

Research Article



Haematological and Histological Evaluation of Camel Bone as a Potential Orthopaedic Biomaterial

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Abstract | Traditionally, metallic materials like titanium, its alloys, and steel are used for treating fractures and skeletal injuries. Although inert, these materials are often removed post-healing, necessitating a second, costly surgery that can impact patient well-being. To avoid this, a bioabsorbable/biodegradable material (xenograft) is needed. This experimental study aimed to evaluate the effects of implanting camel bones into rat muscle tissue, comparing findings with a control group that had Kirschner wire (inert) implants. The study involved haematological and histological assessments of the implants and surrounding muscles. Sixteen male albinos rats (average weight 125g), divided into two groups of eight, were used. Blood samples were collected on the surgery day and at intervals up to day 28 post-implantation for haematological analysis. On days 14 and 28 post-implantation, two rats from each group were randomly selected and sacrificed for histological analysis of tissue samples from the thigh muscles. Overall performance was satisfactory across all groups. The biomaterials showed no adverse reactions, such as swelling, discharge, or skin color changes at wound sites. The xenogenic camel bone exhibited minimal to moderate inflammatory reactions, typical of normal healing. Haematological parameters remained within the reference range throughout the study. The study confirmed that haematological parameters were within the normal range, indicating good biocompatibility. The material showed minimal to moderate inflammatory reactions in rat tissues. These results should be combined with other parameters for a comprehensive biocompatibility evaluation.

Keywords | Camel bone, K-wire, Hematological assessment, Histological evaluation, Biocompatibility

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INTRODUCTION

Bone grafts are considered ideal biomaterials as indicated in cases of osteomyelitis and non-union of frac-

tures, because they stimulate consolidation, preservation of limbs, and complement corrective osteotomies (Keating and McQueen, 2001). The use of xenogenic bone is reported in the literature (Oliveira *et al.*, 2004; Lima Taga *et*

al., 2008, Dehghaniet *al.*, 2008; Castro-Silva *et al.*, 2009; Aliyu *et al.*, 2022). The potential and ease of obtaining and the stock, makes it a promising material for filling bone defects (Johnson *et al.*, 2000).

The biological evaluation of biomaterials includes a broad spectrum of *in vitro* and *in vivo* tests related to the cytocompatibility, genotoxicity, sensitization, irritation, acute and chronic toxicity, hemocompatibility, reproductive and developmental toxicity, carcinogenicity, implantation and degradation as specified by different international standards organizations like the American Society for Testing Materials (ASTM), the United States Pharmacopeia (USP), and the International Organization for Standardization (ISO) for implantable devices and biomaterials (Koschwanetz and Reichert, 2007; Assad and Jackson 2019). Biocompatibility is one of the mandatory requirements for the clinical use of biomaterials in orthopedics, and it refers to the ability of a biomaterial to perform its intended function in a medical therapy without causing undesirable local or systemic effects on the recipient. At the same time, it should provide the most optimized clinically relevant performance of that therapy. Another definition describes it as the ability of a material to perform with an appropriate host response in a specific situation (Helmus *et al.*, 2008; Bruinink and Luginbuehl, 2012; Assad and Jackson, 2019; Huzum *et al.*, 2021). Consequently, biocompatibility testing is essential for the development and regulatory approval of orthopedic materials for clinical use. Biomaterials must adhere to basic biocompatibility criteria established by the International Standards Organization (ISO 10993-6:2016). These criteria require biomaterials to be nontoxic, nonthrombogenic, noncarcinogenic, nonantigenic, and nonmutagenic to ensure an appropriate biological response. According to Helmus *et al.* (2008), a material designed for orthopedic uses should be able to function *in vivo* without showing any undesirable or unwanted local or systemic effects as immune, allergic, inflammatory and carcinogenic responses (Helmus *et al.*, 2008). The foreign body reaction and associated inflammatory/wound healing responses can impact the biocompatibility, safety, and function of implanted medical devices, prostheses, and tissue-engineered constructs. Understanding these processes is crucial for improving the performance of such biomaterials (Anderson *et al.*, 2008). This experimental study is aimed to evaluate the effects of implanting camel bone into rat muscle tissue, and comparing findings with a control group that had Kirschner wire (inert) implants.

