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Histological analysis of the horn of the fighting bull, lesions observed after horns sheathing

Análisis histológico del cuerno del toro de lidia, lesiones observadas tras el enfundado

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ABSTRACT

The bovine horns is an anatomical region that has been poorly studied from an anatomical and physiological point of view. The fighting bull is an iconic animal and its horns a mythological symbol of integrity, to such an extent that farmers resort to applying synthetic resins covers to preserve it from any manipulation. With the present work it is intended to study the histological structure of the horn of the fighting bull, analyzing the possible influence of the practice of "sheathing" on it. To this end, horns have been collected from 30 bulls (4-5 years old) in bullrings in, with a control group of 15 animals not sheathed. After the analyses, the normal histological structure of the bull's horns is described and the lesions observed in some animals, such as spongiosis in the spinosum stratum, cellular disorganization of the basal stratum or the presence of multiple neovessels in the dermis, are described. No effect of sheathing is detected at the histological level.
Keywords: fighting bull, fighting cattle, horns, histology.

RESUMEN

La cornamenta de los bovinos es una región anatómica muy poco estudiada desde el punto de vista anatómico y fisiológico. El toro de lidia es un animal icónico y su cornamenta un símbolo mitológico de integridad, hasta tal punto que los ganaderos recurren a la aplicación de fundas de fibra de vidrio para preservarla de cualquier manipulación. Con el presente trabajo se pretende estudiar la estructura histológica del cuerno del toro de lidia, analizando la posible influencia de la práctica de “enfundado” en la misma. Para ello se han recogido cuernos de 30 toros (4-5 años) en plazas de toros, contando con un grupo control de individuos no enfundados de 15 animales. Tras los análisis se describe la estructura histológica del epitelio corneal compuesto por tres capas: estrato córneo, estrato espinoso y estrato basal que continúan con la dermis y se describen las lesiones observadas en ciertos animales tales como espongiosis en el estrato espinoso, desorganización celular del estrato basal o presencia de múltiples neovasos en la dermis. No se detecta ningún efecto del enfundado a nivel histológico.
Palabras clave: toro de lidia, raza de lidia, cuernos, histología.

INTRODUCTION

The bovine head is one of the most important anatomical regions of this animal as it gives it a singularly beautiful expression and appearance. Horns are located on both sides of the forehead and they are conical, elongated and incurved in shape, being very variable with respect to their size, length and direction. As a general rule, horns have a smooth surface, except in the starting area, which is more irregular and rough, and their size, symmetry and integrity are highly valued. Their configuration has a decisive influence on the tractability or good presentation of the fighting bull (Ezpeleta, 1999). Horns have a circular or oval section, the major axis can be horizontal or vertical, and they are made up of three elements that, from the inside out, are the bony pin, the keratogenous membrane and the horny case (Alonso et al., 2016). The bony peg is an extension of the frontal bone and blood vessels and nerves run inside it. The keratogenous membrane is of gelatinous consistency, has a cushioning function and is located between the bony peg and the corneal case (Calvo, 2005). The corneal case is mostly hollow, and more specifically, in the area covering the bony peg. Its walls, thin at the beginning, gradually thicken until ending, at the end, in a solid cone that ends in a point. The horn is also erroneously called antler, although it is a term more appropriate for ungulates of the Cervidae family, which grow and fall off each year in relation to the reproductive cycle of each species, while horns do not fall off and continue to grow throughout the animal's life (Martínez *et al*., 1994).

Once the horn has reached its full development, three clearly differentiated zones can be distinguished externally: (i) the stump or cob, which is the nexus with the skin. In it, grooves or rings appear annually, which can be used to appreciate the age of the animal (Calvo, 2005). (ii) The center or shovel, which encompasses the intermediate and most extensive portion of the horn. Its shape, generally curved, and its direction serve to characterize the type of antlers of each animal. (iii) The tip or python, located at the distal end of the horn, which corresponds to the solid part of the horny case and represents approximately 20% of the total length of the horn. In young animals, it is covered by a horny lamina that, with age, retracts at its end, forming a kind of thimble known as an acorn, which falls off at approximately three years of age (Sañudo, 2009).

In general, horns are inserted in the frontal bone, horizontally and laterally, that is, perpendicular to the major axis of the bull, following the line of forehead prolongation. However, sometimes horns have an oblique insertion with respect to this line. Then, horns can be born upwards or downwards and/or forwards or backwards with respect to the mentioned line of forehead prolongation, denominating the type of insertion as "cornialta" upward growth, "cornibaja" downward growth, "comidelantera" forward growth, or "cornitrasera" backward growth, respectively. However, it must be taken into account that these terms are also used to name some types of goring depending on their shape or direction, so their use is not recommended. However, it is important to emphasize that the insertion form of horns has a definite influence on their conformation, being characteristic of some horn types (Sotillo *et al.,* 1996).

The existing literature on bovine horns is not very abundant. The classic outdoor books (Sañudo, 2009), deal with the topic of horns as one more fanero, but they do not refer specifically to the bullfighting cattle. Other authors (Barga & Jordano, 1997; Rodríguez, 2022) refer specifically to this breed, but rather make a classification according to its conformation.

Bull´s horns suffer a risk of deterioration, mainly in the last year of life, as a result of potential fights, rubbing, contact or blows with the ground, trees, and fences, feeding troughs or walls of the chutes or handling pens (Aparicio *et al*., 2003).

For this reason horns are protected during the last year of breeding with a synthetic resin bandage, which is easy to handle, porous and hardens quickly by polymerization with water, providing good consistency (Lomillos *et al*., 2013). The distal part of the horn, i.e. the piton, is reinforced in many cases with a harder material, metal tubes or similar, in order to reduce wear in the apical area (Pizarro *et al.,* 2008a y b).

