International Journal of Environmental Sciences
ISSN: 2229-7359
Vol. 11 No. 22s, 2025
https://theaspd.com/index.php

Comparative Evaluation of N-Butyl-2- Cyanoacrylate Glue and Silk Suture on Healing After Periodontal Flap Surgical Procedure: A Single Blind Split Mouth Randomized Controlled Clinico-Histological And Microbiological Analysis

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ABSTRACT

Background: *Wound closure after periodontal flap surgery plays a critical role in healing and infection control. N-Butyl-2-cyanoacrylate glue offers potential advantages over conventional sutures due to its haemostatic and bacteriostatic properties.*

Objective: *To compare the clinical, histological, and microbiological outcomes of N-Butyl-2-cyanoacrylate tissue adhesive versus 3-0 braided silk sutures for flap closure in patients undergoing periodontal surgery.*

Methods: *A randomized split-mouth study was conducted on 11 systemically healthy patients with moderate to severe periodontitis. Each patient received periodontal flap surgery with flap closure using N-Butyl-2-cyanoacrylate on one side (test group) and 3-0 braided silk sutures on the contralateral side (control group). Clinical parameters assessed included Wound Healing Index (day 7), Gingival Index, Sulcus Bleeding Index, and Pocket Probing Depth (baseline and day 28). Histological evaluation of inflammatory response and microbiological analysis of subgingival plaque (total microbial count) were performed on day 7.*

Results: *The test group demonstrated significantly better healing outcomes. Wound Healing Index scores were lower at glue sites, indicating improved tissue repair. Greater reductions in Gingival Index and Sulcus Bleeding Index were observed in the test group, signifying reduced inflammation and bleeding. Pocket probing depth decreased more substantially in the glue group. Histological analysis showed a milder inflammatory infiltrate at glue sites, while sutured sites exhibited moderate to severe inflammation. Microbial colony counts were significantly lower in the glue group. However, primary closure was more consistently achieved with sutures, as some glue sites exhibited partial closure due to lower tensile strength.*

Conclusion: *N-Butyl-2-cyanoacrylate glue presents a promising alternative to silk sutures for periodontal flap closure, offering benefits including rapid haemostasis, reduced inflammation, ease of use, and antimicrobial effects. Despite slightly inferior mechanical strength, its clinical and biological advantages support its potential use in periodontal therapy. Further studies with larger sample sizes and extended follow-up are recommended.*

Keywords: *Cyanoacrylate glue, periodontal flap surgery, silk sutures, wound healing, inflammation, microbiology, histology*

INTRODUCTION

Periodontitis is a multifactorial, microbially associated, host-mediated disease characterized by inflammation extending beyond the gingiva, leading to destruction of connective tissue and alveolar bone. (1) It is typically identified by plaque accumulation, inflammation, and periodontal pocket formation. The main goal of periodontal therapy is to restore and maintain periodontal health and function.

Treatment involves a non-surgical phase followed by surgical intervention when necessary. Periodontal flap surgery is frequently used for moderate to deep pockets and requires close, tension-free adaptation of the gingival tissue to the tooth surface to allow proper healing. Traditionally, this adaptation is achieved using sutures. (2-5)

Sutures, such as silk, nylon, and polyglycolic-polylactic acid derivatives, may be resorbable or non-resorbable. Braided silk is commonly used but has disadvantages like bacterial wicking and heightened inflammatory response. Sutures may also cause tissue trauma, require technical skill, and necessitate a follow-up visit for removal. (6)

Tissue adhesives have emerged as alternatives, minimizing these issues. Cyanoacrylates, synthetic tissue adhesives approved by the FDA in 1998, have been widely used across medical fields, including dentistry. (7) First synthesized in 1949, they polymerize quickly upon contact with moisture, forming strong bonds and offering benefits like ease of use, immediate hemostasis, biodegradability, and bacteriostatic properties. However, they are contraindicated in infected wounds, immunocompromised patients, and those allergic to cyanoacrylate or formaldehyde. (8-9)

This study aims to evaluate and compare healing outcomes following periodontal flap surgery using traditional silk sutures versus N-Butyl-2-cyanoacrylate tissue adhesive.

AIM AND OBJECTIVES

- **AIM:**

To compare efficacy of 3-0 braided silk sutures and N-Butyl-2-cyanoacrylate glue in closure and healing of periodontal flap surgical procedure.

- **OBJECTIVES:**

1. To evaluate healing of the soft tissue using Wound Healing Index (Huang et al, 2005) assessed on the 07^{th} post-operative day.
2. Assessment of clinical parameters such as Gingival Index (Loe and Silness,1963) and Sulcus Bleeding Index (Muhlemann and sons,1971) assessed on Baseline and on the 28^{th} day (04 weeks), at both test and control sites.
3. To assess the inflammatory response of the soft tissue, at both test and control sites, viewed under 40x magnification, using tissue adherent to extracted teeth from each site and subjecting it to standard H&E staining procedure, on the day of suture removal (07^{th} day).
4. To assess total microbial count in both the groups, using sub gingival microbial samples, on 07^{th} post-operative day.

MATERIALS AND METHODS

Source of Data Collection:

The prospective interventional split mouth randomized control trial comparative clinico-histological and microbiological study was conducted in the Department of Periodontics and Oral implantology in collaboration with Dept. of Oral Pathology and Oral Microbiology, School of Dentistry, DY Patil, deemed to be University, Navi Mumbai in a period of 1 month from January 2025 to February 2025. The study was approved by the Institutional scientific and Ethical Review Board (IREB Reference Number: IREB/ 2024/ PERIO/ 11)

Sample size and Randomization:

A sample of 11 patients were divided into 2 groups: test group (N-Butyl-2-Cyanoacrylate glue) and control group (4-0 silk suture) in a split mouth design.

A randomized split mouth design was employed. Selection of the surgical sites for suture and cyanoacrylate glue was done randomly using the 'flip a coin' method.