MATERIALS AND METHODS

A total of 16 male adult Albino rats with weight range of 100-150g, were used in this study. The rats were purchased from reputable breeder and acclimatized for two weeks prior to commencement of the study. The rats were housed

in a standard cage in the laboratory animal house of the Department of Pharmacology and Therapeutics, Ahmadu Bello University (ABU), Zaria. The rats were fed on pelleted feed and had access to water *ad libitum*. All procedures were conducted in accordance with the Institutional Animal Care and Use Committee guidelines for laboratory animals (ABUCAUC/23/104).

GROUPING FOR THE STUDY

Following acclimatization, the rats were randomly assigned into 2 groups of 8 rats each (Table 1).

Table 1: Distribution of rats for biocompatibility study.

Group	Type of implants (5x5mm)	Intended use
Group A (n=8)	Control/stainless steel K-wire	Implanted into the thigh muscle
Group B (n=8)	Xeno-cadaveric bone (Camel)	Implanted into the thigh muscle

SURGICAL PROTOCOL

All the rats were anaesthetized with a combination of Ketamine hydrochloride (100 mg/kg, IM) and Xylazine chloride (10 mg/kg, IM) and operated under sterilized conditions. Prior to the surgery, the hair around the hind limbs was shaved and prepared aseptically with chlorhexidine, povidone iodine and alcohol, and the limbs were draped with sterile drapes. Either a right or left hind limb was randomly selected and put into either the control or the experimental group, both of which contained equal numbers of the right and left femora (Figure 1A). During the surgery, an aseptic surgical incision was made on the lateral aspect of the thigh (penetrating the skin and the muscles), a sterilized kirschnerorthopaedic wire (5mm K-wire) was embedded within the *vastus lateralis* and *bicepsfemoris* (Figure 1B). The muscles were sutured over the implant immediately with size 4-0 vicryl^(R) in a continuous, ford-interlocking pattern. Skin incision was closed routinely using nylon size 3-0 in a simple continuous pattern (Figure 1D). The same procedure of bone implantation was repeated for all the camel bones (Figure 1C). Antiseptic dressing of the surgical site was done with Povidone Iodine solution. Procaine penicillin and streptomycin at a dose rate of 20000 IU/kg and 12.5 mg/kg body weight intramuscularly were administered once daily for 5 days. After 10 days, the sutures were removed. The rats were closely monitored daily for 30 days commencing from the day of implantation and no clinical complication was observed within the period of 30 days.

SAMPLE COLLECTIONS

Blood sample was collected from the rats before surgery (time 0) and at 2, 7, 14 and 28 days post implantation respectively. The samples was collected in 5mls syringes via a retro-orbital sinus/vein and then immediately transferred 1mls into anticoagulant EDTA containing sample bottles

for packed cell volume, Haemoglobin, erythrocytes and differential leucocytes count (Neutrophils, lymphocytes, monocytes, Eosinophils, basophils and platelets) analysis.

