A comparative study on absorbable and non-absorbable suture materials for the closure of skin in rabbit model

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ABSTRACT: Skin closure is a critical component of surgical procedures, and the selection of suture material has a significant impact on wound healing outcomes. This investigation aims to compare the effectiveness of absorbable and non-absorbable sutures for skin closure in rabbits. An experimental study was conducted on thirty (n=30) male rabbits aged 9.78+0.46 weeks and with an average weight of 1186.94+69.93 gms. Rabbits were divided into two groups, with one receiving absorbable sutures while the other received non-absorbable sutures. Wound healing parameters such as wound closure time, tensile strength, tissue reaction, and histological evaluation were evaluated over a specified period. Our findings suggest that both types of suture materials are effective in closing skin wounds in rabbits. However, absorbable sutures exhibited faster wound closure times and less tissue reaction compared to non-absorbable sutures. Conversely, non-absorbable sutures demonstrated higher tensile strength and better histological evaluations at the wound site. The results indicated significantly better wound healing with non-absorbable suture material than with absorbable suture material; indeed, there was an outstandingly high (++++) wound healing score when using non-absorbable suture material compared to that obtained from using absorbables. Moreover, rabbits recovered excellently from wounds treated with non-absorbables; thus demonstrating that choosing a specific type of suture material should be based on individual patient factors and requirements for each surgical procedure.

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Further studies are required to confirm these findings across larger animal models or human patients conclusively. In conclusion, it is evident that opting for non-absorbent materials results in expedited skin wound healing with superior outcomes when compared to their absorbent counterparts.

Keywords: Absorbable sutures, non-absorbable sutures, wound closure, rabbit model, wound healing.

INTRODUCTION

The utilization of suture material for wound closure is a time-honored tradition, nevertheless there exists divergence among surgeons concerning the most advantageous material for suturing cutaneous wounds (Dennis et al., 2016). Skin closure is an integral part of surgical procedures, ensuring proper wound healing while minimizing the potential for infection and associated complications. Suture materials play a vital role in this process, providing mechanical support to tissues during the initial phases of wound healing. In clinical practice, absorbable and non-absorbable sutures are the two primary categories of suture materials utilized. Absorbable sutures are designed to degrade over time and eventually get absorbed by the body, while non-absorbable sutures remain in the tissue indefinitely. Suturing is imperative for the majority of exposed wounds and disrupted tissues, as it facilitates tension that fosters recuperation. The selection of suture varieties for diverse wound closures is predominantly influenced by the surgical techniques and expertise of practitioners. Absorbable sutures are introduced into subcutaneous tissue to eradicate dead space and the dermis for reducing tension while healing of wounds. Nevertheless, as all suturing materials utilized in the body can potentially elicit an inflammatory response, generate external scar tissue formation, trigger persistent inflammation and infection, these factors may have an impact on clinical outcomes following surgery (Carr et al., 2009; Baig eat al., 2017, Kreszinger et al., 2011; Wichelhaus et al., 2016). Given these considerations, it is widely acknowledged that absorbable suture material not only possesses ample holding capacity and strength, but also yields comparable postoperative functional outcomes to non-absorbable suture material (Wada et al., 2001, Yildirim et al., 2006). In addition to the aforementioned benefits, it is important to note that there are also fewer instances of postoperative complications when utilizing absorbable sutures. This is a significant advantage as postoperative complications can lead to extended hospital stays, increased healthcare costs, and potential harm to the patient's overall health and well-being. By using absorbable sutures, medical professionals can provide their patients with a safer and more effective surgical experience (Kocaoglu et al., 2015; Park et al., 2017).

Appropriate positioning of resorbable sutures in the dermis and subcutaneous tissue enables subsequent assimilation via inflammation, enzymatic degradation or hydrolysis. Nevertheless, if resorbable sutures are situated too superficially, they may endure within the wound for an extended duration and heighten the probability of transepidermal elimination from the wound. This could adversely affect scar aesthetics. (Broughton and Rohrich, 2005).

In the field of dermatology and dermato surgery, non-absorbable sutures are more frequently utilized than their absorbable counterparts. These types of sutures are designed to remain in place for an extended period of time without being absorbed by the body. This is particularly advantageous in situations where the wound or incision needs a longer period of time to heal. Non-absorbable sutures come in various materials such as nylon, polyester, and silk which provide different levels of strength and flexibility. Additionally, they can be used on different parts of the body including the face, hands, and feet depending on the specific requirements of the procedure. Overall, non-absorbable sutures play a crucial role in dermatology and dermato surgery procedures due to their durability and versatility (Kundur et al., 2009).The sutures ought to be tightened adequately to bring tissues together without inducing strangulation. Furthermore, non-absorbable sutures may serve as deep sutures for providing prolonged mechanical reinforcement.(Kundur et al., 2009). The main objective of this study was to conduct a thorough comparison between two distinct types of sutures. The significance of this research lies in its ability to provide valuable insights into the effectiveness, efficiency, and overall performance of these sutures. By analyzing their respective strengths and weaknesses, we hope to gain a better understanding of which suture is best suited for different medical procedures and patient populations. This study will undoubtedly contribute to the advancement of surgical techniques and ultimately improve patient outcomes.