Inclusion Criteria:

- Systemically healthy individuals in the age group of 20-60 years, of both sexes.
- Minimum of 20 teeth in the oral cavity.
- Patients with moderate to severe generalized periodontitis, equal to or more than 5mm pocket depth in 3 or more adjacent teeth in at least two sextants, indicated for flap surgery, chosen as the surgical site.
- Minimum of one tooth per sextant, indicated for extraction.
- Patients maintain good oral hygiene.

- Patient providing written consent.

Exclusion Criteria:

- Patients having any known systemic diseases and/or drug therapy which may interfere with wound healing.
- Pregnant or lactating women.
- Patients who are allergic to materials used in the study.
- Current Smokers and tobacco chewers.
- Non-co-operating patients.
- Patients that cannot maintain good oral hygiene.

Preparation of study subjects:

11 systemically healthy individual subjects, of both the sexes, belonging to the age group of 20 to 70 years old, with equal to or more than 5 mm pockets present in any two sextants, having a minimum of one tooth in each sextant being indicated for extraction were chosen for the current study as per the inclusion criteria mentioned above. Participants were informed about the study protocol in detail and written informed consent was obtained prior to the commencement of any treatment. Each individual was subjected to phase 1 therapy (SRP) and Oral hygiene instructions were given to the patients. 04 weeks after the phase 1 therapy, persistent periodontal pockets underwent flap surgery as indicated. In each patient, a brief case history of the patient including the baseline Gingival Index scores (Loe and Silness, 1963), Sulcus Bleeding Index scores(Muhlemann and son, 1971) and probing depth were recorded. A randomized split mouth design was employed. Selection of the surgical sites for suture and cyanoacrylate glue was done randomly, using the 'flip a coin' method.

Full thickness mucoperiosteal kirkland flap elevation and closure of the surgical site with N-Butyl-2-Cyanoacrylate glue: (TEST GROUP):

Under Local anesthesia containing lignocaine and adrenaline (1:80000), intra sulcular incisions were made using no.15c blade and Bard and Parker handle no.07. A full thickness mucoperiosteal access flap was raised using a periosteal elevator. The surgical area was debrided using area specific Gracey's curettes and EMS Piezoelectric ultrasonic scalers, respectively and the debrided surgical site was then irrigated with Povidone-iodine solution I.P. 5% W/V solution. The surgical site was isolated with sterile cotton rolls. N-Butyl-2-Cyanoacrylate adhesive was then applied directly over the flap edges in droplet form while approximating the wound edges with gentle finger pressure. The applied solution was extended to at least 3-4mm on either side of the wound. Digital pressure was maintained till the adhesive polymerized. This was evident by the transformation of the transparent bio adhesive film into an opaque layer. No periodontal dressings were placed. Post operative care instructions were given to the patient.

- **Full thickness mucoperiosteal kirkland flap elevation and closure of the surgical site with 3-0 Braided silk sutures: (CONTROL GROUP):**

The procedure was repeated on the contra lateral side in the similar manner as done in the test group. Simple interrupted 4-0 braided silk sutures were used to approximate the wound edges together. No periodontal dressings were placed.

- **Follow up:**

All the participants in the study were recalled on the 7^{th} and 28^{th} day (04 weeks) for follow up. Suture removal was done on the 7^{th} day in the control site and the cyanoacrylate material was removed from the test site. Wound Healing Index (Huang et al, 2005) (55) was used to assess healing. Teeth indicated for extraction, in both the test and control sites, were extracted on the 7^{th} day and tissue adherent to the extracted teeth, from each site, were examined histopathologically.

Subgingival microbial plaque samples were taken from the area adjacent in both the control and test sites, for microbial analysis using a periodontal curette, and immersed in normal saline as the transport medium. They were cultured in an incubator for 48 hours and evaluated for a total microbial count under a digital colony counter using streak plate method.

On the 28^{th} day, participants were recalled for evaluation of gingival health by assessing Gingival Index (Loe and Silness, 1963) (10) and Sulcus Bleeding Index (Muhlemann and son, 1971). (11)

HISTOPATHOLOGICAL ANALYSIS:

The tissue adherent to the extracted teeth were subjected to H&E staining method and viewed under compound bi- or uniocular microscope at 40x magnification for inflammatory response of the tissue at both the sites. The scoring criteria for inflammatory response of the tissue was categorized as mild, moderate and severe, on the basis of a subjective analysis of the stained specimens.

MICROBIAL ANALYSIS:

Sub gingival microbial plaque samples were obtained from the area adjacent to the tooth to be extracted, using periodontal curette (on 7^{th} day) before extracting the tooth and immediately transferred to a sterile container with 2 ml normal saline (transfer medium) for total microbial count, from both the test as well as control sites. In a sterile environment with 2 different Bunsen burners parallel to each other at a distance of 10cms, sterilized nickel chromium wire loop was dipped into the sterile container, containing the sub gingival plaque. The sub gingival plaque sample was displaced onto the prepared agar plates in a streak plate method, so microbes are separated. The inoculated plates were placed in the BOD (Biochemical Oxygen Demand) incubator at 37 degrees Celsius. After 48 hours, the plates were examined for microbial growth, and counted under a digital colony counter for total microbial count in colony forming units (CFU).

For assessment of Gingival Health:

Gingival Index developed by Loe and Silness, in 1963 (10)**,** assessing the severity of gingivitis based on color, consistency and bleeding on probing was used. Scores were assigned from 0 to 3.

Sulcus Bleeding Index (Table 2) by Muhlemann H.R. and Son. S. in 1971 (11), an index used for assessment of gingival bleeding was used. Four gingival units are scored systematically for each tooth: the labial and lingual marginal gingiva, mesial and distal papilla. After probing, the gingival units are scored according to the bleeding seen after 30 seconds.

For assessment of Wound Healing:

Wound healing index by Huang et al. in 2005 (12) was used, evaluating periodontal soft tissue wound healing with scores from 1 to 3, based on the presence of Gingival edema, erythema, suppuration, patient discomfort, and flap dehiscence.

