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COMPARATIVE EVALUATION OF THE RATE AND ABSORPTION OF MILDLY TREATED CHROMIC CATGUT IN A RAT MODEL

Adamu Abdul Abubakar [1,2]*, Khadija Idris Abubakar [2], Ibrahim Bedi[2], Abdulkadir Salman Zubair[3], Mukaddas Muhammad Ahmad [2], Umar Salisu Ahmad [2], Ekaete Ime Oviawe [2], Nura Abubakar [2], Hassan Abubakar Bodinga [2], Qais Al-Rawahi [1], Abdullahi Aliyu [1,4], Abubakar Sadiq Yakubu [2] and Salisu Buhari [2]

[1]Department of Veterinary Medicine, College of Applied and Health Sciences, A'Sharqiyah University, Oman
[2]Department of Veterinary Surgery and Radiology, Usmanu Danfodiyo University, Sokoto, Nigeria
[3]Department of Veterinary Surgery and Radiology, University of Ilorin, Nigeria
[4]Department of Veterinary Pathology, Usmanu Danfodiyo University, Sokoto, Nigeria

*Corresponding author: adamu.abubakar@asu.edu.om

ABSTRACT

Gut suture materials are natural, sterile, absorbable biological substances composed of purified collagen originating from the outer layer of the intestinal segment of ruminants. They are commercially prepared and packaged in a chemical solution composed primarily of isopropanol and triethanolamine. This study aimed to determine the rate and duration of absorption of mildly treated chromic catgut in different tissue types in a rat model. A total of seventy-five apparently healthy Wister rats weighing between 215 to 225 g were used for this study. The rats were randomly divided into three experimental groups of twenty-five (n=25) rats per group: the abdominal muscle group (AMG), thigh muscle group (TMG), and subcutaneous tissue group (STG). A standard uniform 3 cm incision was made in the abdominal muscle, thigh muscle, and the dorsal skin to the level of the subcutaneous regions. Size 3-0 mildly treated chromic catgut was implanted in the three tissue groups using a simple continuous running suture. The skin in all groups was closed with nylon size 2-0 using a horizontal mattress suture pattern. The rats were humanely euthanized at days 7, 14, 21, 28, and 35 post-implantation of the chromic catgut to remove the remnant of the implanted suture material, and the mass loss was determined at different intervals of absorption. The duration of absorption of the mildly treated chromic catgut implanted in the three different tissue types was 21 days in the TMG and beyond 35 days in the AMG and STG. It was observed that the thigh muscle group appeared to have a shorter duration of absorption (21-day) and absorption rate. Surgeons need to consider the rate and duration of absorption when choosing mildly treated chromic catgut for clinical use.

Keywords: Absorption, Catgut, Rat, Suture material.

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1. INTRODUCTION

Gut suture materials are natural, sterile, absorbable biological substances composed of purified collagen originating from the outer layer of ruminants' intestinal segments (Dennis et al., 2016; Gupta et al., 2020; Tomihari et al., 2025; Furtado et al., 2025). It is commercially prepared and packaged in a chemical solution composed mainly of isopropanol and triethanolamine (Hirko et al., 2018). Gut suture materials can be plain, untreated gut or chromic acid-treated gut; it is believed that chromic-treated gut has a longer absorption duration than plain gut (Kettle & Johanson, 2000; Zhang et al., 2025). The physiological mechanism by which the gut suture material is incorporated and absorbed into the tissue after implantation is fully understood (Naleway et al., 2015). However, the rate at which catgut is absorbed by various tissues of the body is poorly understood, leading to suboptimal utilization of these suture types among surgeons.

Plain catgut, when treated with chromic acid solution, becomes chromic catgut. It is a widely used suture material, especially in clinical settings where supplies of synthetic absorbable suture material are limited (Jummaat et al., 2021; Li et al., 2023). It is indicated for many surgical procedures, including, but not limited to, general soft-tissue procedures where approximation of internal tissues is needed and ligation of blood vessels. It is used in ophthalmic surgery but is rarely used in cardiac or neurosurgery as reported by Fomete et al. (2013), D'Cunha et al. (2022). It has been reported that chromic catgut sutures elicit a minimal acute inflammatory reaction in tissues. The tissue response is followed by a steady loss of tensile strength and the mass of the implanted suture through enzymatic degradation of the surgical gut until it is completely absorbed, as described by Dasgupta et al. (2016).

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The mechanism in which the chromic catgut is absorbed in a manner similar to the digestion of an animal protein by the body (Fomete et al., 2013). The absorption process is influenced by numerous factors such as the type of tissue involved, the size of the suture material, the presence or absence of contaminants or infectious materials around the wound, and the overall general health status of the patient undergoing the surgical procedure (Susmitha & Bidri, 2021; Nappi, 2025).