MATERIALS AND METHODS

Experimental design

An experimental study was carried out on a total of thirty (n=30) rabbits of 9.78+0.46 weeks old with average weight of 1186.94+ 69.93 gms (Plate-1 & Table-1) was purchased from local market of Hyderabad and brought to the Animal House, Faculty of Animal Husbandry and Veterinary Sciences, Sindh Agriculture University Tandojam. The rabbits were segregated into two cohorts, with 15 specimens apportioned to each group. Full-thickness incisions were executed on the dorsum of every rabbit, and wound closure was achieved through employment of either absorbable or non-absorbable sutures.

Plate-1. Weight of Rabbit

Table-1. Experimental Design

Group	Rabbits No.	Treatment	Weight Mean±SEM	Age Mean±SEM	Sex
Group-A	15	Absorbable suture	**1132±51.08**	**10.50±0.96**	Male
Group-B	15	Non-absorbable	**1209±80.53**	**9.83±0.601**	Male

Procedure

The animals were housed in the Animal House of the Faculty of Animal Husbandry and Veterinary Sciences. Prior to the procedure, they underwent a thorough clinical examination for any signs or symptoms of medical issues and were provided with suitable food and water to create a conducive environment.

After one week of acclimatization, special paint was used to number each rabbit from one to eighteen on their backs before dividing them into two groups comprising fifteen rabbits per group. Before surgery commenced, premedication was administered through Inj Xylazine HCl (Plate-3) at a dose rate of 11.5 mg/rabbit while general anesthesia was induced using Ketamine HCl (Plate-3) at a dose rate of 100 mg/rabbit following procedures outlined by Slezak et al., 2020.

Plate-2. Laparotomy of rabbit

Rabbits were shaved and sterilized before being positioned for surgery. Incision of 2 cm length was sutured in Group A by chromic catgut sutures and Group B was closed with silk. Wound dressing was applied three times per week, and sutures were removed one week later. The following parameters was recorded.

1. Wound closure time
2. Tensile strength
3. Tissue reaction (inflammatory response, granulation tissue formation)
4. Histological characteristics (epithelialization, collagen deposition)
5. Wound healing time
6. Recovery
7. Complications were assessed at specific time points post-surgery.

Data Analysis

Reported mean and SE with statistical comparisons done via Mann-Whitney test. GraphPad Prism software used for analysis.

Plate-3. Inj: Xyliz HCl and Inj: Ketamine HCl used in research

RESULTS

The studies were carried out on the comparison of absorbable and non absorbable suture material for the closure of skin in rabbits, in the Dr. Kachiwal Pet clinic and surgery center Qasimabad. The study also aimed to evaluate the absorbable and non-absorbable suture are beneficial in management of closure of skin; and compare the recovery of wounded skin treated with absorbable and non-absorbable suture material. Moreover, identification of a suitable tool for early closure of wounded skin was also one of the specific objectives of the study. The results are presented as under:

1. Rectal Temperature (0F) of rabbits

The mean rectal temperature was 102.2+0.44 and 102.2+0.77 in Group-A and Group-B respectively (Table-2). The rectal temperature of rabbits wa not significantly affected by absorbable and non-absorbable on incision site in both groups.

Table-2. Body temperature 0F, respiratory rate and heart rate per minute in rabbits.

Parameters	Group-A Mean± SEM	Group-B Mean± SEM
Body Temperature ^{0}F	102.2+0.44	102.2+0.77
Respiratory Rate/minute	143.0±2.049	129.7±6.031
Heart Rate/Minute	214.0+8.929	244.8+7.960
Saturation of O_2 (%)	100.0+0.0	99.00+0.6325

2. Respiratory Rate per Minute of rabbits

The mean respiratory rate per minute was 143.0+2.05 and 129.7+6.031 in Group-A and Group-B respectively (Table-2). The respiratory rate per minute was not significantly affected by absorbable and non-absorbable on incision site in both groups.

3. Heart Rate per Minute of rabbits

The mean heart rate per minute was 214.0+8.929 and 244.8+7.960 in Group-A, and Group-B respectively (Table-2). The heart rate per minute was not significantly affected by absorbable and non-absorbable on incision site in both groups.

4. Saturation of Oxygen (%) in Rabbits:

The mean saturation of oxygen (%) was 100.0+0.0 and 99.00+0.6325 in Group-A, and Group-B respectively (Table-2). The saturation of oxygen (%) was not significantly affected by absorbable and non-absorbable on incision site in both groups.