Statistical analysis:

The data was subjected to statistical analysis using SPSS (IBM SPSS Statistics for windows, version 25.0, Armonk, NY: IBM Corp. Released 2015). The significance level was fixed at 5% (α=0.05). To determine if there was a significant difference between the test and control groups, an independent t test was performed. Whereas, for intra group comparison, paired t test was used. For ordinal data, Mann Whitney Test was performed. The significance level was fixed at 5% ($p \leq 0.05$).

CASE DOCUMENTATION

CASE 01:

Figure 04: Residual Pocket Depth recorded, requiring periodontal flap procedure.

Figure 05: Flap Reflection to remove granulation tissue.

International Journal of Environmental Sciences
ISSN: 2229-7359
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Figure 06: Application of N-2-Butyl cyanoacrylate glue at test site and 3-0 braided silk suture at control site.

Figure 07: Closure of the test and control site achieved.

Figure 08: Healing of test and control sites, on the 07th post operative day.

Figure 09: Teeth extracted, and tissue adhered to the teeth sent for histological examination.

Figure 10: Subgingival microbial plaque samples taken from the area adjacent to surgical site.

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CASE 02:

Figure 11: Residual Pocket Depth detected, requiring Periodontal flap surgery.

Figure 12: Periodontal Flap closure at test site (43) with N-2-Butyl cyanoacrylate glue and silk sutures placed at other sites to achieve primary closure.

Figure 13: Periodontal Flap closure at control site with 4-0 silk to achieve primary closure.

Figure 14: Healing assessed at the test site and control site on **the** 07th post operative day.

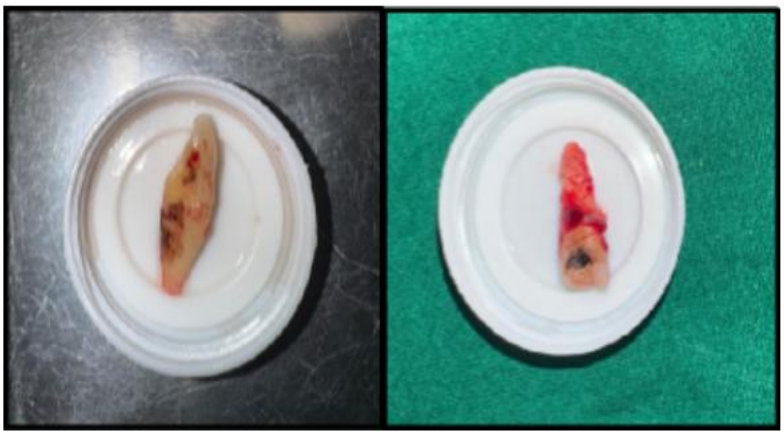


Figure 15: Teeth with poor/ hopeless prognosis extracted on the 7th operative day

Figure 16: Subgingival microbial plaque samples taken from the area adjacent to surgical site.

RESULTS AND OBSERVATION

ANALYSIS METHOD:

The study involved 11 systemically healthy subjects (6 males, 5 females; aged 20–70 years) with ≥5 mm periodontal pockets in at least two sextants and at least one tooth indicated for extraction per sextant. Subjects were randomly assigned to a test group (cyanoacrylate glue) or control group (silk sutures) for primary closure following periodontal flap surgery.

Parameters measured included Gingival Index (GI), Sulcus Bleeding Index (SBI), and Pocket Probing Depth (PPD) at baseline and 28 days postoperatively. Healing Index (Huang et al., 2005), histological inflammatory response, and microbial Colony Forming Units (CFUs) were evaluated on day 7.

No post-treatment complications were observed.

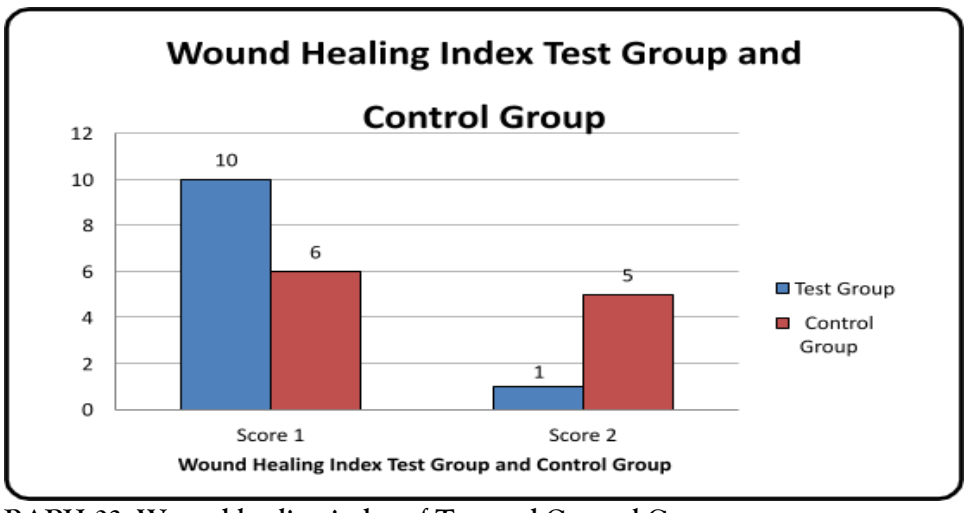
CLINICAL PARAMETERS

Wound Healing Index (Day 7):

In the test group, 10 sites scored 1 and 1 site scored 2. In the control group, 6 sites scored 1 and 5 scored 2. The Mann-Whitney U test revealed a statistically significant difference ($U = 38.5$, $p = 0.004$), indicating better healing in the glue group.

