the control($p < 0.0001$) (Table 2).

The VAS score recorded on the first postoperative day in the study and control group was 5.56 and 8.44 respectively (p-0.24), which was significantly less on seventh post-operative day in the study and control group [0.44 (day1) and 2.19 (day7)] respectively, ($p < 0.0001$) (Table 3).The swelling score on day 1 in the study group was 41.69 mm when compared to control group 48.06 mm (p-0.041) and on day 7, the study group demonstrated lesser

Table 1
Time taken for suturing.

Parameter	Mean (control) (minutes)	SD	Mean (study) (minutes)	SD	*p* Value
Time taken for suturing	4.14	0.61	2.45	1.05	0.026

Table 2
Maximum mouth opening.

Maximum Mouth Opening	Mean (control) mm	SD	Mean (study) mm	SD	*p* Value
Pre Op	38.84	6.2	39.4	6.27	0.86
Day 1	28.27	0.58	33.02	5.41	0.015
Day 3	30.56	1.24	35.22	5.32	<0.0001
Day 7	35.64	5.3	39.4	5.36	<0.0001

Table 3
Pain score.

VAS	Mean (Control)	SD	Mean (study)	SD	*p* Value
Day 1	8.44	0.91	5.56	0.82	0.024
Day 3	5.76	0.96	3.08	0.96	0.035
Day 7	2.19	1.32	0.44	0.65	<0.0001

Table 4
Swelling.

Swelling	Mean (control) (mm)	SD	Mean (study) (mm)	SD	*p* Value
Post Op	36.16	5.5	35.14	5.05	1.16
Day 1	48.06	5.46	41.69	5.45	0.041
Day 7	41.26	5.14	36.1	4.93	0.033

swelling than the control group (36.1 mm vs 41.26 mm) (*p*-0.033) (Table 4).

None of the patients exhibited complications during the trial period. No patients discontinued the trial or were lost to follow up.

4. Discussion

Sutures constitute an integral part of the surgical armamentarium which is employed for wound closure in any anatomical site. They provide the required haemostasis and anatomic tissue approximation in an esthetic manner (Leknes et al., 2005).

4.1. Problems associated with knots

Intra oral suturing, especially in the retro molar region, is technically challenging because of constricted space available for instrumentation and placement of knots. Further wound healing following intra oral suturing may be compromised due to the tendency of the knots to attract food debris and colonization of microbial flora which are inherent to the oral cavity.

There has been an advent of staples, fibrin glue, adhesive tapes etc. as a substitute to suturing and to negate the complications associated with it. However their indications are less due to various limitations related to them. Staples, fibrin glue, and adhesive tapes cannot be used in dynamic regions with immense muscle activity and sites with active bleeding. In addition, transmissible blood borne diseases and hypersensitivity reactions are associated with fibrin glue.

Classic suturing techniques and their strength rely completely on the knots placed to secure the suture. However knots present specific clinical problems; knots attract debris. Knot slippage at time of approximation of tissues leads to inadequate wound closure, wound dehiscence etc. Knotting also causes reduction in the tensile strength of the classic suture by 35–95% due to structural deformation of the suture material (Greenberg and Goldman, 2013). The above mentioned reasons make knotless sutures an effective option for intra-oral wound closure, and the same was assessed by our study.

4.2. Knotless sutures-material and technique

The speciality of knotless sutures is the presence of tiny barbs along the entire length of the suture except the central non-barbed portion called the transition point. The barbs are positioned in opposing directions from the central transition zone. They are monofilamentous in nature with comparatively lesser core diameter as compared to polyglactin 910 of same size. Though the diameter is smaller, the tensile strength and mechanical integrity of a barbed suture is much more efficient than similar sized polyglactin 910 suture.

The barbs in the suture prevent tissue sliding with more than 20 points of fixation per inch of tissue and provide uniform distribution of tension along the wound margins. Knotless Sutures are available in different compositions (Polydioxanone or Polyglycolic acid – Polylactic acid), sizes (5-0 to 2-0) and lengths (3.5 × 3.5 cm to 24 × 24 cm) which may be dyed or non-dyed. The time taken for mass absorption is 180–240 days compared with polyglactin 910 sutures which is 56–70 days (Rajih et al., 2020; Greenberg and Clark, 2009).

Knotless sutures provide the best wound approximation with simple continuous suturing technique. This is mainly because the retention capacity of the sutures, in the absence of knots, is directly proportional to the number of barbs engaging into the tissues.

4.3. Knotless sutures vs other present materials for third molar closure

Many authors (Joshi et al., 2011; Gogulanathan et al., 2015) have conducted prospective trials to demonstrate the efficiency of tissue adhesives, and fibrin glue is providing adequate haemostatis and wound closure. However the authors had highlighted the limitations of tissue adhesives as well as fibrin glue which included creation of a large dead space, failure to achieve a dry surface or inability of the wound to resist extensive lateral tension. This is in contrast to the adequate wound strength offered by knotless sutures even in the presence of dynamic peri oral muscle action.

Gazivoda et al.'s clinical study depicted the superiority of polyglactin 910 over other resorbable suture materials like catgut and dexon. The authors tested the effect of these materials on the rate of infection and inflammation at regular intervals, in which polyglactin 910 demonstrated superior results by eliciting minimal infection, edema and haematoma. In our study knotless sutures displayed better efficiency when compared with polyglactin 910 sutures in relation to edema and other wound complications. Also knotless sutures contributed to a remarkable reduction in the operating time along with improved wound closure (Gazivoda et al., 2015).

4.4. Knotless sutures – impact on surgical outcome

Placement of knots to achieve a secure closure often consumes an enormous amount of time, especially in regions with restricted access such as the retromolar and palatal region. Knotless sutures reduce the suturing time by eliminating the requirement of a knot to provide secure closure. Suturing with knotless sutures is less technique sensitive, and time taken to adapt to this new material is also negligible even in the hands of a trainee surgeon. The same has been demonstrated by our study as the reduction in wound closure time in the study group, which was statistically significant.

As the knotless suture eliminates the nidus of infection (knots), there is negligible entrapment of food debris or surrounding tissue reaction which eliminates inflammatory mediators and microbial colonization. Further, the watertight wound closure prevents any seepage of fluids into the wound. The abovementioned factors may be responsible for the reduced post-operative pain or infection which eventually contributed to better wound healing (Siedhoff et al., 2011; Greenberg and Einarsson, 2008).

4.5. Advantages and limitations of knotless suturing

The advantages of knotless sutures as observed in the study are ease of suturing, less technique sensitivity, reduced suturing time, absence of knots leading to lesser knot related complications such as wound dehiscence and infection, increased patient comfort due to less tissue irritation, and better approximation of the tissue edges due to the deep anchoring of the barbs (Krishnamoorthy et al., 2016; Sah, 2015; Lin et al., 2016). No adverse effects of knotless sutures were observed in our study. Mild erythema on the first post-operative day was the only unusual clinical sign noted with barbed sutures in a few patients. It was painless and subsided spontaneously and could be attributed to the micro-haematoma due to the barbs and tissue reaction to Polydioxanone suture (PDS) (Cortez et al., 2015).

5. Conclusion

Knotless suture simplifies intra-oral suturing technique, especially in areas of difficult access and instrumentation. It facilitates effective wound closure and eliminates knot-related complications. Improvement in patient compliance was also seen, with reduction in patient related complications. On the whole this study indicates the utilization of knotless sutures is an improved alternative to conventional suturing, benefiting both the surgeon and the patient.

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