At the productive level, sheathing is one more measure of the farm to reduce the risk of casualties due to goring in fights. In fact, the agricultural insurance premium is lower in farms that have males for fighting with sheaths (Domingo & Vara, 2013).

It is unknown how this type of horn manipulation affects its structure and thus its toughness (Lomillos & Alonso, 2020). Some authors have observed necrosis of the cornual dermis, with loss of bone structure and the appearance of hollow spaces inside the horn, which could reduce its resistance (Horcajada *et al.,* 2009) or fractures of the distal part in sheathed bulls (Gómez *et al*., 2009).

Regarding the histological structure of the horn, there are very few studies that address the characteristics of the tissues that constitute the bovine horns, and none studying the possible effect of sheathing on the histology of this organ. Therefore, the objective of this work is to expand the knowledge on the histological structure, analyzing the possible effect of sheathing.

MATERIAL AND METHODS

A histological study of the corneal epithelium was carried out on 30 horns of bulls from 5 different herds, 15 belonging to the group of un-sheathed animals and 15 to the group of sheathed animals. Horns were always cut within 12 hours of the bull death with a miter saw with a metal cutting disc that allowed 5 cm thick sections to be made, which were placed in containers with 10% formalin, following the instructions of the personnel of the Pathological Anatomy Department of the Veterinary Medicine Faculty from Leon.

From each of the sections corresponding to the stump or base of the horn (A), pala (middle part) (B) and piton (distal part) (C) (in the area where there is bone) a 0.5 x 0.5 x 0.5 cm fragment was taken, comprising the deep keratin layer, the corneal epithelium (composed of corneum stratum, spinosum stratum and basal stratum), the dermis and the external part of the bone (Figure 1). After being decalcified for 30 days, these samples were embedded in kerosene. Sections of 2 µm were made and after dehydration in a gradient of alcohols and xylol, they were stained with hematoxylin-eosin stain.

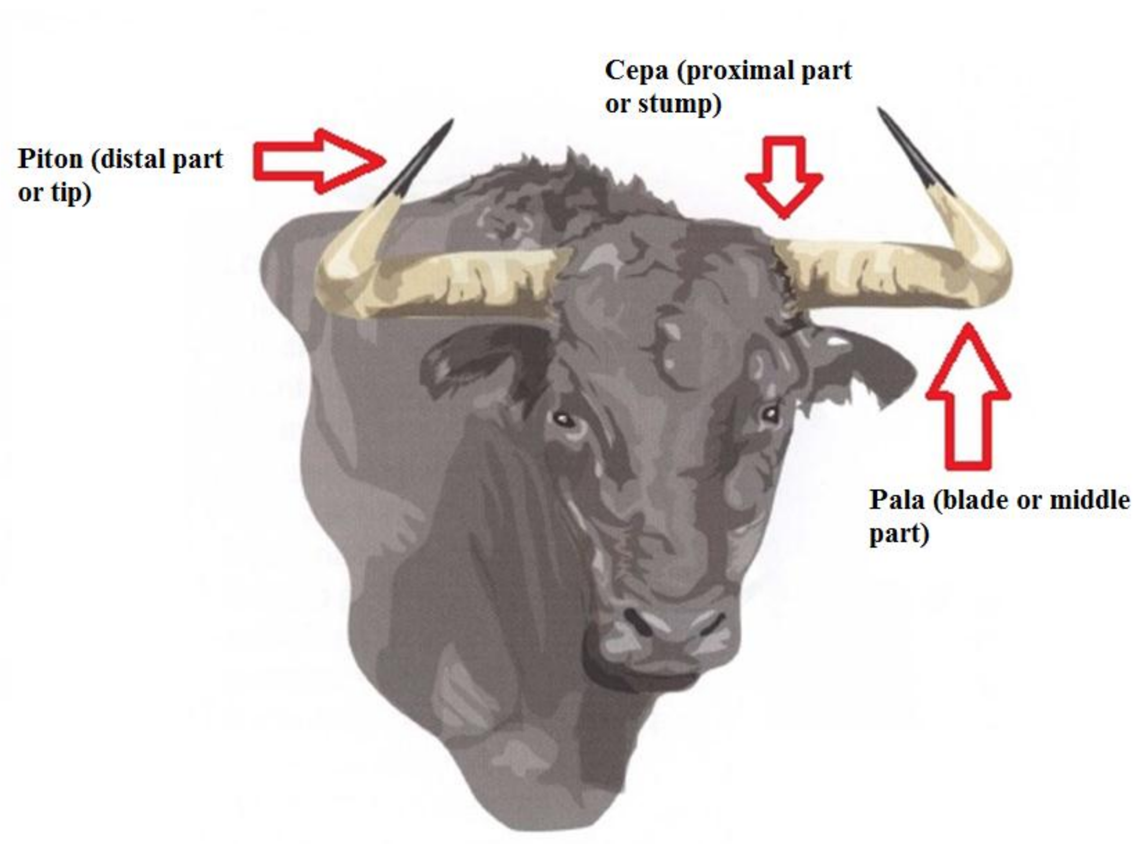

Figure 1. Diagram of sampling points for histological analysis

They were then examined by microscopy by a pathologist, who was unaware of the origin and animal history, performing a subjective qualitative histological evaluation of each sample.
All the data were processed using the IBM® SPSS® statistic program, Ver. 19.0 package for Windows, performing a Chi-square test to verify the existence of significant differences between the percentages of the various lesions found, considering group 0 as the unsheathed animals and group 1 as the sheathed ones.