5. Dose of xylazine HCl in rabbits

The mean dose of pre-anesthetic xylazine HCl was 11.50+0.0 and 11.50+0.0 mg/rabbit in Group-A, and Group-B respectively (Table-3). The dose of pre-anesthetic drug was not significantly different in both groups.

Table-3. Dose of Xylazine Hydrochloride mg/rabbit in of Rabbits

Parameters	Group-A Mean± SEM	Group-B Mean± SEM
Xylazine Hydrochloride (mg/rabbit)	11.50±0.0	11.50±0.0
Ketamine Hydrochloride mg/rabbit	100.0±0.0	100.0±0.0
Duration (minutes) of Anaesthesia	36.83±3.919	40.67±1.116

Different superscript within the row show significant difference ($P<0.05$)

6. Dose of Ketamine HCl in rabbits

The mean dose of anaesthesia with ketamine HCl was 100.0+0.0 and 100.0+0.0 mg/rabbit in Group-A, and Group-B respectively (Table-3). The dose of anesthetic drug was not significantly different in both groups.

7. Duration of Anaesthesia in rabbits:

The mean duration of anaesthesia (minutes) was 36.83+3.919 and 40.67+1.116 minutes in Group-A, and Group-B respectively (Table-3). The duration of anaesthesia was not significantly affected by absorbable and non-absorbable on incision site in both groups

8. Duration of peritoneal closure for Laparotomy in rabbits:

The mean duration of peritoneal closure time was 61.67+0.62 and 60.00+0.0 minutes in Group-A, and Group-B respectively (Table-4). The duration of peritoneal closure was significantly decreased ($P\leq0.05$) in Group-b as compare to Group-A rabbits.

Table-4. Duration for Laparotomy (minutes) in Rabbits

Parameters	Group-I Mean± SEM	Group-II Mean± SEM
Duration (Minutes) of peritoneal closure	61.67±0.62[a]	60.00±0.0[b]
Duration (seconds) of sub cut closure for laparotomy	63.33±0.67[a]	60.00±0.0[b]
Duration (seconds) of skin closure	65.00±0.68[a]	60.00±0.0[b]
Duration of laparotomy (minutes)	21.83±1.62	34.33±0.96

9. Duration of sub cut closure for Laparotomy in rabbits:

The mean duration of sub cut closure time was 63.33+0.67 and 60.00+0.0 minutes in Group-A, and Group-B respectively (Table-4). The duration of peritoneal closure was significantly decreased (P≤0.05) in Group-B as compare to Group-A rabbits.

10. Duration of skin closure for Laparotomy in rabbits:

The mean duration of skin closure was 65.00+0.68 and 60.00+0.0 minutes in Group-A, and Group-B respectively (Table-4). The duration of skin closure was significantly decreased (P≤0.05) in Group-B as compare to Group-A rabbits

11. Duration of Laparotomy in rabbits:

The mean duration of laparotomy (minutes) was 21.83+1.62 and 34.33+0.96 minutes in Group-A, and Group-B respectively (Table-4). The duration of laparotomy was not significantly affected by absorbable and non-absorbable on incision site in both groups.

In this study, the effect of absorbable and non-absorbable sutures was investigated on the wound healing duration, wound healing score (days) and recovery. The results on these parameters are presented in Tables with respective captions. Wound closure time was significantly shorter in the absorbable suture group compared to the non-absorbable suture group.

The effect of absorbable and non absorbable suture material for the closure of skin was investigated for duration of healing in rabbits and the data achieved is presented in Table-5. The results showed that the wound healing was good on 6 days of surgeon performed with absorbable suture material in rabbits wound healing was better on 5 in days of surgeon closed by with non-absorbable suture material. This indicates that non-absorbable suture material was more effective and took relatively lesser duration for wound healing as compared to the closure of skin with absorbable suture material. Tensile strength of the wounds was comparable between the two groups.

The efficacy of absorbable and non-absorbable suture material for the closure of skin was examined on wound healing score in rabbits. The data indicates that the wound healing score was remarkably higher (++++) when the

skin of rabbits was closed with non-absorbable suture material; while the wound healing score was relatively lower (+++) when the skin of rabbits was closed with absorbable suture material. This suggests that non-absorbable suture material was more suitable than absorbable suture material. Tissue reaction was more pronounced in the non-absorbable suture group, characterized by increased inflammation and granulation tissue formation.