Primary Closure:

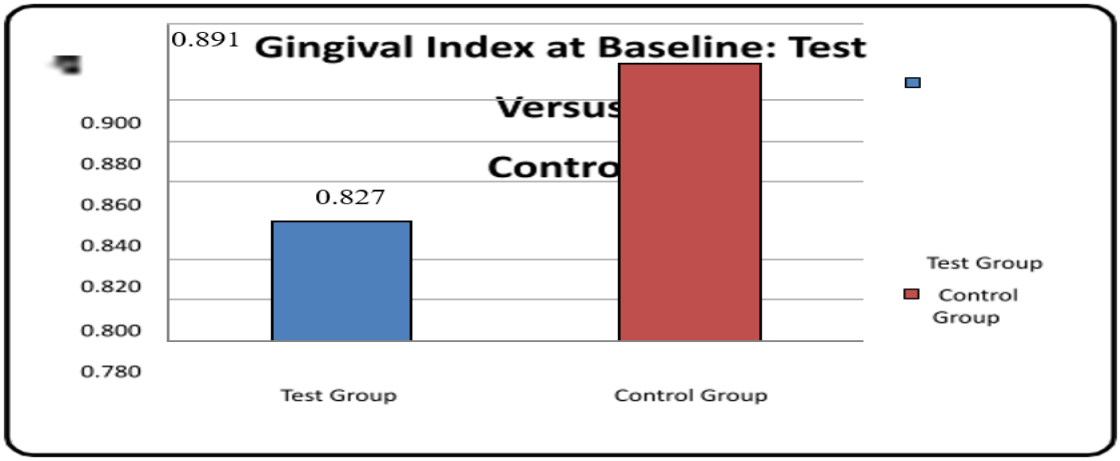
All control sites (100%) achieved complete closure. Among test sites, 7 showed partial closure.



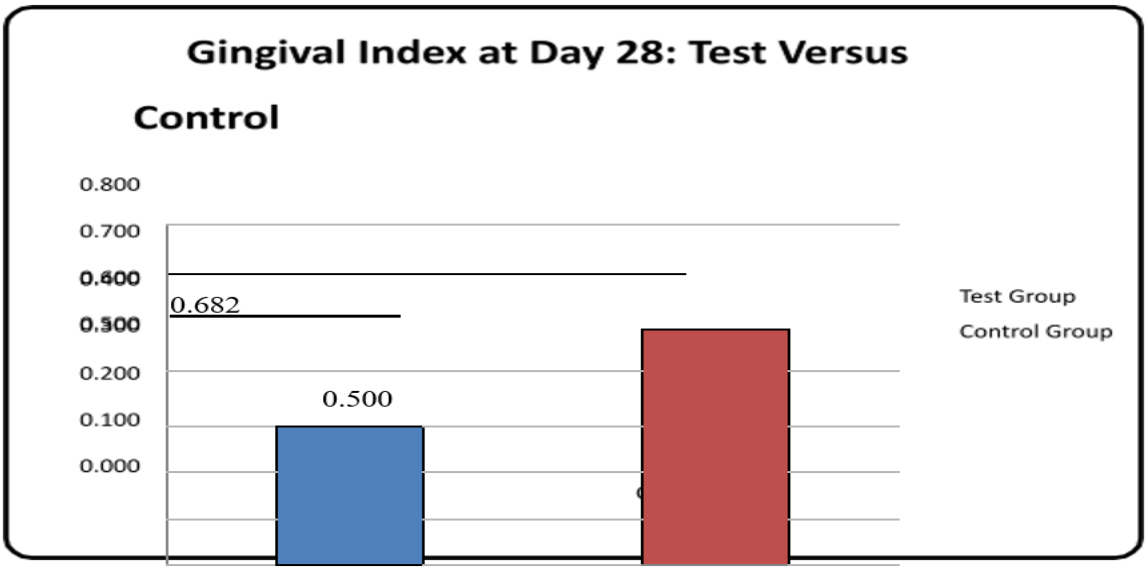
RAPH 03: Wound healing index of Test and Control Group.

GINGIVAL INDEX (GI)

At baseline, the mean GI in the test group was 0.87 ± 0.3, reducing to 0.50 ± 0.19 on day 28 ($p \leq 0.05$). The control group showed a decrease from 0.89 ± 0.3 to 0.68 ± 0.17 ($p \leq 0.05$). Greater GI reduction was noted in the test group.



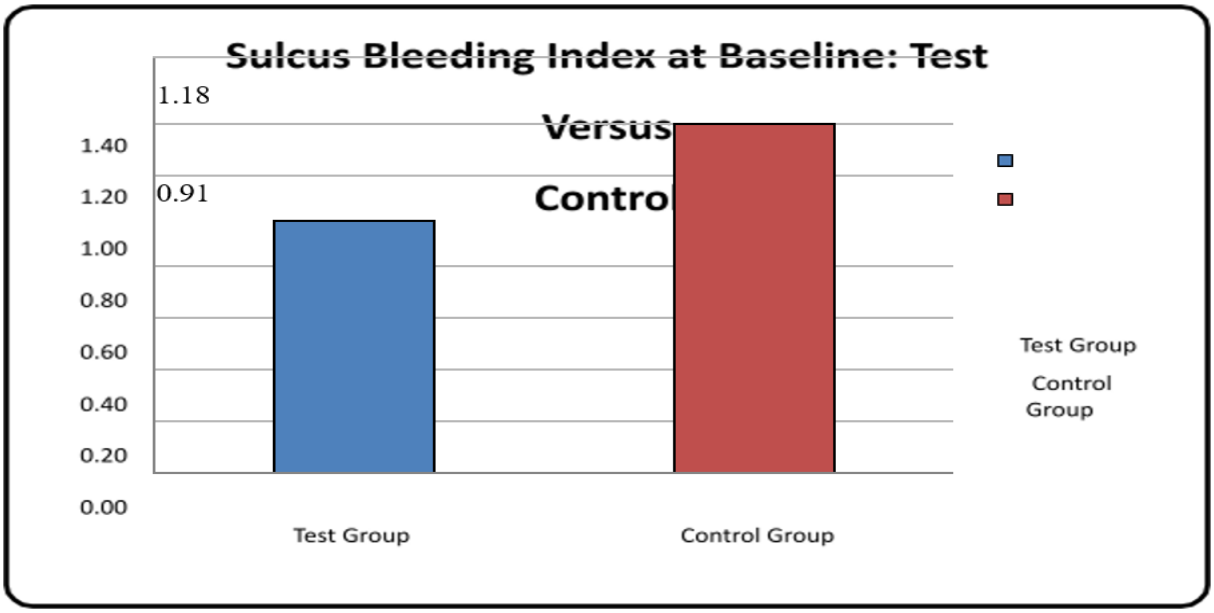
GRAPH 04: Gingival Index at baseline of test and control groups.