DISCUSSION

The horn, like the skin and hair, is mainly constituted by keratin, a natural biological compound with a hierarchical structure (Vicent, 1990). Keratinized tissues are usually associated with several important biological functions such as attack, defense, temperature and humidity regulation, etc. Their mechanical properties have been studied in both bovine hoof (Franck, *et al*., 2006) and horn (Chen *et al*., 2009; Kitchener & Vincent, 1987; Kitchener, 2000; Lomillos *et al*., 2021a). Bovine horns are permanent throughout the life of the animal, unlike antlers that shed and regrow each year (Mercer, 1961). Therefore, the term "antlers" would not be appropriate.

The horn is different from other biological structural materials, such as bones, tusks, teeth, antlers and mollusk shells. It does not have a mineralized component and is composed mainly of α-keratin. In recent years, structural biological materials have attracted increasing attention, however, this interest has mainly focused on bones, teeth, mollusc shells and hooves (Meyers *et al.,* 2008). Bovine horns, which are the subjects of this study, have not been studied in detail except for studies on their length (Trillo, 1961), structure (Lomillos *et al*., 2021b) and external hardness (Lomillos *et al*., 2022), with practically no attention paid to their histological characteristics (Mozos, 2002). There is some reference regarding the histological study of the horn surface in relation to its possible fraudulent manipulation (Salamanca, 2011, Blasco, 2015; Moya & López, 2016, Seva *et al.,* 2017), more directed to the arrangement of the corneal tubules than to their internal structure.

Corneal tubules, which are observed microscopically at low magnification, originate from the papillae of the keratogenous membrane and extend along the horn parallel to the outer surface of the horn. When a horn has been manipulated to shorten its length ("shaved") and subsequently a new tip is created, a histological image is obtained where it can be seen that the horny tubules, in the artificially altered areas, do not run parallel to the surface, on the contrary, they emerge obliquely and in a staircase, which, as a consequence of this situation, appears irregular and deflected (Blasco, 2015).

In our case, the complete histological study has been performed in animals without any manipulation and identifies three layers of corneal epithelium: corneum stratum, spinosum stratum and basal stratum that continue with the dermis (Figure 2).
After analysis, certain lesions have been identified in the different layers. In order to facilitate data management and to allow the use of statistics, the results are presented in the form of a table summarizing the histologic evaluation of the lesions found, on which

the corresponding statistical analysis was performed. Lesions with variable incidence are observed in each of the mentioned layers except in the stratum corneum. To facilitate the interpretation of the results, we will describe them focusing on the different dermal layers:

Corneum stratum: No alterations were observed in any case.

Spinosum stratum:
- Sparse damage (+): Spongiosis of up to 30% of the corneum stratum cells (Figure 3).
- Mild (++): Spongiosis of more than 30% of the corneum stratum cells and slight cellular disorganization (Figure 4).
- Moderate (+++): Spongiosis of more than 30% of corneum stratum cells, evident cellular disorganization and presence of neovessels.

Basal stratum:
- Scant damage (+): Loss of palisade structure.
- Mild (++): Cellular disorganization of the basal stratum with loss of palisade structure (Figure 4).
- Moderate (+++): Cellular disorganization of basal stratum, cell spongiosis, loss of palisade structure and loss of continuity.

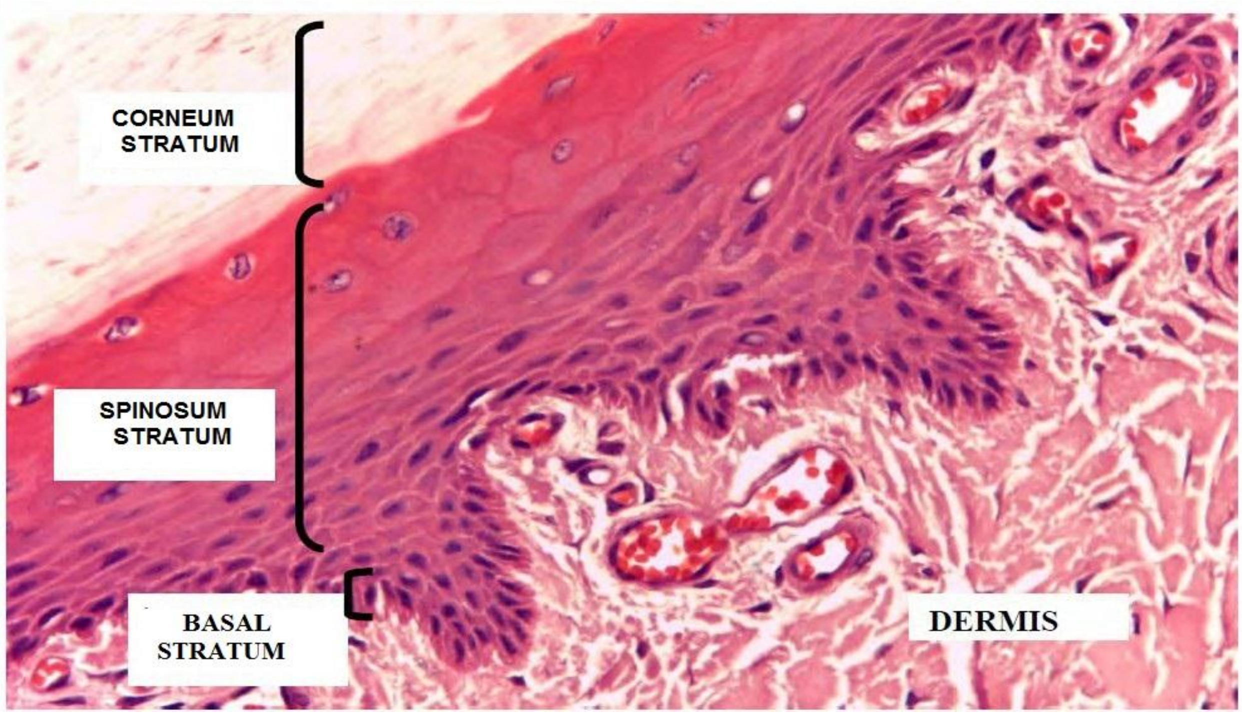

Figure 2. Layers of the corneal epithelium

Dermis:

- Scarce damage (+): Presence of neovessels in superficial dermis and congestion (Figure 5).
- Mild (++): Presence of multiple neovessels in superficial dermis, congestion and hemorrhages.
- Moderate (+++): Presence of multiple neovessels in superficial dermis, erythrocyte extravasation and mild (Figure 6) or moderate collagenolysis phenomena.