The mechanism of chromic catgut absorption was reported to be via phagocytosis; however, the rate of absorption is slowed by the concentration of chromic acid used in treatment (Deshpande et al., 2019). An absolute mass absorption of this suture material has been reported to occur within an estimated 90 days, irrespective of the tissue type involved (Chellamani et al., 2013; Khalid & Billa, 2023; Kolaib et al., 2023; Bahnick et al., 2025). Some benefits of chromatizing the gut suture material include resistance to enzymatic body activities, prolonging absorption time, and retaining tensile strength until complete wound healing has occurred (Dart & Dart, 2017; Elgohary et al., 2025). However, there were reported incidences of rapid absorption when used in infected tissues or in tissues with high concentrations of proteolytic enzymes, such as the cervix and stomach, as reported by Pillai & Sharma (2010).

We hypothesized that there could be variation in the duration and rate of absorption of chromic catgut in different tissue types within the body. To test this, there is a need to evaluate and determine the specific rate and duration of absorption of different types of chromic catgut in different tissues or organs of the body, as this may help to provide clinically relevant information guidance on the choice of absorbable suture materials for closure of incisional wounds and ligation of vessels. The aim of this study is to determine the absorption rate and duration of chromic catgut in different tissues of the body using a rat model.

2. MATERIALS AND METHODS

2.1. Research Animals and Experimental Design

A total of 75 Wister rats were utilized for this study. The rats were sourced from the animal resource facility of the Faculty of Veterinary Medicine, Usmanu Danfodiyo University, Sokoto. The rats weighed between 215 and 225 g and were kept under good sanitary conditions in a plastic cage with adequate ventilation and a normal 12L:12D light-to-dark cycle. They were fed with commercial rodent feed (Vital Feed, Jos), and clean water was provided *ad libitum*. The experimental room temperature was maintained at 26ºC with relative humidity of 45%. The rats were randomly divided into three experimental groups of twenty-five each (n=25). The experimental groups were: Abdominal Muscle Group (AMG), Thigh Muscle Group (TMG) and Subcutaneous Tissue Group (STG).

2.2. Surgical Implantation of the Chromic Catgut

Prior to the surgery, the weights of the rats and chromic catgut to be implanted were recorded using sensitive analytical balances (Infitek, BA-E series, USA). The rats were restrained and anesthetized with an intramuscular injection of Zoletil (Virbac, USA) at a dose of 0.5 mg/kg. The surgical site was clipped and scrubbed with methylated spirit (Binji Global Pharmaceutical Company, Sokoto, Nigeria) and chlorhexidine gluconate (Saro Life Care Limited, Nigeria). A standard uniform 3 cm incision was made at the abdominal muscle (ABM), thigh muscle (TM), and the skin (ST) to the level of the subcutaneous layer. The mildly treated chromic catgut (Absorbable Surgical Suture, Mission Pharmacy, Denmark) size 3-0 was implanted in the three tissue groups using a simple continuous running suture (Fig. 1). The skin in all groups was closed with nylon (Agary Pharmaceuticals, China) size 2-0 using a horizontal mattress suture pattern.

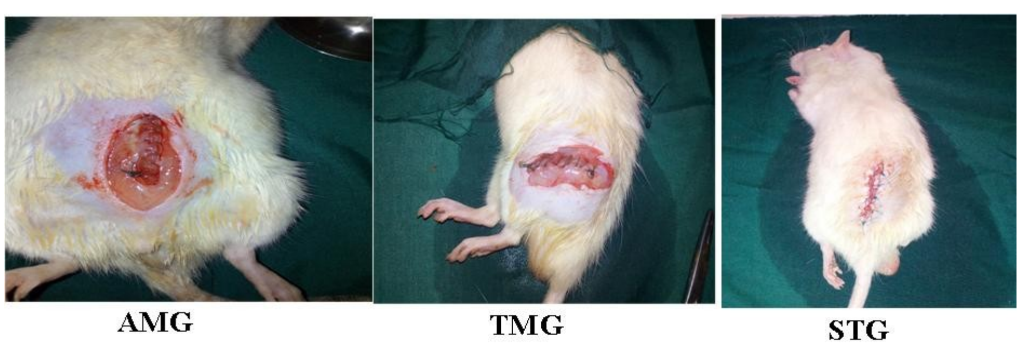

Fig. 1: Implantation of the Chromic Catgut in Different Tissue Groups, Abdominal Muscle Groups (AMG), Thigh Muscle Group (TMG) and Subcutaneous Tissue Group (STG).