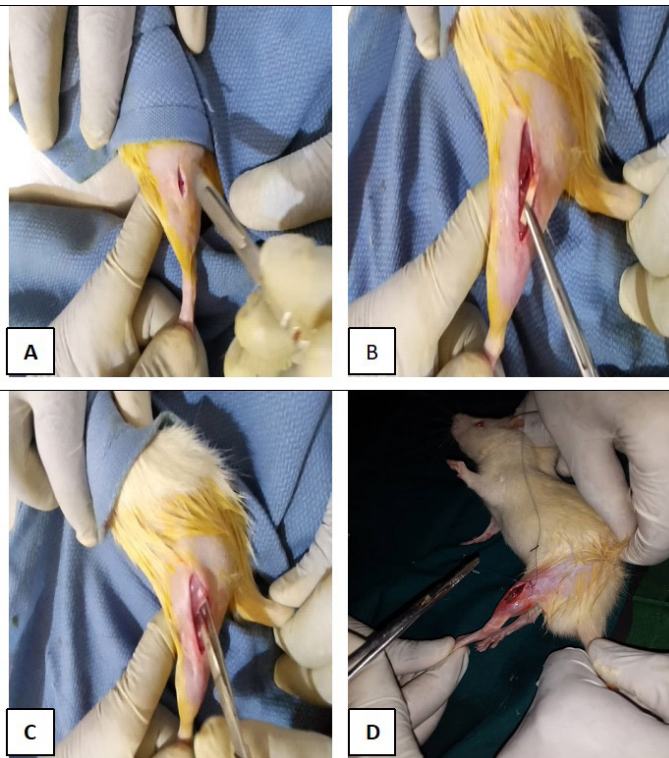


Figure 1: A, incisions site, B and C, positioning of the implants and D muscle and skin losures following implantations.

MUSCLE (HISTOPATHOLOGY)

At day 14 and 28 post implantation, the rats were sacrificed and Muscle tissue samples were collected for histological analysis. Two representative samples from each group was randomly selected, euthanized and tissue samples from the thigh muscles (surgical/implantation site) were harvested and fixed in 10% buffered formalin until use. Thereafter, the muscle sample was embedded in paraffin and three sections (5 μ m thickness) were cut at the central region of each specimen to obtain maximum standardization of the cutting surface. All sections were xylenedeparaffinized at 56°C, and incubated in graded concentration of alcohol. The fixed tissue samples were then processed based on standard histopathological techniques as described by [Slaoui and Fiette \(2011\)](#), in the Histopathological laboratory of Ahmadu Bello University, Teaching Hospital, Shika. The tissues were then dehydrated in several grades of alcohol, embedded in paraffin, sectioned at 5-7 μ m thickness and stained with Hematoxylin and eosin (H and E). The slides were studied for evidence of possible reactions.

RESULTS AND DISCUSSION

GROSS EVALUATION

The experimental rats were maintained under controlled

environmental conditions and monitored daily for 28 days for any physical or general clinical signs. No sign of gross adverse reactions like swelling, discharges, or changes in skin color were observed at the wound sites in both group and all the rats survived the 28 days period of the implantation. The surgical wounds healed by secondary intention with presence of granulation tissue and mild scab formation in both groups. The suture materials were removed on the 11th post implantation day and by 14th day, the incisional scar has almost disappeared. Gross observation of the camel bone and k-wire implants revealed the presence of fibrous encapsulation around all the implants.

HAEMATOLOGICAL PARAMETERS EVALUATIONS

The mean $\pm$ SEM of haematological parameters of packed cell volume (PCV), haemoglobin (Hb), Total erythrocytes count (TEC), Total leucocytes count (TLC), neutrophils, lymphocytes, monocytes, and platelets are presented in [Table 2](#).

The preoperative mean values for white blood cells (WBC) were 11.26 ± 0.91 for Group A and 12.83 ± 1.41 for Group B. The highest values recorded were 14.16 ± 1.17 and 14.92 ± 2.10 , observed on days 14 and 7 for both groups, respectively. The lowest values were 6.63 ± 0.68 and 9.70 ± 1.04 , also on days 14 and 7 for both groups, respectively. All values fell within the reference range, and no statistically significant differences were observed between the groups.

The preoperative mean lymphocyte counts for Group A and Group B were 73.71 ± 1.70 and 72.19 ± 1.46 , respectively. The highest lymphocyte counts were 85.01 ± 1.02 and 85.09 ± 1.577 , recorded on days 2 and 7 for both groups, respectively. The lowest counts were 68.52 ± 3.53 and 70.36 ± 2.24 , also observed on days 2 and 7, respectively. Both groups showed an increase in lymphocyte counts; however, these changes were statistically non-significant.

The preoperative mean neutrophil values were 14.62 ± 0.72 for Group A and 19.66 ± 1.48 for Group B. The highest values recorded were 21.30 ± 2.62 for Group A on day 7 and 19.66 ± 1.48 for Group B on day 2. The lowest values were 14.62 ± 0.72 for Group A on day 0 and 9.74 ± 1.13 for Group B on day 2. There was a statistically significant difference between the groups on day 0. However, all values remained within the normal range.