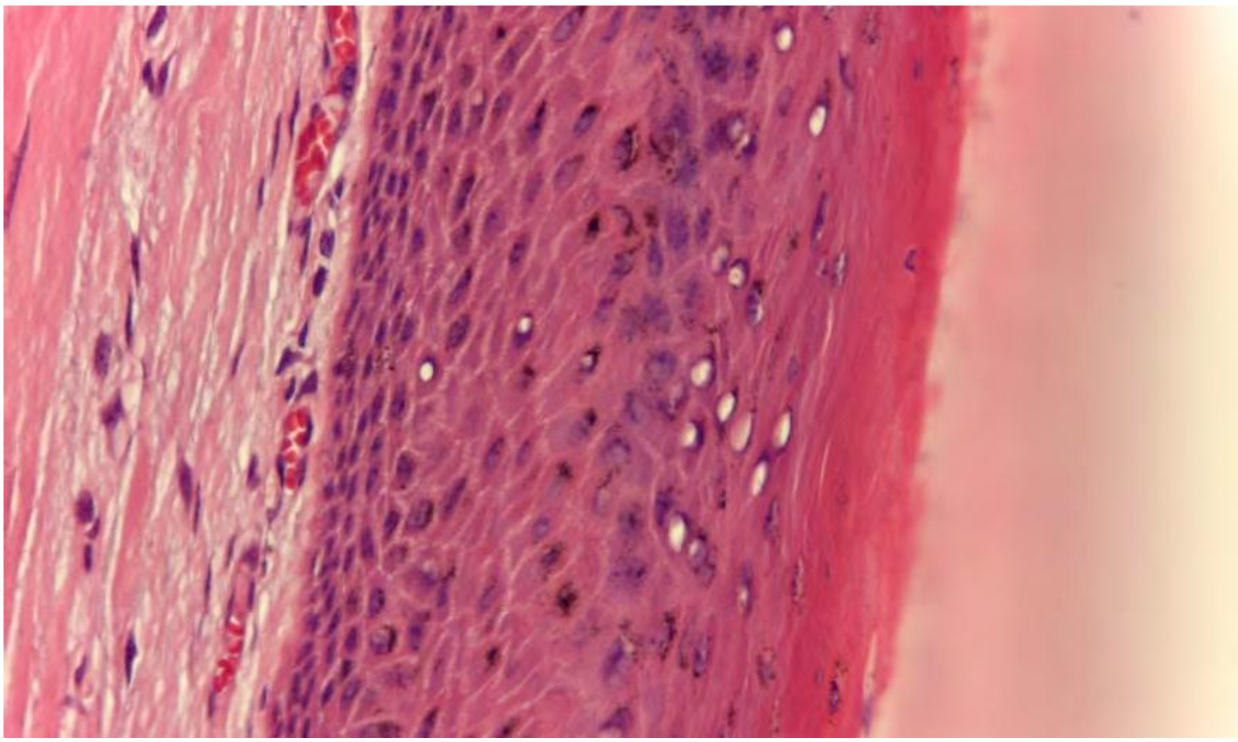

Figure 3. Spongiosis of less than 30% of cells of the spinosum stratum

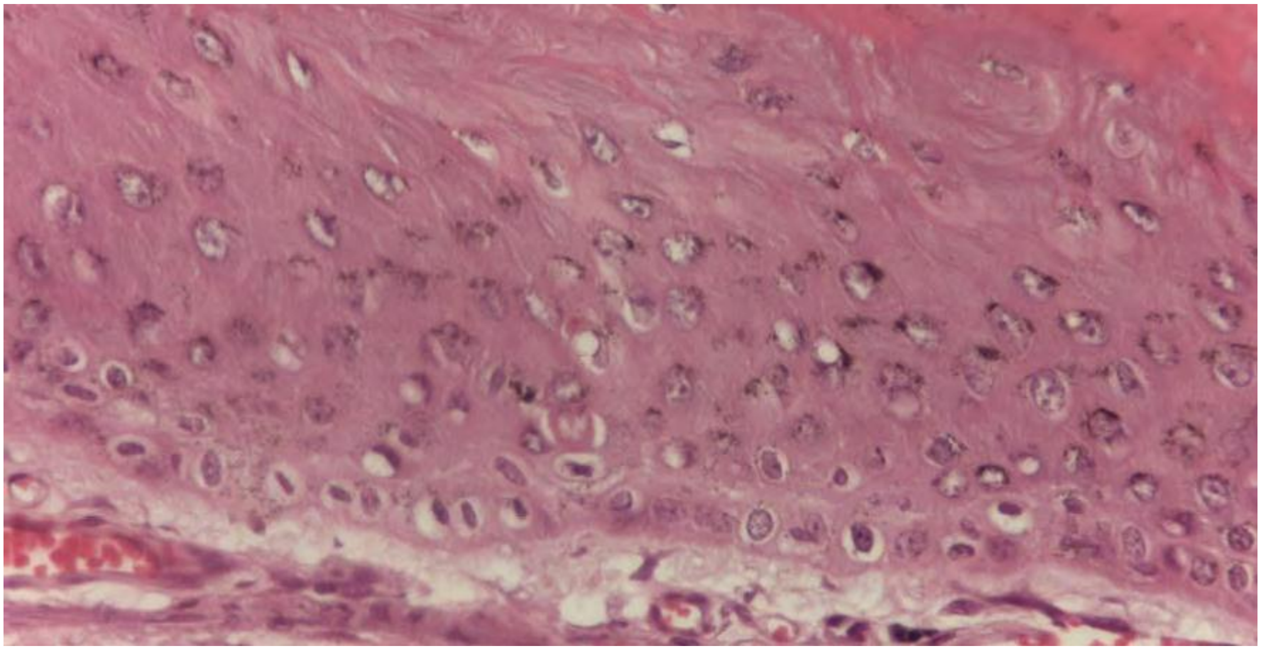

Figure 4. Spongiosis of the spinosum stratum greater than 30% of affected cells. Disorganization and loss of the palisade structure of the stratum basal, with cellular spongiosis

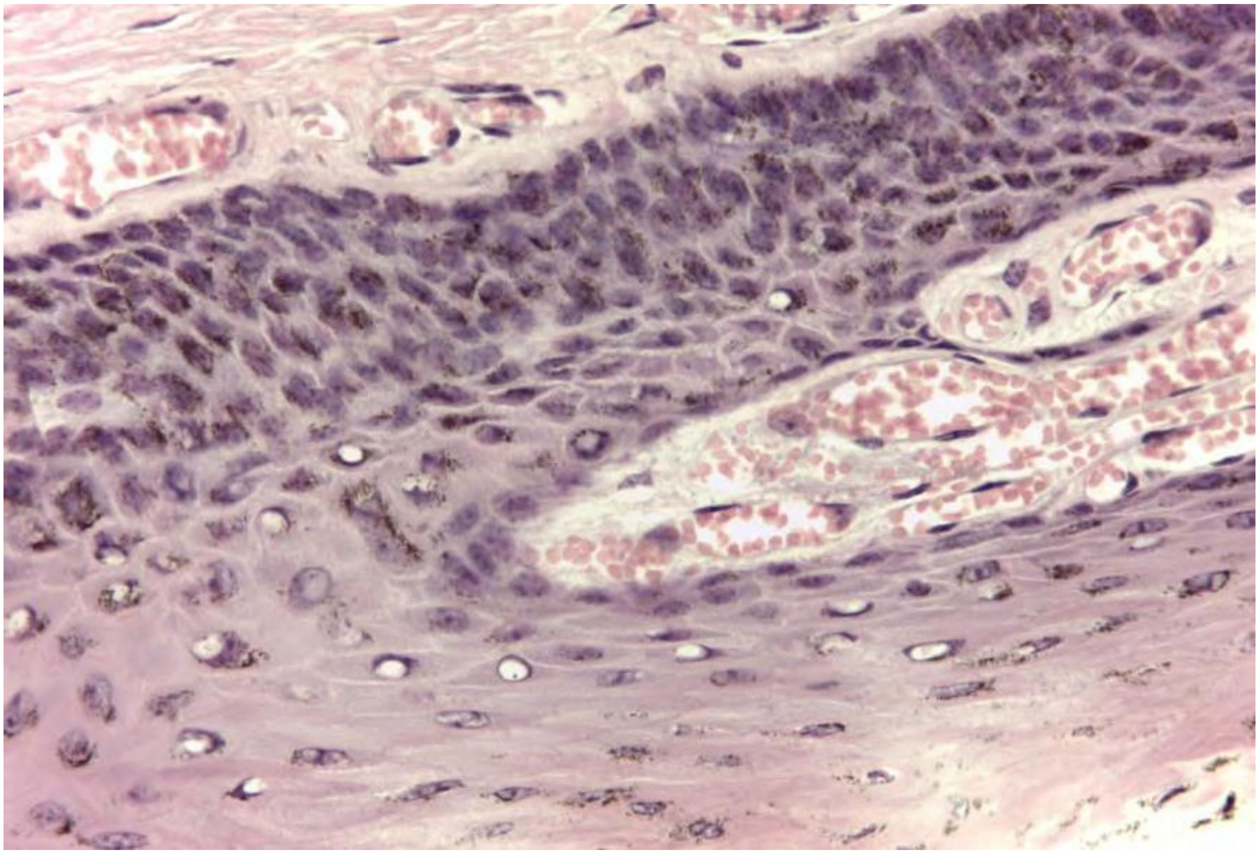

Figure 5. Neovessel formation in dermis

In a previous histological study carried out to assess the damage caused by the sheathing of the horns, the presence of areas of basophilic appearance was detected in the connective tissue (dermis) that separates the bone from the keratinized epithelium, where the collagen fibers themselves appeared retracted and basophilic, and a histological image that was related to necrosis due to coagulation. This article associates this lesion with a possible prolonged absence of ventilation due to sheathing (hypoxia), or with burns (Fernández-Gómez, 2011).