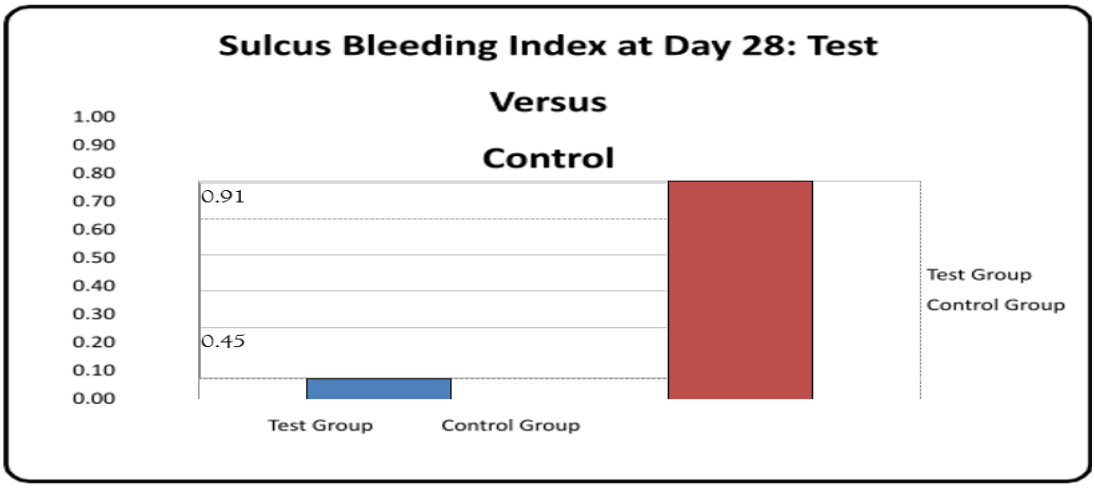
GRAPH 05: Gingival Index at Day 28 of test and control groups.

SULCUS BLEEDING INDEX (SBI)

The test group showed a drop from 0.91 ± 0.70 to 0.45 ± 0.52, while the control group decreased from 1.18 ± 0.60 to 0.91 ± 0.70 by day 28, both with $p \leq 0.05$. The test group had a more significant reduction.



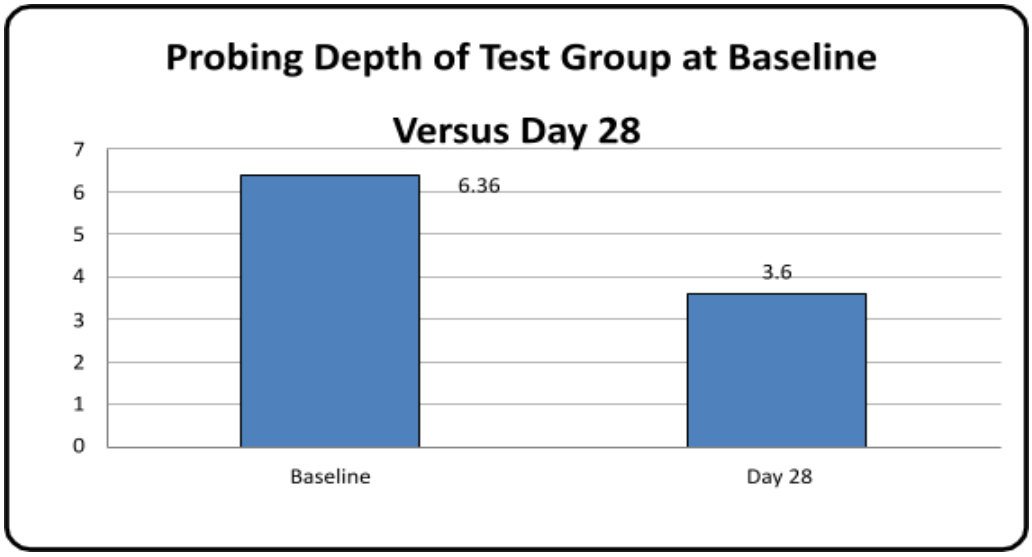
GRAPH 06: Sulcus Bleeding Index at baseline of test and control groups.



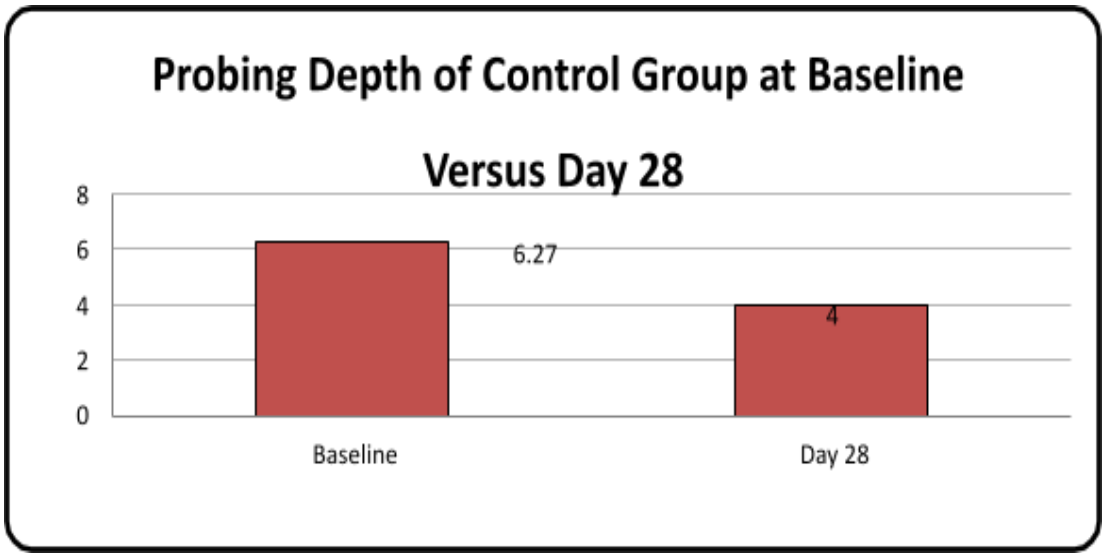
GRAPH 07: Sulcus Bleeding Index on Day 28 of test and control groups.