The preoperative mean monocyte values for Group A and Group B were 8.11 ± 0.84 and 6.28 ± 0.74 , respectively. The highest values observed were 8.11 ± 0.84 on day 0 and 8.30 ± 1.23 on day 7, while the lowest values were 3.40 ± 0.45 on day 2 and 4.17 ± 0.35 on day 2, respectively, in both groups. Although there was an increase in mean monocyte values at certain time points, these changes were not statistically significant.

Table 2: Mean $\pm$ SE Haematological values in pre and postoperative Days (A and B).

Parameters	Time (Days)				
	0	2	7	14	28
WBC $\times 10^3/\text{mm}^3$ (A)	11.26 $\pm$ 0.91	13.93 $\pm$ 0.72	6.63 $\pm$ 0.68	14.16 $\pm$ 1.17	12.04 $\pm$ 0.87
WBC $\times 10^3/\text{mm}^3$ (B)	12.83 $\pm$ 1.41	12.16 $\pm$ 0.94	9.70 $\pm$ 1.04	14.92 $\pm$ 2.10	10.80 $\pm$ 1.18
LYMPHOCYTES % (A)	73.71 $\pm$ 1.70	85.01 $\pm$ 1.02	68.52 $\pm$ 3.53	77.82 $\pm$ 2.52	73.40 $\pm$ 1.92
LYMPHOCYTES % (B)	72.19 $\pm$ 1.46	85.09 $\pm$ 1.58	70.36 $\pm$ 2.24	80.49 $\pm$ 2.24	75.86 $\pm$ 2.11
NEUTROPHILS % (A)	14.62 $\pm$ 0.72*	10.91 $\pm$ 0.85	21.30 $\pm$ 2.62	14.84 $\pm$ 1.46	15.29 $\pm$ 2.33
NEUTROPHILS % (B)	19.66 $\pm$ 1.48*	9.74 $\pm$ 1.13	18.77 $\pm$ 1.89	12.82 $\pm$ 1.00	16.00 $\pm$ 1.41
MONOCYTES % (A)	8.11 $\pm$ 0.84	3.40 $\pm$ 0.45	6.51 $\pm$ 0.51	5.67 $\pm$ 0.59	6.57 $\pm$ 0.52
MONOCYTES % (B)	6.28 $\pm$ 0.74	4.17 $\pm$ 0.36	8.30 $\pm$ 1.23	5.00 $\pm$ 0.82	5.86 $\pm$ 0.71
EOSINOPHILS % (A)	3.11 $\pm$ 0.79*	0.22 $\pm$ 0.15	2.56 $\pm$ 0.38	1.44 $\pm$ 0.53	1.86 $\pm$ 0.46
EOSINOPHILS% (B)	1.38 $\pm$ 0.53*	0.78 $\pm$ 0.36	2.00 $\pm$ 0.41	1.33 $\pm$ 0.50	1.57 $\pm$ 0.43
BASOPHILS % (A)	0.44 $\pm$ 0.18	0.00 $\pm$ 0.00	0.56 $\pm$ 0.18	0.22 $\pm$ 0.15	0.29 $\pm$ 0.18
BASOPHILS % (B)	0.25 $\pm$ 0.16	0.22 $\pm$ 0.15	0.56 $\pm$ 0.18	0.33 $\pm$ 0.18	0.14 $\pm$ 0.14
RBC $\times 10^6/\text{mm}^3$ (A)	7.04 $\pm$ 0.21	6.84 $\pm$ 0.15	7.73 $\pm$ 0.19	7.67 $\pm$ 0.19*	7.97 $\pm$ 0.19
RBC $\times 10^6/\text{mm}^3$ (B)	7.23 $\pm$ 0.30	7.15 $\pm$ 0.21	7.70 $\pm$ 0.27	6.74 $\pm$ 0.61*	7.58 $\pm$ 0.31
HB G/DL (A)	14.47 $\pm$ 0.22	14.22 $\pm$ 0.19	15.86 $\pm$ 0.36	15.23 $\pm$ 0.27*	16.33 $\pm$ 0.28
HB G/DL(B)	14.03 $\pm$ 0.44	14.62 $\pm$ 0.40	15.51 $\pm$ 0.56	13.58 $\pm$ 1.30*	14.87 $\pm$ 0.55
PCV% (A)	48.47 $\pm$ 1.05	50.11 $\pm$ 0.54	50.01 $\pm$ 0.84	52.41 $\pm$ 0.56	51.89 $\pm$ 0.44
PCV % (B)	46.51 $\pm$ 1.03	50.93 $\pm$ 1.52	48.57 $\pm$ 1.19	49.24 $\pm$ 2.23	48.51 $\pm$ 1.27
PLATELETS $\times 10^6/\text{mm}^3$ (B)	493 $\pm$ 34.61	560.67 $\pm$ 44.24	532.56 $\pm$ 49.36	620.11 $\pm$ 65.91	567.43 $\pm$ 29.09
PLATELETS $\times 10^6/\text{mm}^3$ (B)	470 $\pm$ 36.40	527.11 $\pm$ 45.40	555.44 $\pm$ 35.01	557.11 $\pm$ 57.63	621.43 $\pm$ 83.67