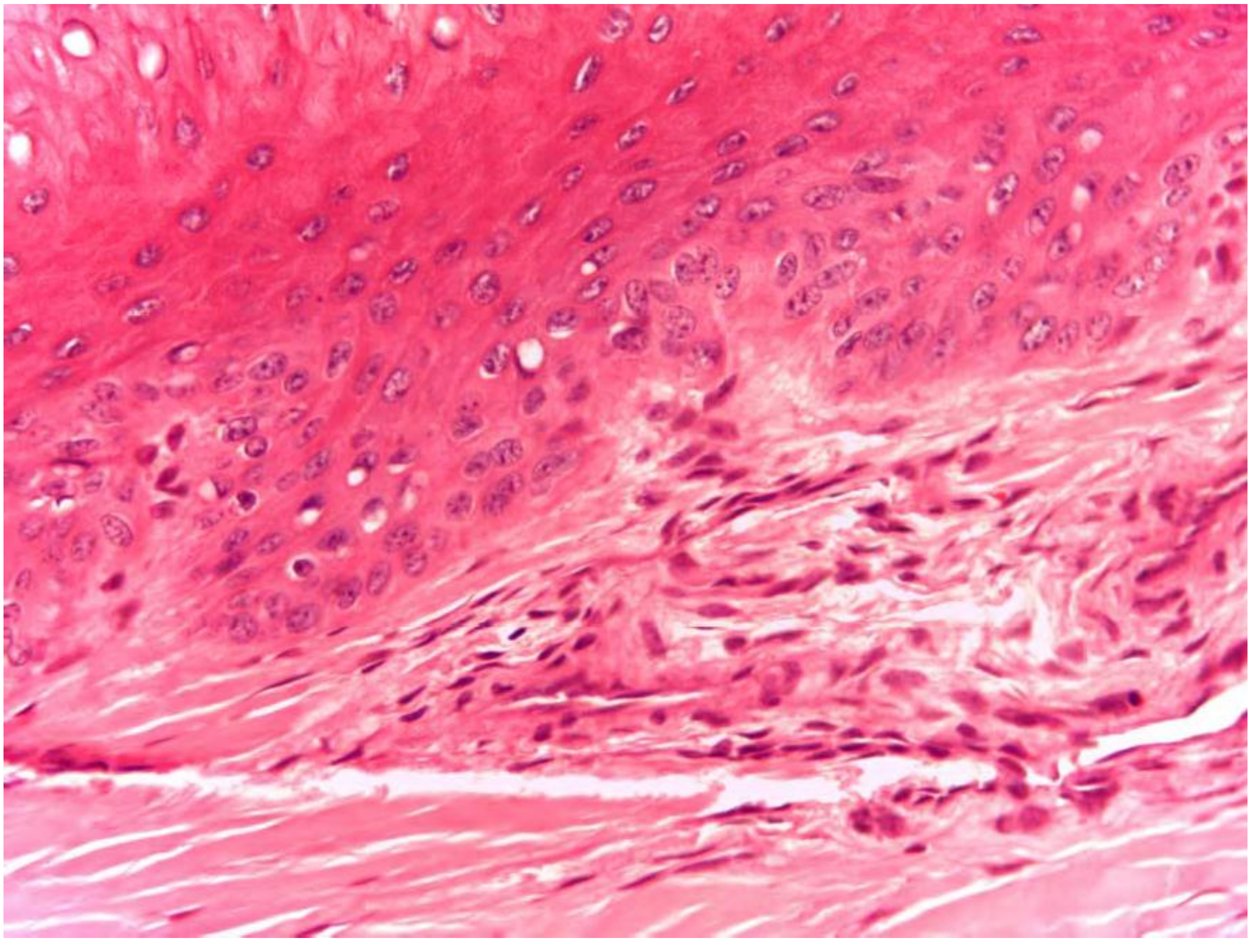

Figure 6. Spongiosis (cytoplasmic vacuolization) of the spinosum stratum less than 30%. Slight co-lagenolysis of the dermis

The hypothesis of our study is to know if the placement of sheaths on bull horns can cause epidermal damage that alters the corneal structure. In this sense, the lesions that we could expect in a histological section of a horn after a situation of prolonged hypoxia in time would be mainly chronic lesions, associated with ischemic processes in the different strata such as:

1. Corneum Stratum: disorganization of the keratin layer even loss of keratin.
2. Spinosum stratum: spongiosis and cellular disorganization, and/or pronounced and very irregular epidermal hyperplasia.
3. Basal stratum: loss of the palisade structure of the basement membrane, intense disorganization of the cell monolayer, including degeneration and necrosis.
4. Dermal stratum: phenomena of intense collagenolysis, vascular damage in vessels (mainly vascular thrombosis and hemorrhages), and even tissue repair as proliferation of neovessels and fibroblasts, and onset of fibrosis.

The final damage, or more serious, that hypoxia could produce would be the loss of the epidermal layers due to necrosis from the underlying dermis, a lesion that would manifest macroscopically as a separation of the horny case of the bone, which could occur in the square at the time of its attack on the horse, defeat him on the board, etc. (Martín-Albo, 2010).

The results of the histological study show that the most serious lesions that have been observed are really of a mild-moderate nature. In no case has necrosis phenomena or loss of dermis or epidermis tissue been observed. Lesions described seem to be related to mild processes of degeneration and repair, being mainly the piton the most affected location.

Statistical analysis was performed using the Chi-square test, which did not show significant differences between the lesions found in sheathed and un-sheathed bulls, as can be seen in Table 1, which corroborates the mild nature of the lesions observed.

Except for few individual differences found in the group of sheathed animals, only two animals in the group of not sheathed animals seemed to present a slightly more evident damage, with a higher degree of spongiosis of the spinosum stratum, alterations in the basal stratum and dermis at the level of the distal part (Image 4). These lesions are nonspecific and cannot be clearly associated to a specific cause. These degeneration and repair phenomena could have their origin in traumatism, which could be due to fights or blows during transport or stay in the corrals of the bullring. However, as previously mentioned, these are mild lesions and in no case were specific lesions of tissue hypoxia observed.