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2.3. Determination of Duration of Absorption

To determine the duration of absorption of the implanted chromic catgut, the rats were humanely euthanized using overdose intra-peritoneal administration of 20% sodium pentobarbital (Vetoquinol, France) at a dose rate of 100 mg/kg according to the standard procedure described by Underwood & Anthony (2020) and Abubakar et al. (2022). The rats were euthanized at day 7, 14, 21, 28 and 35 intervals after mild chromic catgut implantation.

The longevity or duration of absorption of the implanted chromic catgut was determined by taking into consideration the appearance and disappearance of the implanted chromic catgut at the specified interval of absorption as described by Fomete et al. (2013). This was achieved by dissecting the tissue containing the chromic catgut implant and tracing the suture material. The traced suture material was then removed, and the mass of the implanted, removed chromic catgut was determined using a sensitive digital weighing balance.

2.4. Determination of Absorption Rates of the Implanted Chromic Catgut

The absorption rates of implanted chromic catgut were determined using two different methods. The percentage absorption rate of the chromic catgut was determined using semi-quantitative six (6)- point subjective scoring criteria designed and validated by the authors (Table 1).

The rate of absorption of the implanted chromic catgut was also determined using the gradual change of mass of the implanted suture material as described by Hochberg et al. (2009). The specific mass of the chromic catgut implanted in each tissue group was weighed prior to implantation at the beginning of the experiment, and subsequently, the mass loss was assessed at different intervals of absorption (Day 7, 14, 21, 28, and 36).

Table 1: Criteria used for Percentage Absorption Rates of the Implanted Chromic Catgut

	Absorption criteria	Percentage scoring (%)
1	No tissue adhesion with suture material	0
2	Minimal tissue adhesion with suture material	15
3	Moderate adhesion of tissue with suture material	30
4	Marked adhesion of tissue with sutures+ separation of suture material	50
5	Marked adhesion of tissue without sutures, separation of suture material	75
6	Inability to demarcate between suture materials and the surrounding tissues	100

2.5. Data Analysis

The generated data were tabulated and presented as graphs where applicable. The mass change of the suture material was computed as mean ± SEM. One-way ANOVA was used to compare the mean change in chromic catgut mass across the three tissue groups. Non-parametric ANOVA was employed to compare the percentage absorption rates across the three distinct tissue groups. GraphPad InStat software version 3.1 was employed for the data analysis. Statistical significance was considered significant at $P<0.05$.

3. RESULTS

3.1. Duration of Absorption of the Mildly Treated Chromic Catgut

The duration of absorption of the mildly treated chromic catgut implanted in three distinct tissue types (thigh muscle, abdominal muscle, and subcutaneous tissue) was evaluated based on physical observation of the visibility (presence or absence of the suture material). It was observed that the thigh muscle group appeared to have a shorter duration of absorption (21-day) (Table 2).

Table 2: Duration of absorption of mild-treated chromic catgut implanted in three different tissue types

Assessment of Absorption (Days)	Tissue Groups Absorption Status		
	TMG	AMG	STG
Day 7	Present	Present	Present
Day 14	Present	Present	Present
Day 21	Absorbed	Present	Present
Day 28	Absorbed	Present	Present
Day 35	Absorbed	Present	Present

Throughout the observation period, the chromic catgut implanted in the abdominal muscle and subcutaneous tissues was not absorbed. This implied that the absorption duration for the abdominal muscle and subcutaneous tissues exceeded 35 days.

3.2. Rates of Absorption of the Mild Treated Chromic Catgut

The rate of absorption of the mildly treated chromic catgut implanted in three distinct tissue types within the body was assessed based on the serial loss of mass determination at different intervals of absorption. It appeared

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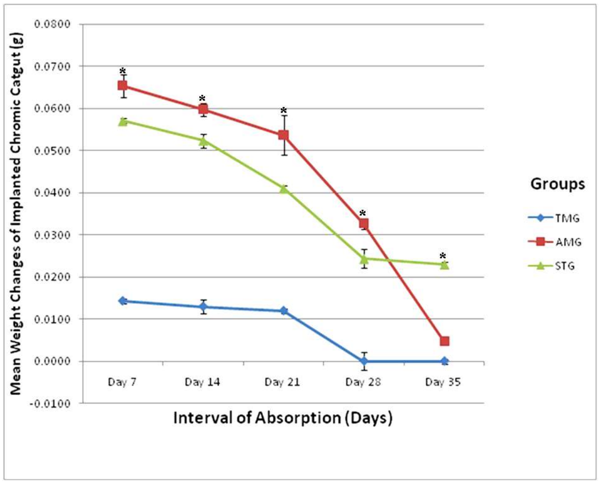