Means with * shows a significant difference $p < 0.05$. **Group A:** Implantation with Stainless steel K-wire; **Group B:** Implantation with camel bone.

The preoperative mean eosinophil values for Group A and Group B were 3.11 $\pm$ 0.79 and 1.38 $\pm$ 0.53, respectively. The highest values recorded were 3.11 $\pm$ 0.79 on day 0 and 2.00 $\pm$ 0.41 on day 7, while the lowest values were 0.22 $\pm$ 0.15 on day 2 and 0.78 $\pm$ 0.37 on day 2, respectively, for eosinophils in both groups. All values were within the normal range, and a statistically significant difference was observed between Group A and Group B on day 0.

The preoperative mean basophil values for Group A and Group B were 0.44 $\pm$ 0.18 and 0.25 $\pm$ 0.16, respectively. There was no significant difference in basophil counts between the groups or within each group at different time intervals. However, the highest recorded values were 0.56 $\pm$ 0.18 on day 7 for both groups, while the lowest values were 0.00 $\pm$ 0.00 on day 2 and 0.14 $\pm$ 0.14 on day 28, respectively, for basophils in both groups. All values remained within the normal range.

The preoperative mean RBC values for groups A and B were 7.04 $\pm$ 0.21 and 7.23 $\pm$ 0.30, respectively. The highest RBC values, 7.97 $\pm$ 0.19 for group A and 7.70 $\pm$ 0.27 for group B, were recorded on days 28 and 7, respectively, while the lowest values, 6.48 $\pm$ 0.15 and 6.74 $\pm$ 0.61, were observed on days 2 and 0. A statistically significant difference

was noted between the groups on day 14, though all values remained within the normal range.

The preoperative mean Haemoglobin values for group A and B were 14.47 $\pm$ 0.22 and 14.03 $\pm$ 0.44. The Haemoglobin values of 16.33 $\pm$ 0.28 and 15.51 $\pm$ 0.56 were the highest on day 28 and 7 while 14.22 $\pm$ 0.19 and while 13.58 $\pm$ 1.30 were the lowest on day 2 and 14 for both groups respectively. A statistical significant difference was observed between the groups in day 14, however all the values were within normal range.

The preoperative mean PCV values for groups A and B were 48.47 $\pm$ 1.05 and 46.51 $\pm$ 1.03, respectively. The highest PCV values, 52.41 $\pm$ 0.56 and 50.93 $\pm$ 1.52, were observed on day 14 for both groups, while the lowest values, 48.47 $\pm$ 1.05 and 46.51 $\pm$ 1.03, were recorded on days 0 and 2. Although the mean PCV values showed an increase postoperatively across different time intervals, this increase was not statistically significant for either group.

The preoperative mean platelet counts for groups A and B were 493 $\pm$ 34.61 and 470 $\pm$ 36.40, respectively. The highest values, 620.11 $\pm$ 65.91 for Group A and 621.43 $\pm$ 83.67 for Group B, were observed on days 14 and 28, while the

lowest values, 493 ± 34.61 and 470 ± 36.40 , were recorded on day 0 for both groups. Postoperatively, there was a non-significant increase in platelet counts at various time intervals in both groups, but all values remained within the normal range.