Similarly, other authors do not observe histological alterations worth mentioning except for dilatation of some isolated venule or even the presence of some small thrombus inside blood vessels in isolated bulls (Pizarro *et al.,* 2009). Gómez (2011) mentions the finding of isolated lesions at the level of the keratogenous membrane in sheathed bulls, but does not specify what they are, nor their degree of severity, without a control group with which to compare.

CONCLUSIONS

The histological structure of the corneal epithelium consists of three layers: corneum stratum, spinosum stratum and basal stratum that continue with the dermis. Different lesions are detected such as spongiosis in the spinosum stratum, cellular disorganization of the basal stratum or presence of multiple neovessels in the dermis, but not attributable to the 12-month sheathing of the horn.

Table 1. Chi-square performed on the percentage of histological lesions described in each of the strata of different parts of the horn studied

CEPA (proximal part)

Spinosum S	SL	*	**	***	Chi^2	P
Sheathing	50	50	0	0	0.666	0.716
No	60	20	20	0		
Basal S						
Sheathing	20	60	20	0	0.200	0.977
No	20	40	40	0		
Dermis						
Sheathing	80	20	0	0	0.733	0.865
No	40	30	20	10		

PALA (middle part)

Spinosum. S	SL	*	**	***	Chi^2	P
Sheathing	60	20	10	10	0.014	0.999
No	70	20	10	0		
Basal. S						
Sheathing	40	40	02	0	0.253	0.881
No	20	50	30	0		
Dermis						
Sheathing	40	40	0	20	0.253	0.968
No	50	30	20	0		

PITON (distal part or tip)

Spinosum. S	SL	*	**	***	Chi^2	P
Sheathing	20	30	20	30	0.075	0.994
No	20	40	20	20		
Basal. S						
Sheathing	10	60	10	20	0.200	0.978
No	20	40	20	20		
Dermis						
Sheathing	30	40	20	10	0.378	0.945
No	0	90	10	0		

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CITED LITERATURE

ALONSO ME, Lomillos JM, González JR. 2016. La cornamenta del toro de lidia análisis de su integridad y efecto del enfundado. León: EOLAS Ediciones. Pp. 168. ISBN: 9788416613472.

APARICIO JB, Peña F, Barona LF. 2003. Aplicación del Análisis de imagen al Estudio Exteriorista de las encornaduras. *Revista de Estudios Taurinos*. 16:311-314. ISSN: 1134-4970. https://dialnet.unirioja.es/servlet/articulo?codigo=6644599

BARGA R, Jordano D. 1997. Biometría de las astas de toros de lidia y dictamen acroqueratómico (afeitado). Secretaría general técnica. Ministerio del interior. Madrid.

BLASCO JL. 2015. Avances en la aplicación de la termografía en el toro de lidia. XII Simposium del Toro de lidia. Zafra, España. Pp. 70-74.
http://www.simposiotorozafra.org/index.php?simposio=12

CALVO LA. 2005. Escuela gráfica de toros. Valladolid: Colegio Oficial de Veterinarios de Valladolid. Pp. 269. ISBN 9788460972730

CHEN P, Stokes Y, MCkittrick AG. 2009. Comparison of the structure and mechanical properties of bovine femur bone and antler of the North American elk (*Cervus elaphus canadensis*). *Acta Biomaterialia Volume.* 5(2):693 – 706.
https://doi.org/10.1016/j.actbio.2008.09.011

DOMINGO A, Vara G. 2013. Particularidades del seguro de explotación de ganado vacuno de lidia comprendido en el plan de seguros agrarios combinados. XI Simposio del Toro de Lidia. Zafra, España. Pp. 199-203.
http://www.simposiotorozafra.org/index.php?simposio=1

EZPELETA E. 1999. Biometría de los cuernos de las reses de lidia. IV Simposium Nacional del Toro de lidia. Zafra, España. Pp. 227-325.
http://www.simposiotorozafra.org/index.php?simposio=9

FERNÁNDEZ-GÓMEZ J. 2011. Trabajo presentado a la convocatoria del XXII Premio Literario Taurino “Doctor Zumel” Edición 2010. Las Fundas: ¿Son Beneficiosas o Perjudiciales para la Fiesta?
http://veterinariostaurinos.blogspot.com/2011_10_06_archive.html

FRANCK A, Cocquyt G, Simoens P, de Belie N. 2006. Biomechanical Properties of Bovine Claw Horn. *Biosystems Engineering*. 93(4):459-467.
https://doi.org/10.1016/j.biosystemseng.2006.01.007

GÓMEZ FJ, Fernández FJ, Pizarro M, Carpintero CM, Durán JM. 2009. Fractura de pitón durante la lidia, hipotéticamente asociado al enfundado de los cuernos. IX Simposium Nacional del Toro de Lidia. Zafra, España. Pp. 285-288.
http://www.simposiotorozafra.org/index.php?seccion=17&categoria=63

GÓMEZ-PEINADO A. 2011. El enfundado del Toro de Lidia. VII Congreso Mundial Taurino de Veterinaria. Consejo General de Colegios Veterinarios de España. Cáceres, España. Pp. 23-34.
https://bibliotecadigital.jcyl.es/bdtau/en/consulta/registro.do?id=31974

HORCAJADA FJ, Fernández C, Ortuño S, Pizarro M. 2009. Diferencias físicas de comportamiento entre pitones enfundados y sin enfundar con vendas de resina de fibra de vidrio: prueba de compresión simple. IX Simposium Nacional del Toro de Lidia. Zafra, España. Pp. 237-242.
http://www.simposiotorozafra.org/index.php?seccion=17&categoria=63

KITCHENER AC. 2000. Fighting and the mechanical design of horns and antlers. In: Domenici P, Blake RW, editors. Biomechanics in Animal Behaviour. Oxford: BIOS Scientific Publishers. Pp. 24-48. ISBN 9781003210801.

