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Research Article

# Use of Polyurethane as a Sealing Material for Frontal Bone Cavities during the Dehorning Technique in Adult Bovines

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## Abstract

The germinal button of the cornual structure is present in the males and females of the entire Bovidáe family; unlike the antlers found in species such as deer, elk and antelope, where the horns are not permanent and are branched. The already developed horns are made up of a bony nucleus that corresponds to the prolongation of the frontal bone, which internally houses the sinus, emerging from its base and growing to the tip, where it presents a thin layer of tissue with keratin deposit that externally forms the protective covering, composed of structural protein and not mineralized, as found in the nails, hooves, hair and feathers of birds [1]. Total amputation of horns or cornuectomy, is recommended not only with aesthetic purposes, but also to avoid fractures of the bone support, due to trauma or blows, which are very painful especially when the frontal bone is overexposed (avulsion), in addition to generating infectious processes and even the formation of

fissures [2]. In intensive production units, the germinal button of the horn is normally prevented from developing by using caustic ointments, or if there is already a certain development of the horn, Barnes forceps or Liz's clasp are used, however some specimens continue to develop the cornual structure and when they reach adulthood (2 years of age onwards), the horns are already quite developed and it is only recommended aesthetic dehorning that is not very manageable because it requires a surgical procedure, preceded by good preoperative management; local anesthesia and sedation. An intraoperative that is to amputate the horns and a postoperative with the necessary care (administration of antimicrobials), as well as respecting the principles of asepsis and antisepsis [3]. Anatomically, the horns are supplied by branches of the anterior and superficial temporal auricular artery that form the cornual artery, which emerges crossing the caudal portion of the frontal tuberosity; There is also a deep branch that runs caudally to the zygomatic process of the temporal bone and irrigates from the keratogenic rim or chorion and as well as the entire horn. Its innervation is through external branches of the V cranial nerve (Trigeminal), lacrimal nerve and zygomatic-temporal; which form the anterior auricular plexus from which the cornual nerve emerges [4].

The cutaneoplastic amputation technique of adult bovine horns, and its variants, refers to making incisions around the horn, to form flaps, which are used to close the wound once the horn is amputated and prevent infections. The material and type of suture are variable and are mainly due to the comfort and mastery of the technique developed by the surgeon, as well as the results obtained in its performance, healing time and postoperative complications (bleeding or presence of sinusitis) [5]. The foundation of a correct dehorning technique is to promote rapid healing by first intention, since the defect left by the amputation must be closed by using skin flaps, to protect the frontal sinus and the stump that is formed from the cornual process; thus avoiding the presentation of frontal sinusitis and hemorrhages [6]. The cutaneoplastic amputation technique is better suited for one-year-old animals, since in older patients, where the horns are very wide, skin may be missing to close the amputation area [7].

**Keywords:** Polyurethane; Frontal bone cavities

## 1. Introduction

Horned animals turn out to be extremely more dangerous than acorn, and not only for the other animals with which they live, but also for the personnel who handle them. Therefore, dehorning techniques (cornuectomy) turns out to be necessary to avoid that with said antlers injure each other as well, considering traumas as considerable losses [8]. Antlers in bovines use it as a form of defense, either to maintain the hierarchy, or as a natural and ethological behavior since they frequently tend to strike with them voluntarily or involuntarily. That is why the management of dairy and meat farms requires zootechnical dehorning when the animals are very young and leaving surgical dehorning as the last possibility for those who were not performed for various reasons. To obtain a beneficial dehorning, it is necessary to perform a total amputation from its implantation [9], that is, from the base where the frontal bone emerges to the surface, since otherwise

the animal will retain the tendency to hit and if It is not done correctly, the horn will grow and be oriented towards different parts of the animal's skull, causing compression injuries and altering its aesthetics. Surgical dehorning provides not only aesthetics but also safety since operated animals stop beating, allowing a higher milk yield to be obtained [10].

For all these causes, the ideal for the management of bovines is that they do not have antlers and this can be achieved with several techniques to prevent them from developing until they are surgically removed. The younger the dehorning is performed, the easier, faster, less costly and less traumatic for the animal and therefore with less loss, it should be done at one month of age and this prevents the horns from coming out [11].

Dehorning is recommended when an animal is injured the horns splintering them, brushing them, losing the cap, part or all of the horn, is very traumatic due to pain and possible infection, causing a decrease in milk production, loss of weight gain, which can cause sinusitis, pneumonic, nervous problem and even death [12].

## 2. Types of Dehorning

### 2.1 Caustic paste

Dehorning is done in the first weeks of age at the site of the horn's germ bud. Horn growth. Be careful to wax around the button, and be careful to apply petroleum jelly around the paste so that the latter does not run off.

### 2.2 Cauterization

In this technique an electric cauterizer or a hot iron is used from the fourth week of age in calves.

### 2.3 Barnes Tweezers

It is recommended to use the Barnes forceps in steers up to one year of age, taking the precaution of once the amputation has been carried out, to perform hemostasis in the small bleeding blood vessels.

### 2.4 Cutting method or technique in adult bovines (cutaneoplastic)

This technique is used in adult bovines with great cornual development, using the so-called Liz saw, which by friction cuts the corneal tissue at its base. The disadvantage of this technique is to close the cavity of the frontal bone that occurs when the horn is removed and for this the skin is dissected around the base of the body, in order to make its confrontation, however frequently the base of the horn is too large and prevents such confrontation of the skin, so it is common to use unconventional materials to seal said cavity, which is why the need arises to use a conventional material that allows a prompt post-surgical recovery, this being possible Through the use of polyurethane (rigid foam), to fill and avoid the presence of contaminating secretions or worms, since this substance is easy to apply, inexpensive. The polyurethane foam adapts perfectly to the shape of the wet tissue walls, creating a mold that completely fills the entire volume of the frontal bone cavity. These polyurethane foams are especially effective in preventing bleeding, pain and / or fistulas in patients such as cut-off dehorning.

