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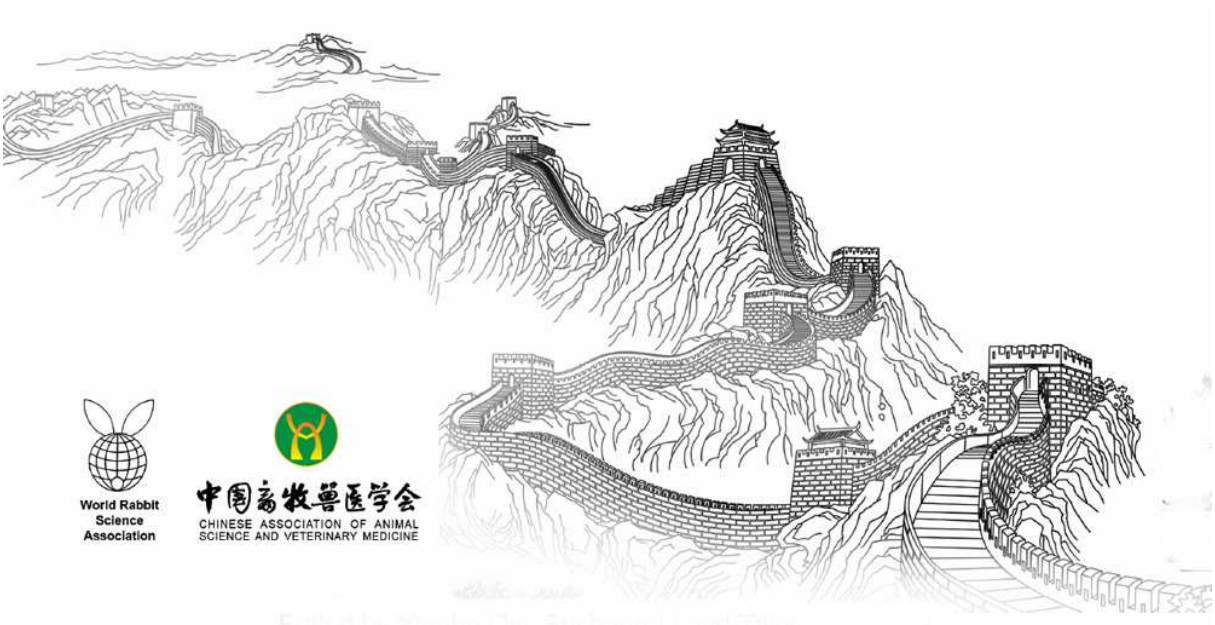

STUDY OF HEALING OF THE UMBILICUS IN NEWBORN FARMS RABBITS (*Oryctolagus cuniculus*).

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ABSTRACT

To be transported a mammal must have healed navel. When is the navel of the rabbit healed? Our study is divided into two parts:
- An observational study of cord wet or dry, its length and the time when the cord is naturally detached.
- Histological study of umbilical structures showing from when the epidermis closes the belly.
The study focuses on rabbits 2862 Hy + (GP and PS19) and 40 dwarf rabbits (black and chocolate silver color)..It shows that the cord falls between 6 and 15 days, and the healing of the belly is complete at 6 Days

RÉSUMÉ

Pour pouvoir être transporté un mammifère doit avoir l'ombilic cicatrisé. A partir de quand l'ombilic du lapin est-il cicatrisé ? Notre étude est divisée en deux parties :
- une étude d'observation du cordon mouillé ou sec, sa longueur et le moment où le cordon s'est naturellement détaché.
- une étude histologique des structures ombilicales montrant à partir de quand l'épiderme referme le ventre
L'étude porte sur 2862 lapins Hy+ (GP et PS19) et 40 lapins nains de couleur argentés noirs et havane. Elle montre que le cordon tombe entre 6 et 15 jours et que la cicatrisation du ventre est terminée à 6 Jours

Key words: Rabbit, *Oryctolagus cuniculus*, healing, umbilical cord, umbilicus

INTRODUCTION

We need to transport rabbits in the rabbit production chain. From the age of one day, future breeding rabbits could all travel over the world. In these conditions, as in nature, once fed, the mother will give them milk 24 hours later. If rabbits are placed in a warm and clean nest box, with inert insulating material, they can travel without problems during one or two day(s) if they have drunk before the departure. This is now the most common method chosen by farmers for future breeders travel.
The advantage of this method is double. It is simple and inexpensive compared to the transport of adult animals and limits the transmission of pathogens.
The regulations in force in France concerning the transport of animals is based in particular on the "European Convention for the Protection of Animals during International Transport" of 13 December 1968, revised on 6 November 2003 from the Council Regulation (EC) No 1/2005 of 22 December 2004 on "The protection of animals during transport and related operations", the Decree No. 99-961 of 24 November 1999 on "The protection of animals during transport" and on the Decree 5 November 1996 , as amended by the Decree of 24 November 1999 on "the protection of animals during transport".
The primary objective of these regulations is to avoid causing the animal any stress, pain, suffering or unnecessary damage during transport. Only animals deemed healthy and correctly identified are allowed to travel and can be transported. The conditions of transport do not have to cause injury or unnecessary suffering to the animals. In the case of the rabbit, the transportation is done in boxes lined with wood shavings or other suitable insulated material that mimic perfectly the nest of the mother. The rabbit comfort is similar to that it