Fig. 2: Line Graph Showing Mean Weight Loss Pattern of the Implanted Chromic Catgut at Different Intervals of Absorption. *Signified significant difference among the groups at different absorption intervals.

that the thigh muscle had the fastest absorption rate, followed by the abdominal muscle and subcutaneous tissue, with mean decreased mass losses of 0.0143 ± 0.0003, 0.0653 ± 0.0027, and 0.0570 ± 0.0006, respectively (Fig. 2). The thigh muscle recorded 100% absorption at 28 days post implantation. There were progressive absorption rates for the other tissue types (abdominal muscle and subcutaneous tissue), but neither was 100% at 35 days (Fig. 2).

There were significant differences ($P<0.05$) in the mass change of chromic catgut among the tissue type groups at days 7, 14, 21, 28 and 35 of the absorption intervals (Fig. 2). There were also significant differences ($P<0.05$) in mass changes of the chromic catgut within the groups among the absorption intervals (Table 3).

Within the abdominal muscle group, significant differences were recorded between day 7 and 28 also between day 7 and 35 (Table 3). Equally, significant differences in the absorption rate were also recorded within thigh muscle groups between day 7 with 28 and day 7 with 35. Similarly, significant differences in absorption rate were also observed within the subcutaneous tissue group between days 7 and 21, 28, and 35 (Table 3).

There were no significant differences ($P>0.05$) in the percentage absorption rates of the implanted chromic catgut among the three tissue groups at day 7 of the absorption interval. However, there were significant differences ($P<0.05$) in the percentage absorption rates of the chromic catgut among the three tissue groups at day 14, 21, 28, and 35 absorption intervals (Fig. 3).

Table 3: Mean Weight (g) Loss of the Implanted Chromic Catgut at Different Intervals of Absorption

Groups	Mean Weight of the Chromic Catgut (g)				
	Day 7	Day 14	Day 21	Day 28	Day 35
TMG	0.0143 ± 0.0003^a	0.0130 ± 0.0006	0.12 ± 0.0015	0.0 ± 0.00^b	0.0 ± 0.0^c
AMG	0.0653 ± 0.0027^a	0.060 ± 0.0015	0.0537 ± 0.0047	0.0327 ± 0.0013^b	0.005 ± 0.0003^c
STG	0.0570 ± 0.0006^a	0.0523 ± 0.0017	0.041 ± 0.0006^b	0.0243 ± 0.0022^c	0.023 ± 0.0006^d

Values (mean ± SEM) bearing superscript within the group (column) at different interval of absorption denote significant ($P<0.05$) difference.

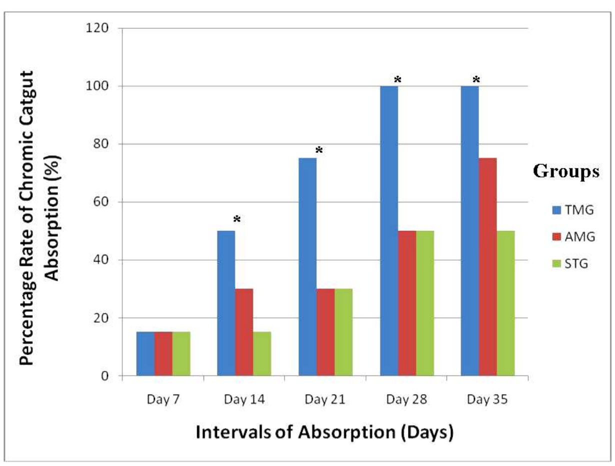

Fig. 3: Bar Chart Indicating Percentage Rate of Absorption of the Chromic Catgut Implanted at Different Tissue Types. *Signified a significant difference among the groups at different absorption intervals.

