A Histological Study Of The Autotomized Plane In The Tail Of Christinus Marmoratus (Wall Gecko).

S OLAUYI, G OMOTOSO, O OYEWOPO, O ASHAOLU, A CAXTON-MARTINS, A JIMOH

Citation

Abstract
Lizards have a way of shedding their tails as a defense strategy to facilitate escape from predators. Specific mechanisms are involved in this process of caudal autotomy, as well as in the subsequent tissue regeneration leading to the restoration of the structure and function of the sacrificed tail. Twenty Christinus marmoratus (wall gecko) were used for this study. Under anesthesia with Chloroform, the autotomizing plane of Christinus marmoratus was located (which is about 5 mm to the cloaca), and excised with a clean surgical blade and fixed in 10% formalin. The tails were processed and stained in Hematoxylin and Eosin stains; and connective tissue fibers were demonstrated using Gordon and Sweet's, van Gieson's and Gomori's aldehyde fuchsin's stains. Images of 1.2 mm² areas were viewed using an Olympus binocular microscope and captured with a panasonic video camera. The histological results showed the presence of connective tissue fibers such as collagen, elastic and reticulin fibers, as well as adipose tissue. The spine was sheathed with a thick layer of longitudinal skeletal muscle fibers. The epithelial lining was stratified squamous with the presence of goblet cells, and apposed to the joints are elastic cartilage and blood vessels. These observations support the practices of tail autotomy and regeneration by Christinus marmoratus.

INTRODUCTION
Caudal autotomy, a self-induced tail separation from the body, is a common and effective antipredator strategy widespread among most species of lizards1, with an immediate benefit of increased running speed2,3. This attribute however depends on a complex array of environmental, individual, and species-specific characteristics4. Occurrence of autotomy could be due to the effect of external forces at the fracture planes, as well as loss of tensile strength5. Each autotomy plane can be regarded as an assemblage of breakage zones traversing the individual anatomical components of the autotomous structure5.

Many species have evolved specialized behavioral and physiological adaptations to minimize or compensate for any negative consequences; one of the most important steps following a successful autotomous escape involves regeneration of the lost limb or tail6,4. Studies by Simou et al7 observed the presence of higher lipid levels in regenerated tails than original tails.

Impaired lymphatic drainage in human limbs causes the debilitating swelling termed lymphedema. In mammals, known growth factors involved in the control of lymphangiogenesis (growth of new lymph vessels) are vascular endothelial growth factors-C and –D (VEGF-C, VEGF-D), which characterize a model of lymphangiogenesis in which the tail of lizard is regenerated without becoming edematous8. Different biological investigations have been carried out on effects of prostanglandin metabolism during cell aggregation period9. This study was designed basically to demonstrate the morphology and histology of the autotomized tail of lizards (gecko), using different staining techniques, as the tissues at this autotomized plane are critical in the adaptive mechanisms employed by lizards in order to survive this state, as well as the regeneration of the tail that later occurs.

MATERIALS AND METHODS
Twenty Christinus marmoratus were used for this study. They were obtained from Adewole Estate, Ilorin, Nigeria. They were sedated using Chloroform and were observed to be totally inactive before the commencement of the study. The autotomized plane of Christinus marmoratus was located, which was about 5 mm distal to the cloaca in the tail.
region. Surgical blades were used to cut 3-5 mm region of the tails and fixed in 10% formalin. The tissues were fixed for 24 hours and subsequently processed using Hematoxylin and Eosin’s stains, Gordon and Sweet’s stains, van Gieson’s stains, and Gomori’s aldehyde Fuchsin’s staining procedures.

Images of 1.2 mm² areas were viewed using an Olympus binocular microscope and captured with a Panasonic video camera.

RESULTS

The transverse section of the autotomized plane showed the presence of skeletal muscle fibers (Figure 1a), stratified squamous epithelium, and mucus-secreting goblet cells with their secretions (Figure 1b). The articulating surface revealed the presence of bone and cartilage with a cartilaginous joint (Figures: 2a, 2b, 3).

Few blood vessels (Figure 4) were recognized by the presence of nucleated red blood cells. Also there was the presence of connective tissue bands rich in adipose tissue (Figure 5). The connective tissues demonstrated include: elastin fibers (Figure 6: Gomori’s aldehyde fuchsin stain); reticulin fibers (Figure 7: Gordon and Sweet’s stain); and collagen fibers (Figure 8: van Gieson’s stain).

Figure 1
Figure 1(a): Transverse section of the autotomized plane showing glands (G) and skeletal muscles (S) (H&E ×120).

Figure 2
Figure 1(b): Transverse section of the autotomized plane showing stratified squamous epithelium, gland (G), goblet cells (GC) and glandular secretion (GS) (H&E ×300).

Figure 3
Figure 2(a): Transverse section of the articulating surface (A) showing bone (B) and cartilage (C) in the lumbar region of (H&E ×300).
Figure 4
Figure 2(b): Transverse section of the autotomized plane showing cartilaginous joint (CJ) (H&E x300).

Figure 5
Figure 3: Transverse section of the autotomized plane showing bone (B) and lacunae (L) (H&E 1200).

Figure 6
Figure 4: Transverse section of the autotomized plane showing small blood vessel (V) and compact bone (B) (H&E x300).

Figure 7
Figure 5: Transverse section of the autotomized plane showing adipose tissue (Ad) (H&E x120).
DISCUSSION

Caudal autotomy in Christinus marmoratus is made possible by a complex system of interdigitating muscle segments10. The histological study observed that the spine was sheathed with a thick layer of highly organized longitudinal skeletal muscle bundles, as well as connective tissue (collagen, elastic and reticulin) fibers. Mammalian tissue repair share common cellular and molecular mechanisms, and the activation of a multipotent skeletal muscle satellite cell population is said to be involved11.

Few blood vessels were recognized at the autotomy plane by the presence of nucleated red blood cells. The blood vessels at this plane are usually constricted, explaining the minimal blood loss occurring during the process of autotomization.

The epithelial lining was stratified squamous. The cells closer to the underlying connective tissue were either cuboidal or columnar, but changed to thin and squamous cells as they moved progressively close to the surface. Dry surfaces such as the skin, are lined by keratinized stratified squamous cells especially in places subject to attrition12. Mucus-secreting goblet cells were also observed, and their viscous secretion subserves some protective functions. The skin of Christinus marmoratus serves as protection against abrasion, due to the wearing process they are subjected to in the wall crevices where they live.

Lizards utilize the tail as a major fat-storage organ13. These
lipids are disproportionately stored along the length of the tail, with much concentration in the proximal portion14,15. Of the two types of adipose tissue, Christinus marmoratus is composed of brown adipose tissue, which has numerous lipid droplets and abundant mitochondria, and is important in heat production16.

The histological observations from this study support the practices of autotomy by Christinus marmoratus as a way of escape from predators, and also serve as basis for their ability to regenerate the lost tail.

References

Author Information

Solomon OLAWUYI
Department of Anatomy, Faculty of Basic Medical Sciences, University of Ilorin

Gabriel OMOTOSO
Department of Anatomy, Faculty of Basic Medical Sciences, University of Ilorin

Oyetunji OYEWOPO
Department of Anatomy, Faculty of Basic Medical Sciences, University of Ilorin

Olumide ASHAOLU
Department of Anatomy, Faculty of Basic Medical Sciences, University of Ilorin

Ademola CAXTON-MARTINS
Department of Anatomy, Faculty of Basic Medical Sciences, University of Ilorin

AbdulGafar JIMO
Department of Obstetrics and Gynecology, Faculty of Clinical Sciences, University of Ilorin