POCKET PROBING DEPTH (PPD)

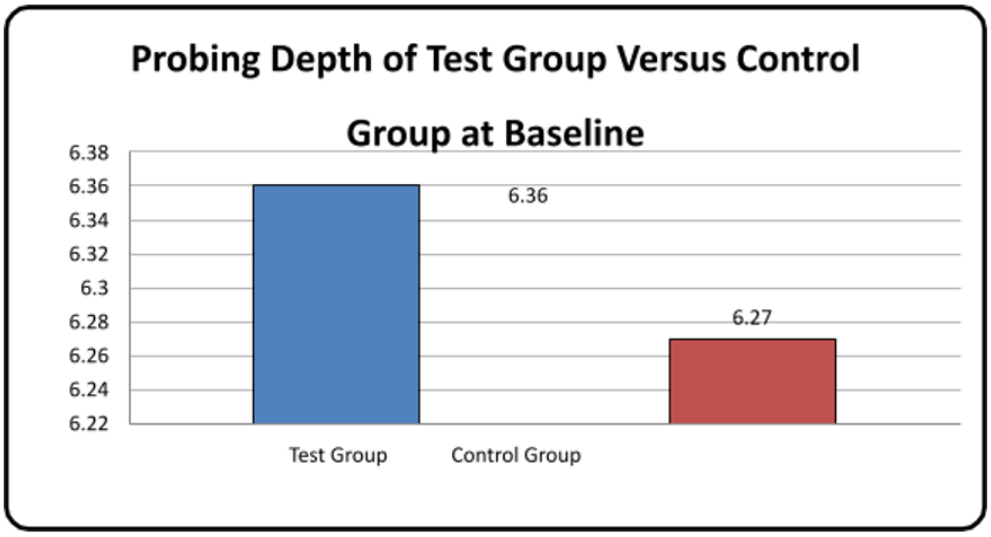
Test group PPD reduced from 6.36 ± 1.69 mm to 3.60 ± 1.35 mm. Control group reduced from 6.27 ± 1.27 mm to 4.0 ± 0.77 mm by day 28. A greater reduction was observed in the test group.



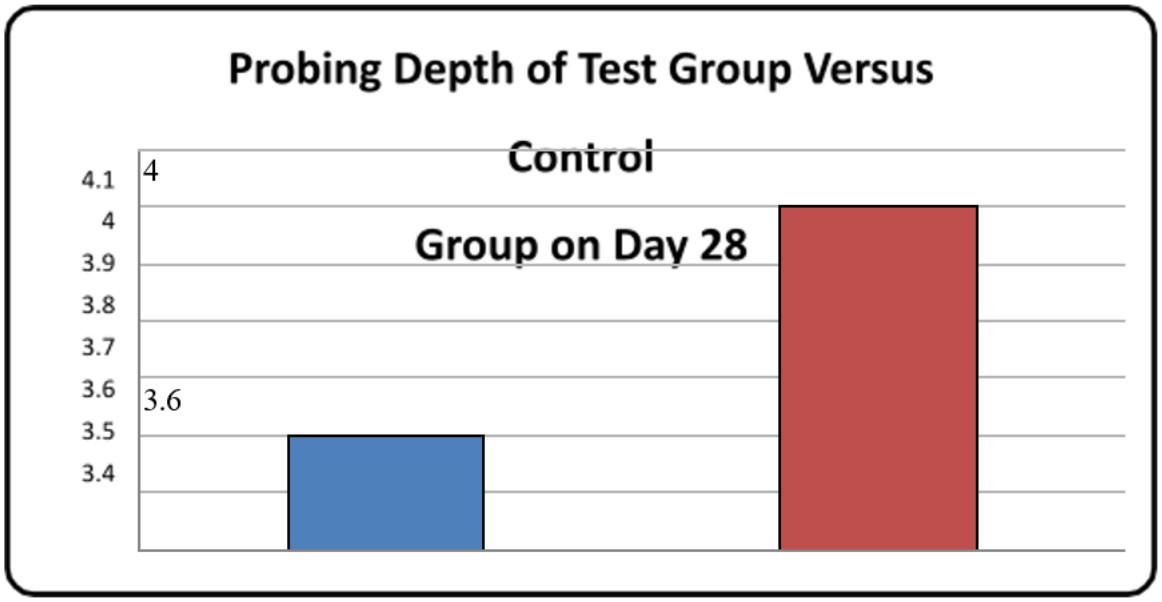
GRAPH 08: Probing Depth of test group at baseline and Day 28



GRAPH 09: Probing Depth of control group at baseline and Day 28



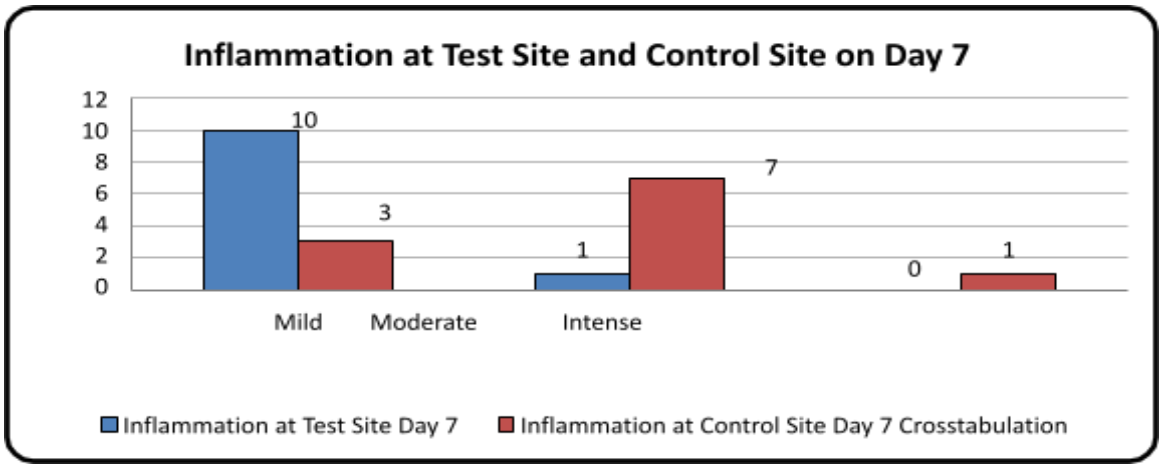
GRAPH 10: Probing Depth of test group and control group at baseline