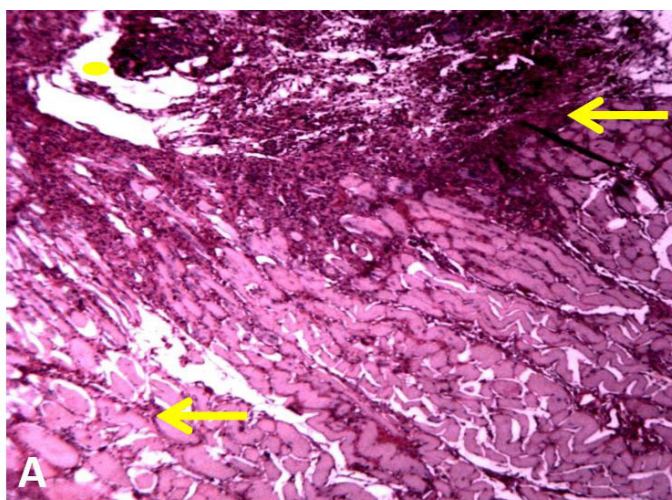


Figure 2: A, Photomicrograph of muscle tissue of rats at 2 weeks post-implantation of K-wire (yellow dot) showing moderate cellular infiltration around the implant (arrows), H and E stain $\times 100$.

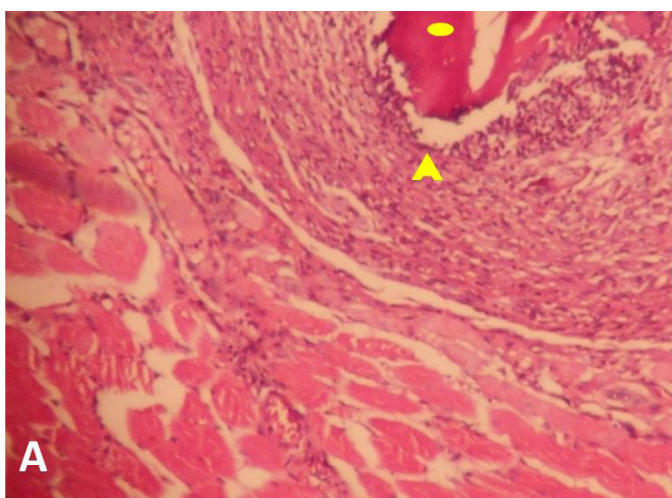


Figure 3: A, Photomicrograph of muscle tissue of rats at 2 weeks post-implantation of camel bone (yellow dot) showing moderate cellular infiltration and capsule formation around the implant (arrow head), H and E stain $\times 100$.

HISTOPATHOLOGICAL EVALUATIONS

For histopathological evaluation of muscle and cellular tissue responses, the samples were examined under a light microscope. Histopathological images of muscle tissue sections (at $5\mu\text{m}$) for representative of each treatment group at 14 and 28 days post-implantation were shown at $\times 100$ magnification in Figure 2, 3, 4 and 5. Both the Control (Inert implant) and the test group showed presence of milder to moderate degree of cellular infiltration and capsule for-

mation around the implant with mild muscular degeneration observed (Figure 2 and 3). Myocytes being infiltrated with cartilage-like cells were also observed in both groups. Presence of osteocytes in the camel bone implants were also observed in the test groups at 14 and 28 day muscle tissue sections (Figure 2 and 4). The muscle tissue in contact with the implanted materials demonstrated a moderate acute and chronic inflammatory response characterized by the presence of neutrophils, lymphocyte, and polymorphonuclear leukocytes infiltrates after 14 days in both groups (Figure 2 and 3). By 28 days both materials continued to elicit a moderate acute and chronic inflammatory response characterized by neutrophils, lymphocytes, and polymorphonuclear leukocytes infiltrate (Figure 4 and 5).