found in the nest built by his mother. The animals travel in small groups in a transport nest, like siblings, and therefore will fit perfectly warm.
Annex I to Regulation (EC) No 1/2005 states that animals injured or present physiological weaknesses or pathological condition are not considered fit. This is the case especially newborn mammals in which the navel is not completely healed (Chardon et al 2015).
The question that therefore arises is this: at what age can we consider that the umbilicus of a newborn rabbit is completely healed?
To answer this question, two types of analysis are implemented. The first was the observation of newborn rabbits for which it is noted:
- The presence of wet or dry umbilical cord.
- Its length and when the cord is naturally detached.
The second was the histological analysis of umbilical structures to note at what point we can consider that healing is advanced enough to establish that "the belly is closed," the definition of a healing navel.

MATERIALS AND METHODS

Observation of the umbilicus

Two types of rabbits are jointly observed in December 2015 in France: a first lot mainly represented by 2,862 white rabbits from 300 Parental females and 18 grandparent Hy + strains (PS19 and GP) bred in closed building with forced ventilation and a second lot of 40 dwarf rabbits from 9 dwarf rabbit breed female black and silver color raised in outdoor hutch on cement soil mulched.

The mother puts its young in a nest lined with wood shavings while the dwarf rabbits are placed in a nest lined with straw. Both the types of nests are also furnished with hairs pulled from rabbits females. We just retained still live rabbits to the 15th day. The few deaths (2.3% of total white rabbits and 0% of dwarf rabbits) were withdrawn from the study retrospectively.

90 white rabbits and 5 dwarf rabbits have been observed within few minutes after birth. The cord was then cut and the wet red exudate (blood and jelly) collected on a paper towel.

All white rabbits were visually observed daily one by one and the size of the remaining cord is estimated on the first day. During fourteen days, the umbilical regions have been palpated to identify the presence or absence of the dried cord. The day they lose their cord we mark of a colorful little spot on the back so not to recount the day. Dwarf rabbits are observed daily, and their dark color prevents any rapid marking.

Histological examination

The rabbits analyzed come from the grand parental strains white rabbits. Three young rabbits have been collected daily between 0 and 15 days of age. Each preparation contained a skin flap centered on the residual of the umbilical cord. They were immersed in a fixing liquid (Excell). The tissues have been stained with Hematoxylin Eosin Saffron and then observed under an optical microscope.

RESULTS AND DISCUSSION

Results

Clinical observations of the umbilicus

One hour after birth, the cords and all the paper towels were dry. Twelve hours after, the cord appeared blackish and was completely dried.

The day of birth, 34 rabbits on 2862 showed a small lump at the umbilical level suggestive of a small hernia. The following days, the rabbits were observed and/or palpated and the number of cords naturally removed have been tried to evaluate .

On the 15th day, the hairs have grown and some rabbits still have their cord in the middle of the hair. Rubbing the

Age	Cord				%
	< 2 mm	2 - 4mm	>5 mm	Fallen	
Birth	29	2799	34	0	0%
1 à 5 d	NO	NO	NO	0	0%
6d	NO	NO	NO	3	0%
7d	NO	NO	NO	4	0%
8d	NO	NO	NO	6	0%
9d	NO	NO	NO	34	1%
10d	NO	NO	NO	279	10%
11d	NO	NO	NO	1137	40%
12d	NO	NO	NO	1870	65%
13d	NO	NO	NO	2589	90%
14d	NO	NO	NO	2804	98%
15d	NO	NO	NO	2862	100%

Table 1: Size of cords, cord date fall on 2862 white rabbits strain Hy + (NO = not observed):

umbilical area, the umbilical cord may fall as the crust of a wound.

Table 2: Size of cords, cord date fall on 40 dwarf colored rabbits strain (NO = not observed):

Age	Cord < 2 mm	2mm<Cord>4 m	Cord > 5 mm	Fallen cord	percentage
birth	20	20	0	0	0%
1 à 5d	NO	NO	NO	0	0%
6d	NO	NO	NO	0	0%
7d	NO	NO	NO	0	0%
8d	NO	NO	NO	0	0%
9d	NO	NO	NO	0	0%
10d	NO	NO	NO	32	80%
11d	NO	NO	NO	40	100%

Histological examination

At D0 (day of birth), the remains of the umbilical cord appears as a cylindrical segment of variable length containing vascular sections whose lights are occupied by blood cells. These vessels are included in a loose connective densely cellular enough, micro-bleeding. The set is bare in its distal part and lined by squamous epithelium keratinized in the proximal area, connection area with the integument of the newborn.
On the subcutaneous side, the vessels have disorganized media (aspect of proliferation of smooth muscle fibers).