The polyurethane foams have a great expansion and modeling capacity, which is why they adapt perfectly to the anatomy of each patient, thus avoiding the

aggressive surgical and palliative treatments that were used until now. In addition, the filling and sealing of the pleural cavity with polyurethane foam prevents the accumulation of liquids and the development of bacteria, controlling the possibilities of infection after the intervention. Another advantage of the injection of polyurethane foams for filling and sealing cavities is its lightness.

This characteristic of the polyurethane makes it not adhere to the walls of the tissue, preventing breakage problems that make a second intervention necessary for the patient to remove it. Polyurethane foams are a biocompatible material with a very low risk of toxicity, so together with its qualities of adaptability and resistance; it becomes a material on the rise within biomedical innovation.

## 3. Material and Methods

5 adult bovines with horns were selected to perform dehorning using as an innovative technique, the use of polyurethane foam that favors resolution after dehorning, seeking to fill and seal the cavities present in the frontal bone, avoiding the collection of liquids. And avoiding the presence of spaces that would generate the proliferation of contaminating material and consequently the presence of localized infection.

Before performing the procedure to be performed, the physiological constants of each patient were evaluated and a clinical sheet was opened for each patient. Following up on the procedures after dehorning, the physiological constants were taken without finding any change or physiological alteration. Finding on the second day, the hardening of the foam in the entire frontal cavity left by dehorning, without the presence of secretions that indicate an infectious process, as well as its complete sealing. The following week it was possible to observe that the filler material continued in the application site without showing any alteration on the patients, as well as on their physiological constants, so all the patients involved were discharged.

The discovery of polyurethane dates back to 1937, thanks to the research carried out by Otto Bayer. It began to be used in the 1950s since until then there were no machines capable of processing it. Polyurethane systems, today, are very versatile and allow a wide range of applications that are part of our lives. Its use extends, for example:

- Mattresses and sofas (in padding form)
- Automobiles (steering wheels, spoilers, spoilers, seats, dashboards, such as vibration and noise damping, etc.)
- Shoe soles (especially sports)
- Furniture manufacturing
- Paints and varnishes
- Windows
- Medical engineering (manufacture of parts for transplants and orthopedics, hemofilters, etc.)
- Aerospace engineering
- Cold industry (pipes, cold rooms, refrigerators, cryogenics, etc.)
- And of course, in buildings, such as thermal, acoustic and waterproofing insulation.

The raw materials come from two products: oil and sugar, to obtain, after a chemical transformation process, two basic components, generically called ISOCYANATE and POLYOL. Mixing these two components in the right conditions will provide us, depending on the type of each of them and the additives that are incorporated, a solid or porous, rigid or flexible material, with open or closed cells, etc.

The mixture of the two components POLYOL and ISOCYANATE, which are liquid at room temperature, produces an exothermic chemical reaction. This chemical reaction is characterized by the formation of bonds between the polyol and the isocyanate, achieving a solid, uniform and very resistant structure. If the heat given off by the reaction is used to evaporate a swelling agent, a rigid product is obtained that has a cellular structure, with a volume much greater than that occupied by liquid products. This is what we call rigid polyurethane foam, or PUR. Rigid polyurethane foam is a non-fusible, highly spatially crosslinked, duroplastic synthetic material. In the usual densities, for thermal insulation, the foam contains only a small part of the volume of solid matter (with a density of 35 kg / $m^3$, only 3% of the volume is solid matter).

There are two manufacturing systems that lead to two differentiated products:

- Rigid polyurethane foam applied in situ by spraying, or sprayed polyurethane, which is obtained by simultaneously spraying the two components on a surface called substrate
- Rigid polyurethane foam applied in situ by casting, or injected polyurethane, in which the two components are physically mixed by beating and introduced into a cavity where the expansion takes place.

Polyurethane foaming process: The components are mixed and stirred until homogenized, and immediately the chemical reaction that generates the rigid foam begins. In projection systems, the reaction is complete in about 10 seconds.

## 4. Results

When evaluating the use of polyurethane in the dehorning technique, especially in adult animals, where it is common to observe the cavities of the frontal sinuses when removing the horn, it is impractical to try to fill these sinuses with material that commonly generates rejection and even infection due to bacterial proliferation, likewise trying to close the gap with the skin around the horn is impractical due to the lack of skin to face and suture. Due to these circumstances, it was thought to use the polyurethane foam that given its characteristics of being innocuous and of not representing any risk to the health of the animals, it was applied looking for the sealing of the cavity or frontal sinus, remaining as a fairly material solid that fills all the spaces, thus avoiding the secretion of liquids, as well as purulent material; being an excellent product to perform the horn removal method especially when there is exposure of the frontal sinus.

## 5. Discussion and Conclusions

Different substances and materials have been used to plug the holes that occur after dehorning, especially in adult animals, with an unfavorable response, since post-dehorning infections, infectious-type secretions

and sometimes even the presence of worms on the mentioned site; Therefore, different solution alternatives are analyzed, being the use of poly-urethane foam in a fast and very economic way, where after several dehorning procedures in adult animals, it shows very efficient results and with a high resolution power.

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