GRAPH 11: Probing Depth of test group versus control group on Day 2

HISTOLOGICAL ANALYSIS

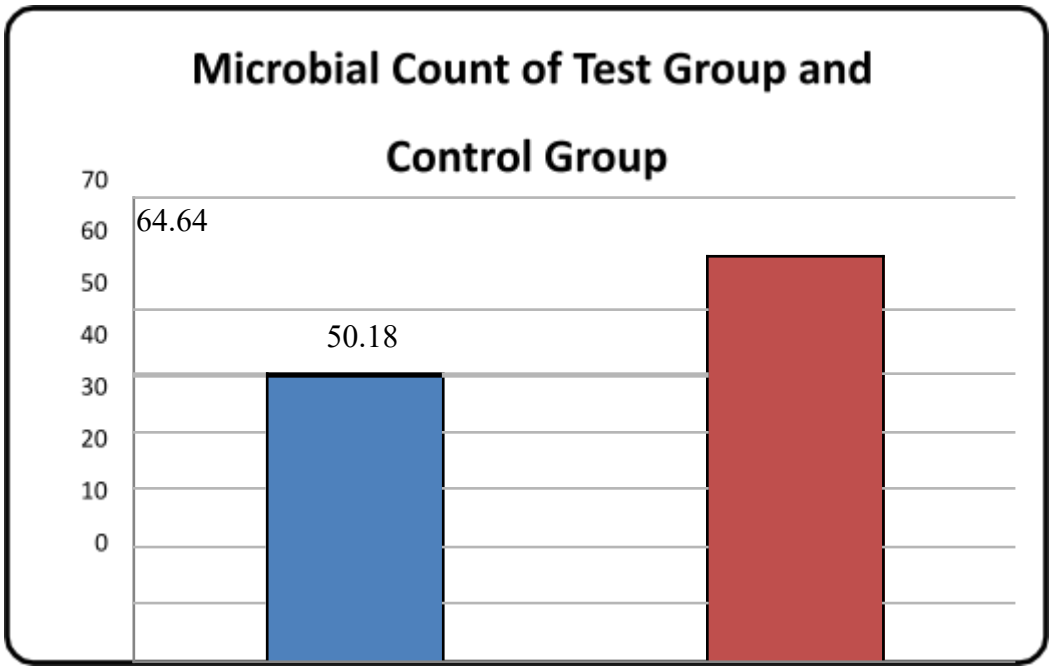
On day 7, 10 test sites showed mild and 1 showed moderate inflammation. In contrast, 3 control sites had mild, 7 moderate, and 1 intense inflammatory response. Mann-Whitney U test ($U = 21.5$, $p = 0.003$) confirmed significantly less inflammation in glue-treated sites.



GRAPH 12: Inflammation at test and control sites on day 7

MICROBIAL ANALYSIS

Mean CFU in the test group was 50.18 ± 28.7, while in the control group it was 64.64 ± 8.37. The difference was statistically significant (p = 0.002), indicating fewer microbial colonies and demonstrating the **bacteriostatic property** of cyanoacrylate glue.



GRAPH 13: Microbial Count of Test and Control Group Day 7

DISCUSSION

Management of moderate to deep pockets includes periodontal flap surgery to gain access to the underlying bone and root surfaces for debridement. Silk is the most commonly used suture material for approximating flap margins together post flap surgery (3) and cyanoacrylate is the most widely used tissue adhesive to close traumatized and incision wounds. (9)

The cyanoacrylate material used in the present study, N-2-Butyl Cyanoacrylate Glue (Epiglue), is known to have good bonding properties and bond strength to hold the tissue margins together. Other properties include good hemostatic ability and are bacteriostatic in nature. It also has good working properties like the flow and fast setting. (9)

In this study, Wound Healing Index, Huang et al. (2005) (12) **scores** presented a significant difference with suture sites exhibiting increased score of Wound Healing Index. A better healing response was exhibited at cyanoacrylate sites (test sites) in comparison to suture sites (control sites). Cyanoacrylate forms a thin layer that holds the wound's edges together, acting as a mechanical barrier that prevents debri collection and prevents secondary infection. It maintains a moist surface, over which epithelial migration occurs more readily, thus, aiding in uninterrupted wound healing and accelerating epithelial keratinization (13). The finding was in conjunction with study done by **Vastani** and **Maria.** (14)

Nearly a third of the sites receiving glue application showed incomplete primary closure of the flap, on the seventh post operative day. Studies have reported incidence of wound dehiscence with N-butyl-2-cyanoacrylate. **Qureshi et al**. (15) reported less than two percent cases of partial dehiscence after general and laparoscopic surgeries and related its occurrence to inadequate drying of skin edges before adhesive application. Krishna S used Isoamyl 2-cyanoacrylate for closing extraoral incisions placed in maxillofacial region and reported few cases of wound dehiscence. According to them, wound dehiscence was seen in 2 cases treated with N- butyl-2- cyanoacrylate while 8 cases had dehiscence treated with iso amyl cyanoacrylate.