KITCHENER AC, Vincent JFV. 1987. Composite theory and the effect of water on the stiffness of horn keratin. *Journal of Materials Science*. 22(4):1385-1389. https://doi.org/10.1007/BF01233138

LOMILLOS JM, Alonso ME, Gaudioso V. 2013. Análisis de la evolución del manejo en las explotaciones de toro de lidia. Desafíos del sector. *Revista ITEA*. 109(1):49-68. https://www.aida-itea.org/aida-itea/files/itea/revistas/2013/109-1/(049-068)%20SEPARATA%20A2299%20ITEA%20109-1.pdf

LOMILLOS JM, Alonso ME. 2020. Análisis de la integridad del cuerno del toro de lidia: métodos oficiales y complementarios. *Rev. CES Med. Zootec*. 15(1):44-62.
https://doi.org/10.21615/cesmvz.15.1.4

LOMILLOS JM, Gonzalo JM, Alonso ME. 2021a. Análisis de la estructura del cuerno del toro de lidia mediante análisis de imagen. Efecto del enfundado. *Abanico veterinario*. 3:1-13. http://dx.doi.org/10.37114/abaagrof/2021.2

LOMILLOS JM, González-Montaña JR, Alonso ME. 2021b. Análisis de la resistencia mecánica del cuerno del toro. Influencia del enfundado. *Rev. Ciencias Veterinarias*. 40(1):1-9. https://doi.org/10.15359/rcv.40-1.4

LOMILLOS JM, Blasco JL, Alonso ME. 2022. Análisis de la dureza superficial del cuerno en el Toro de Lidia e influencia del enfundado. *Revista Científica De La Facultad De Ciencias Veterinarias De La Universidad Del Zulia*. 31(4):129-136.
https://doi.org/10.52973/rcfcv-luz314.art1

MARTÍN-ALBO A. 2010. La mujer del Cesar. Premio Literario Taurino Doctor Zumel. Madrid, España. http://www.realfederaciontaurina.com/XXII%20Prem...pdf

MARTÍNEZ J, Cabanás JM, Rosa M, Gualda MJ. 1994. Estudio de la composición mineral de las astas del toro bravo. Anales de la Real Academia de Ciencias Veterinarias de Andalucía Oriental, ISSN 1130-2534, 7:209-220.
https://dialnet.unirioja.es/servlet/articulo?codigo=7433957

MERCER EH. 1961. Keratin and Keratinization—An essay in molecular biology: E. H. Mercer: Modern Trends in Physiological Sciences. 7(5):316-656.
https://doi.org/10.1016/0003-9969(62)90075-4

MEYERS MA, Chen PY, Lin AYM, Seki Y. 2008. Biological materials: Structure and mechanical properties. *Prog. Mater. Sci*. 53(1):1-206.
https://doi.org/10.1016/j.pmatsci.2007.05.002

PIZARRO M, Carceller H, Alonso R, Horcajada J, Hebrero C. 2008a. Utilización de fundas en cuernos I: Colocación e incidencia en el reconocimiento y comportamiento. VI Congreso Mundial Taurino de Veterinaria. Murcia, España. Pp. 175- 178.
https://bibliotecadigital.jcyl.es/es/consulta/registro.do?control=CYL20180057083

PIZARRO M, Alonso R, Ortuño S, Fernández C. 2008b. Utilización de fundas en cuernos II: Posible modificación de la estructura y consistencia. VI Congreso Mundial Taurino de Veterinaria. Murcia, España. Pp. 179-182.
https://bibliotecadigital.jcyl.es/es/consulta/registro.do?control=CYL20180057083

PIZARRO M, Horcajada FJ, Fernández C, Ortuño S. 2009. Diferencias estructurales entre pitones enfundados y sin enfundar con vendas de resina de fibra de vidrio. IX Simposium Nacional del Toro de Lidia. Zafra, España. Pp. 285-288.
http://www.simposiotorozafra.org/index.php?seccion=17&categoria=63

RODRÍGUEZ, A. 2022. Entre campos y ruedos. Madrid: Ed. Consejo General de Colegios Veterinarios de España. Pp. 344. ISBN 978-8460406266.

SAÑUDO C. 2009. Valoración morfológica de los animales domésticos. Ministerio de Medio Ambiente y Medio Rural y Marino. Madrid. España. ISBN: 9788449109294.

SALAMANCA F. 2011. Estudio histológico de la disposición de los túbulos epidérmicos del estrato corneo en 12 toros de lidia enfundados. Simposium del Toro de Lidia. Zafra, España. Pp. 127-129. http://www.simposiotorozafra.org/index.php?simposio=1

SEVA J, Mas A, de Jodar C, Martínez-Gomariz F, López-Albors O, Sanes JM. 2017. Propuesta de aplicación de técnicas de plastinación al estudio histológico del cuerno para la detección de manipulación artificial (afeitado). IX Congreso Mundial Taurino de Veterinaria. Toledo, España. Pp. 227-231.
https://bibliotecadigital.jcyl.es/bdtau/es/consulta/registro.do?control=CYL20180057144

SOTILLO F, Ramírez AR, Sotillo JL. 1996. Biotipología del Toro de Lidia. En: Producciones equinas y de ganado de Lidia, Cap. XV. Zootecnia, bases de producción animal, tomo XI. Ed. Mundiprensa. Madrid. España. ISBN: 9788471146380.

TRILLO F. 1961. Estudio métrico del asta del toro de lidia y su aplicación práctica. *Archivos de Zootecnia*. 39(10):34-67.
https://dialnet.unirioja.es/servlet/articulo?codigo=8128008

Errata Erratum

https://abanicoacademico.mx/revistasabanico-version-nueva/index.php/abanico-veterinario/errata