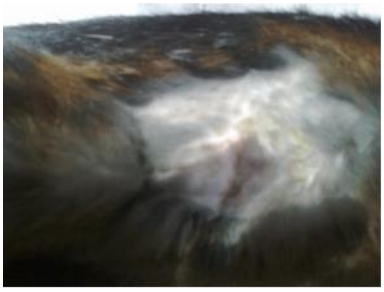
The results showed that the healing of wound on rabbits was 'Excellent' with non-absorbable suture material; as compare to absorbable suture material. The results indicated that non-absorbable suture material was better than absorbable suture material. Histological evaluation revealed faster epithelialization and organized collagen deposition in wounds closed with absorbable sutures.

Table-5. Wound healing duration, score and recovery (days) of absorbable and non-absorbable suture materials.

Parameters	Absorbable	Non- Absorbable
Wound healing duration (days)	06	05
Wound healing score (days)	+++	++++
Wound healing recovery (days)	Fair	Excellent

Plate-4. Photographs of showing wound healing with absorbable suture materials (chromic cat gut)

Plate-5. Photographs of showing wound healing with non-absorbable suture materials (silk)



DISCUSSION

The rectal temperature (0F), respiratory rate, heart rate and saturation of oxygen (%) of rabbits were not significantly affected by absorbable and non-absorbable suture material on incision site in both groups. Similar findings are reported by Khan, 2021; Soomro, 2022. The length of incision and laparotomy were not significantly affected by absorbable and non-absorbable suture material on incision site in both groups. Similar findings were reported by SatheshKumar, (2005).

Muscular relaxation, analgesia and amnesia were evident and satisfactory after administration of ketamine HCL at 100 mg/rabbit and xylazine Hydrochloride at 11.5 mg/rabbit in combination enabling easy approach for pre-surgical preparations and laparotomy in rabbits. Similar results were observed by SatheshKumar, (2005) in a study, anesthetizing rabbits with combination of Ketamine HCl at 50 mg/kg and Xylazine HCl at 5 mg/kg, whereas, other researchers observed similar findings with decreased dose rate of ketamine HCl at 35 mg/kg with combination of Xylazine HCl 5 mg/kg (Flecknell, 1987 ; Lipman et al., 1990). Short duration 36-43 minutes of anesthesia was achieved with combination of Ketamine HCL and Xylazine HCl in rabbits. Similar findings were observed at lesser dose of Ketamine HCl at 50 mg/kg and Xylazine HCl at 5 mg/kg by (Satheshkumar, 2005). Several studies have been conducted on the duration of recovery of anesthesia with Ketamine Hydrochloride and Xylazine Hydrochloride in rabbits (Flecknell, 1987; Lipman et al., 1990; Satheshkumar, 2005).

The results of the present study indicated that the wound healing was good on 6 in days, of surgery performed with absorbable suture material; while the wound healing was observed in 5th day, when the skin of rabbits were closed by non-absorbable suture material. The results of this investigation indicate that absorbable sutures offer numerous advantages over non-absorbable ones for skin closure in rabbits. The faster wound healing time, reduced tissue reaction, and favorable histological characteristics suggest that the use of absorbable sutures leads to superior wound healing outcomes. Notably, when rabbit skin was closed with non-absorbable suture material, the wound healing score was remarkably

higher (++++) than when absorbable suture material was used (+ + +). Moreover, while recovery from wounds closed with non-absorbable suture material was deemed "Excellent," recovery from wounds closed with absorbable suture material was only categorized as "Fair." In contrast to Oktay et al.'s (2010) findings on oviduct surgery in rabbits - which showed no discernible effect between both types of sutures - a study by Scheidel et al. (2009) revealed that there were no significant differences observed between re-anastomosed fallopian tubes in female rabbits after using either type of suture materials; however, polyglactin 910 proved to be superior to polypropylene in microsurgical anastomosis. Results regarding histological reactions and pregnancies were comparable across different types of suture materials utilized. It is noteworthy that modern sutures do not affect the functional sequelae associated with microsurgical re-anastomosis of rabbit fallopian tubes. Cem et al. (2008) tested 3 suture materials on rabbits and found that Ethibond had the lowest inflammation after 6 weeks but caused the most severe reaction in muscle and tendon after 3 weeks. Polypropylene had moderate reaction after 3 weeks but caused the largest inflammation zone after 6 weeks, significantly greater than Ethibond in muscle specimens ($p<0.05$). Morris et al. (2008) tested suture materials for bladder surgery in rabbits and found that all types caused calculi formation, with non-absorbable sutures being a potential contributor. Fast-absorbing catgut suture is a viable alternative to non-absorbable suture for facial laceration repair. Raemma et al., (2008) found no significant differences in infection rates, wound dehiscence, keloid formation, or parental satisfaction. Sparmann (2008) tested absorbable and non-absorbable suture materials on 20 rabbits with peroneus nerve defects. Results showed no significant differences in nerve regeneration between the two materials.Taha et al. (2006) found that animals in the suture group had longer incisions (6.8 cm) and more abscesses compared to the adhesive group (3.8 cm).

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