Figure 4: A, Photomicrograph of muscle tissue of rats at 4 weeks post-implantation of camel bone (yellow dot) showing moderate cellular infiltration and capsule formation around the implant (arrow) and mild muscular degeneration (arrow head), H and E stain $\times 100$.

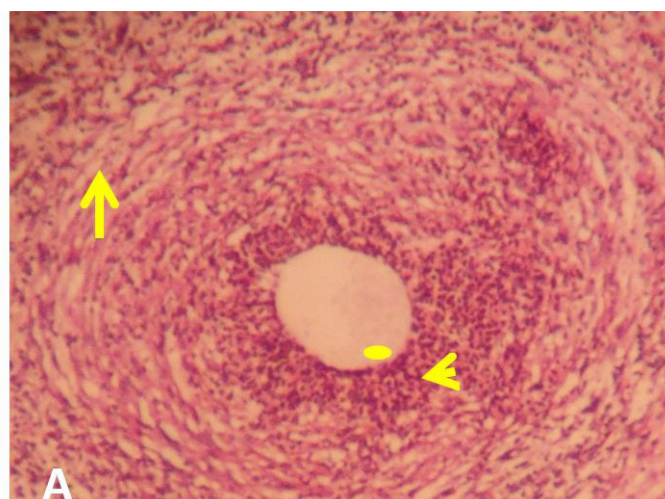


Figure 5: A, Photomicrograph of muscle tissue of rats at 4 weeks post-implantation of K-wire (yellow dot) showing moderate cellular infiltration around the implants (arrow head) and muscular degeneration (arrow), H and E stain $\times 100$.

Preclinical *in vivo* testing is widely used to evaluate the biocompatibility, degradation behaviour, and mechanical and biomechanical properties of biodegradable implants. In such studies, investigational devices are implanted in test animals (e.g. rats, rabbits, sheep, goats, pigs, and dogs), which are monitored over time to assess various parameters and observe tissue healing (Väänänen, 2009). Key parameters studied in this research include haematology, as well as gross and histopathological lesions. Gross evaluation of the implanted biomaterials revealed no signs of adverse reactions, such as swelling, discharge, or changes in skin colour at the wound sites in either group. No behavioural signs of discomfort were observed in the rats, and all rats survived the 28-day implantation period without mortality. The surgical wounds healed by secondary intention, with granulation tissue formation and mild scabbing observed in both groups. These findings are consistent with those of Aliyu *et al.* (2022), who reported similar results after implantation of these biomaterials in rat tissues. Additionally, in accordance with ISO 10993-6:2016, which specifies tests for local effects after implantation, the anticipated results include minor and transient oedema and erythema, which are characteristic of the initial inflammatory response. No evidence of prolonged pain or sensitivity was observed.

Histopathological analysis of both the control group (inert implant) and the test group showed varying degrees of cellular infiltration and capsule formation around the implant, ranging from mild to moderate, along with mild muscle degeneration. According to ISO 10993-6:2016, an ideal biomaterial should demonstrate minimal-to-moderate inflammation, which is characteristic of a normal healing process. Fibrosis should be limited to indicate a mild foreign body reaction. There should be no significant necrosis or muscle damage, and muscle regeneration around the implant should occur normally to ensure high compatibility with the surrounding muscle tissue. The biocompatibility and harmlessness of different hard biomaterials intended for bone treatment were also initially tested in soft tissues (i.e. the subcutis and muscles). The idea behind this concept is as follows: if the material shows low levels of biocompatibility in soft tissues, it will not pass to the next stage (testing on bone tissue). This order of testing reduces the suffering of experimental animals and saves funds and time (Anderson and Jiang (2019); Ratner *et al.*, 2012; Marković *et al.*, 2009). WBC levels remained within the reference range throughout the study period. The lack of substantial variations across the groups suggests that camel bone or stainless steel did not significantly alter WBC levels. This observation implies that the overall immune response was not significantly affected by camel bone or stainless steel. Lymphocyte counts increased in both groups over time. The changes, however, were not statistically significant, indicating that although there was an increase, it was not significant enough to demonstrate