The Gingival Index (GI) difference between the test and control scores was statistically significant, for both the groups. The suture sites were found to show greater inflammatory response as compared to the cyanoacrylate sites. This can be attributed to the suture threads acting as a site of plaque accumulation (wicking effect) leading to a greater inflammatory response of the tissue or due to presence of a non-resorbable foreign material (silk). Bacteriostatic ability of cyanoacrylate glue, is further responsible for the

reduced signs of inflammation at the test sites. Cyanoacrylate glue forms a water-tight barrier atop the approximated wound edges preventing any foreign body invasion, thus promoting faster healing. This is in accordance with the studies by **Binnie et al**. (16)**, Giray et al**. (17) and **Macht et al.** (6)

An improvement was noted in the sulcus bleeding due to the periodontal intervention in the test and control groups. The difference between baseline and 28th day scores was **statistically significant**. A greater reduction in SBI scores was observed in the test site, attributed to bacteriostatic property, early healing and mechanical barrier exhibited by the glue. A similar result was seen by **Padhye** and **Pol.** (18)

Statistically significant reduction of periodontal probing depth was seen in both the groups from baseline to 28th day. Mucoperiosteal flap surgery provides better visibility and accessibility for the debridement of the pocket lining. Closure of the periodontal flap with cyanoacrylate demonstrates a significant reduction in plaque accumulation due to its bacteriostatic property, early healing time as it acts as a scab to prevent ingestion of foreign material and haemostatic property, postoperatively. Thus, showing a superior result in reduction of pocket depth when compared to the group of sutures. Similar results were obtained in the study by **Kulkarni et al.** (19)**, Vastani et al.** (14) and Khurana et al. (20)

Inflammatory response was presented statistically significant difference between the suture and the cyanoacrylate sites on the seventh day. The overall incidence of inflammation and vascularity was higher on the sutured side on the seventh postoperative day. According to a preliminary report by **Bhaskar et al**, (21) the absence of seepage under the covering formed by cyanoacrylate may be responsible for the reduced postoperative inflammation with cyanoacrylate compared with the conventional sutures. They also observed that this material inhibits Staphylococcus aureus and Escherichia coli growth, minimizing infective sequelae. The increased inflammatory response on the sutured side could be attributed to increased plaque accumulation on the suture threads or occur as a tissue reaction to silk material. Local trauma caused by the suture needle penetrating the flaps can also cause an exaggerated inflammatory response. This is in accordance with studies conducted by **Binnie et al.** (16) and **Giray et al**. (17) In the present study, there was a correlation between the clinical and histological findings i.e. the intensity of the clinical inflammation reflected in the histological picture as well. This was similar to those reported by **Kulkarni et al.** (19) and **Bhasker et al.** (21)

N-2-Butyl cyanoacrylate (NBCA) and silk sutures both have microbial implications when used in wound closure. Microbial analysis demonstrated that the sub gingival plaque accumulation was less in glue sites than sutures, signifying the bacteriostatic properties of cyanoacrylate. NBCA, as a tissue adhesive, can create a physical barrier against microbial invasion, leading to lower infection rates compared to silk sutures. Cyanoacrylate has shown to have intrinsic anti- microbial activity against gram-positive (including methicillin- resistant Staphylococcus aureus) and non-pseudomonas gram-negative bacteria. The mechanism consists of cyanoacrylate molecules destabilizing the cell capsule of bacteria through electromagnetic interactions between the negative charge of cyanoacrylate and the positive charge of the bacterial capsule.**(49)** On the other hand, silk, a non resorbable material with no intrinsic bacteriostatic property of its own, can harbor and retain bacteria (wicking phenomenon), increasing the risk of infection and greater microbial counts. These results are in accordance with the study done by **Bhasker et al.** (21)

Padhye and **Pol** (18) stated that cyanoacrylate has an added advantage with respect to time and methodology of diminishing the two-step procedure of suturing followed by dressing to just one step of application of the material. Time taken during surgical procedures using cyanoacrylate is crucial because it:

1) Lessens trauma to the patient.
2) Lessens fatigue to the surgeon
3) Reduces postoperative swelling and operating time
4) Easier to apply than suture
5) More comfortable to the patient.

Furthermore, cyanoacrylate adhesives provide immediate hemostasis on application due to their ability to form a mechanical barrier at the wound site, which favors the coagulation process and allows hemorrhage control. Moreover, cyanoacrylate saves cost of preparing, sterilization, and storing instruments at the time of suture removal.

SUMMARY AND CONCLUSION

Healing of periodontal flap tissues when approximated with N-2- Butyl cyanoacrylate was satisfactory, uneventful and healed by primary intention. Cyanoacrylate helps in initial healing of the periodontal

tissue clinically and histologically. Both the materials have similar healing over a longer period of time. N-2-Butyl Cyanoacrylate is better as compared to sutures as it has advantages like immediate hemostasis, ease of application, lesser treatment time, better patient acceptability, non-invasive intervention and bacteriostatic in nature. It is well accepted by the oral tissues and shows good results with no side effects by all subjects in the study. However, a disadvantage associated with the application of glue is lack of primary closure due to its inadequate tensile strength. Further investigation with larger cohorts and longer observation periods is necessary to confirm these preliminary results and thoroughly assess the long-term effects of cyanoacrylate in periodontal surgery.

LIMITATIONS OF THE STUDY AND FUTURE APPLICATIONS:

The drawbacks of the present study were:

1) Short follow up period and a concise sample size.
2) The inflammation and microbial colony formations could have been assessed with subsequent follow up visits.
3) The cost and limited shelf life of N-Butyl-2-Cyanoacrylate glue.

Future applications of N-2-Butyl cyanoacrylate glue in the field of periodontics, could be:

1) For fixation of autologous bone grafts and soft tissue grafts in various perioplastic surgeries.
2) The adhesive can be used to accelerate healing on the donor area, in terms of a periodontal dressing after palatal graft harvesting.
3) To stabilize collagen membranes in the extraction sockets as to protect sites that are going through secondary wound healing.

Cyanoacrylate glue can be used for multiple purposes in the field of periodontics and can be soon seen as an integral part of dental surgeries in routine practice

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