4. DISCUSSION

The absorption process of chromic catgut does occur through degradation by hydrolysis, enzymatic digestion or phagocytosis (Kim et al., 2007; Das et al., 2023; Yohannes, 2024; Barbosa et al., 2024; Nappi, 2025). The rate of absorption in the body has been reported to be faster in body regions where there is localized infection or an increase in tissue concentration of proteolytic enzymes (Pillai & Sharma, 2010; D'Cunha et al., 2022; Alam, 2022). The duration of absorption of the mildly treated chromic catgut implanted in three different tissue types (thigh muscle, abdominal muscle and subcutaneous tissue) was evaluated based on physical observation of the implanted suture materials (present or absence of the suture material). It was observed that the thigh muscle group appeared to have a shorter duration of absorption (21-day). The chromic catgut implanted in the abdominal muscle and subcutaneous tissues was not absorbed throughout the observation intervals (day 7 to day 35). This implied that the duration of absorption of the abdominal muscle and subcutaneous tissues were beyond 35 days, which may require an extension of this type of study to establish the exact duration of absorption in the abdominal and the subcutaneous layers of the skin. The possible difference in absorption rate and duration of absorption amongst the three groups could be attributed to the variation in the amount of collagen content in the tissues, as reported by Kudur et al. (2009), Sriyai et al. (2021), Kawecki (2023), and Hagh et al. (2024). It could also be as a result of variation in the concentration of proteolytic enzymes present in the tissue, which help in the degradation of the suture materials as reported by Freudenberg et al. (2004), Karabulut et al. (2010) Abubakar et al. (2015), Alves et al. (2023), Ge et al. (2025) and Dalos et al. (2026).

The rate of absorption of mild chromic catgut implanted in different tissue types was assessed using serial mass loss measurements at different intervals. It was observed that the thigh muscle had the fastest absorption rate, followed by the abdominal muscle and subcutaneous tissue, with a significant decrease ($P < 0.05$) in the mean mass loss of the implanted suture material. The thigh muscle recorded a 100% absorption rate at 28 days. There were progressive absorption rates of the other tissue types (abdominal muscle and subcutaneous tissue) but both were not 100% absorbed at 35 days. The variation in absorption rate could be attributed to the fact that different tissues in the body have different tissue reactivity responses; the reactivity response variation is majorly based on the inflammatory cells present within the locality of the implanted suture materials (Selvi et al., 2016; Guillaume et al., 2025; Mellado et al., 2025; Markel et al., 2025). There were significant differences ($P<0.05$) in the mass change of chromic catgut among the groups at days 7, 14, 21, 28, and 35 of the absorption intervals. It was also observed that there were significant differences ($P<0.05$) in mass changes of the chromic catgut across the groups at healing intervals (days 7, 14, 21, 28, and 35). This indicates that the three tissues of interest have a specific absorption pattern. There were no significant differences ($P>0.05$) in the percentage absorption rates of the implanted chromic catgut among the three tissue groups at day 7 of the absorption interval. This implies that, amongst the groups, the percentage absorption rate was identical for all three tissue groups (AMG, STG, and TMG). However, there were significant differences ($P<0.05$) in the percentage absorption rates of the chromic catgut amongst the three tissue groups at the 14th, 21st, 28th, and 35th day absorption intervals. This could also indicate that at subsequent days of healing (day 14, 21, 28, and 35) the absorption rates of the mildly chromic catgut vary amongst the tissues; the variation in intervals of days of absorption is a result of the presence of inflammatory cells triggered by the implanted suture materials (Fawi et al., 2023; Seger et al., 2024; Makrygiannis et al., 2025; Schonebaum et al., 2025; Wheeler et al., 2025). Further *in-vivo* and *in-vitro* research can be conducted on other animal models to examine the rate and duration of chromic catgut absorption in tissues beyond the thigh muscles, subcutaneous tissue, and abdominal muscles.

5. CONCLUSION

It can be concluded that there is a significant disparity in the rate and duration of mild chromic catgut absorption amongst the thigh muscle, subcutaneous tissue and abdominal muscle. The absorption rate of mild chromic catgut appeared faster in thigh muscle tissue, followed by abdominal muscle and subcutaneous tissue. The absorption duration of mild chromic catgut was shorter in the thigh muscle group compared to the abdominal muscle and subcutaneous tissue, which required more days for complete absorption. Surgeons should consider the absorption rate and duration, along with the healing timeline, when selecting mild chromic catgut for any surgical intervention.

Declarations

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Conflicts of Interest: There exists no financial or other conflict of interest with any individual or organization.

Data Availability: The data presented in this research are available from the corresponding author upon reasonable request, provided it will be appropriately utilized.

Ethics Statement: This study was carried out in compliance with the ARRIVE guidelines. Ethical approval was sought from the Faculty Animal Research Ethics Committee of the Faculty of Veterinary Medicine, Usmanu Danfodiyo University, Sokoto, with the reference number UDUS/FAREC/2020/ AUP-R0-7.

Author's Contributions: All authors contributed equally to this research. AAA and KIA conceived the research idea, SB, ASY, USA, AA designed and conducted the experiment. QA, HBA, NA, EIO and MAM made the initial manuscript, QA and AA analysed the data and interpreted the experimental results. All authors reviewed and approved the final draft before submission.

Generative AI Statements: The authors declare that no Gen AI/DeepSeek was used in the writing/creation of this manuscript.

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