a significant immunological response or group differences in both the control and treatment groups. Despite fluctuations and significant differences on day 0, all neutrophil values remained within the normal range throughout the study. This suggests that while there was a measurable difference between the groups, it did not indicate an abnormal or potentially harmful deviation from the normal physiological range. The significant difference seen on day 0 may be important for understanding the baseline differences between the groups. This suggests that neither the control nor the treatment groups caused any untoward effects or abnormal responses related to the neutrophil counts. Despite the fluctuations in monocyte values from day 0 to day 7 and across different days, these changes were not statistically significant, indicating that the procedure or treatment did not have a substantial impact on monocyte levels. As a specialized connective tissue, blood is the first to interact with any implanted material when introduced into the body (Paramitha *et al.*, 2015). As part of the body's immune system, leucocytes are specifically transported to the body with any foreign substance, infection, or inflammation, which serves as an indicator of the systemic inflammatory response (Noviana *et al.*, 2012). All recorded eosinophil values were within the normal physiological range, suggesting that neither group had eosinophil levels outside what was typically expected. The results indicated that Group A had higher eosinophil counts than Group B preoperatively and on day 0, with statistically significant differences between the two groups. The preoperative basophil counts in both groups were relatively similar, with no significant differences observed between or within the groups over time. The results indicated that basophil levels remained stable and unaffected by both camel bone and stainless steel implants. These observations were consistent with those reported by Paramitha *et al.* (2015); Wood (2017); Aliyu *et al.* (2022). They reported that the absence of eosinophils and basophils in the later days and throughout the post-implantation period, respectively, suggested a likely absence of allergic reactions, thereby confirming the high biocompatibility of the implants. A statistically significant difference in RBC counts between the two groups was found on day 14, suggesting that meaningful differences occurred on that day. However, it is important to note that all RBC values remained within the normal range, indicating that despite these fluctuations, there were no RBC abnormalities in either group at any time during the study. Haemoglobin levels fluctuated over time, and a significant difference was noted on day 14. Both groups maintained haemoglobin levels within the normal range throughout the study, indicating stable haemoglobin levels without any abnormalities. Although PCV values increased after surgery, the increase was not statistically significant at any of the measured time intervals in either group. This showed that a progressive increase in packed cell volume, haemoglobin, and total erythrocyte count

on post-operative days indicates erythropoiesis, however, within the normal physiological limits. This finding was in agreement with the findings of Aliyu *et al.* (2022), who observed non-significant variations in packed cell volume, haemoglobin, RBCs, and total protein from the base values. Postoperatively, platelet counts increased over time, but this increase was not statistically significant. However, platelet levels remained within the normal range throughout the study period, indicating no abnormalities related to platelet levels in either group. Platelet functions are designed to: (1) initially arrest bleeding through the formation of platelet plugs and (2) stabilize the initial platelet plugs by catalysing coagulation reactions leading to the formation of fibrin. However, the same process may have adverse consequences when artificial surfaces are in contact with the blood (Ratner *et al.*, 2012).

CONCLUSIONS AND RECOMMENDATIONS

The present study confirmed that haematological parameters were within the normal range, suggestive of good biocompatibility. The material demonstrated minimal to moderate inflammatory reactions within the rat tissues. These parameters may have to be combined with other parameters for a realistic evaluation of the biocompatibility.

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NOVELTY STATEMENTS

This study explores the potential of camel bone as a novel orthopedic biomaterial for xenogenic bone graft production. Given its abundance as a biowaste and cost-effective accessibility, camel bone presents a sustainable alternative to conventional sources. Moreover, due to cultural and religious constraints associated with bone grafts derived from pigs and cows, camel bone could offer a more widely acceptable option for clinical applications.

AUTHOR'S CONTRIBUTIONS

The study was conceptualised by USA, AZH, EGE, and MAS. AZH, AAA and FOA designed the experimental protocols. Animal experimentation was conducted by USA, EGE, and MAS. AZH, AAA, and FOA, conducted the data analysis. All authors participated in drafting and reviewing the manuscript.

CONFLICT OF INTEREST

The authors declare that there is no conflict of interests regarding the publication of this article.

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