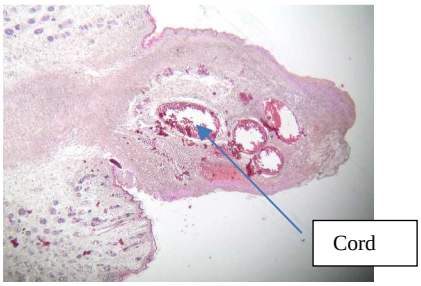

Figure 1: D0: umbilicus cut and adjacent structures (x2.5)

At D1 umbilical cord is more clearly necrotic, coagulated (coagulation necrosis appearance). Umbilical dermal vessels of newborn show images comparable to those of D0. The distinction between necrotic and viable tissue cord of the newborn is clear.

Figure 2: Umbilicus on dwarf rabbit 1 day old

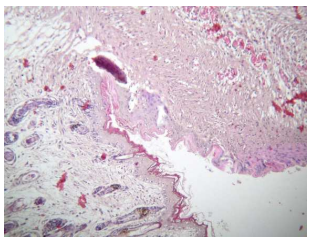

Figure 3: D1: Junction skin covering the cord (x 20)

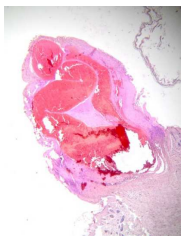

Figure 4: D4-early disjunction groove (x 2.5)

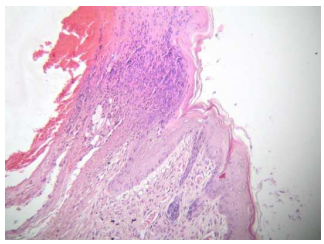

Figure 5: D4 furrow disjunction (x 40)

From D4, the remains of the umbilical cord are less prominent; a disjunction groove is set up as a linear surge of heterophilic granulocytes altered from the peripheral areas of the umbilicus. The heterophilic infiltrate ends up being continuous and forming a linear weakened zone (cut-groove) that allows the separation of the cord. At this stage, the skin of the newborn is still interrupted at the furrow by heterophilic infiltrate as in children (Oudesluys-Murphy and den Hollander, 1990; Oudesluys-Murphy and et al., 1990). The absence of bacterial colonies within the infiltrate could be observed. In dermal areas of the umbilicus, the dermis is densely cellular and contains sections of umbilical vessels whose media shows fibrinous deposits associated or not with a proliferation of smooth muscle fibers. At D6 sealing is ensured because the epidermis is now continuous

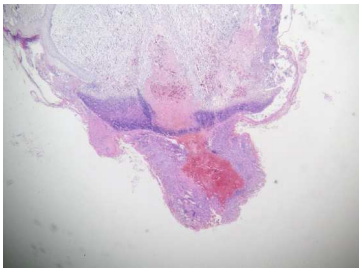

Figure 6: D6 disjunction groove (x 2.5)

Figure 7: D6-disjunction navel groove (x 2.5)

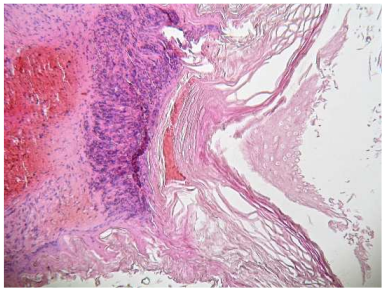

Figure 8: D6 umbilicus and disjunction (x 20)

DISCUSSION

The umbilical cord of young rabbits is short (2 cm) and not coiled. It is usually broken and separated from the placenta and annexes at birth. Then,the mother eat the placentas. The cord has two umbilical arteries directed towards the bladder of the fetus and umbilical vein that goes to the liver (Hudson et al. 1999; Miller, 1999).
The cord is dry one hour after birth, but it starts to fall after about six days for white rabbits to 10 days for dwarf rabbits with an average fall of around 11 to 12 days. No cord is still present after 15 days on the white rabbit; no dwarf rabbit has kept his more than 11 days. The strains of rabbits and breeding conditions are different, we cannot know what link this observation. Are there genetic variations? Are wood chips less traumatic than straw? Other experiments would be useful to provide answers.
Anyway, we can consider that healing arrives before the fall of the cord. Histological sections show that seems advanced at 4 days of age and it is complete on day 6. The "belly is closed," even if the cord has not yet fallen. The risk of contamination at the umbilical rabbit is limited at a young age.

Further study could be conducted as a result of this work to determine the factors influencing the fall of the cord and perhaps healing the umbilical area.
In children, several factors influence the fall of the umbilical cord. Thus, antibiotic administration or use of antiseptic appears to delay the time of the fall. In this case, the rabbits and their mothers received no antibiotic but for white rabbits antiseptic talc was in the nests, which have not received the dwarf rabbits and might explain the fall more early cord home. (Oudesluys-Murphy et al. 1987; Gold 2014).
Some authors have also noticed that the cord girls fell earlier than the boys. This finding is not accepted by all authors. In our study we have not sexed young rabbits and so we have not noticed these differences (Oudesluys-Murphy et al. 1987)
The fall of the cord is delayed if the mother undergoes a caesarean or if the parturition is anticipated (Novack et al. 1988; Wilson et al. 1985; Gold 2014). In the case of rabbits of this study, the delivery took place over 3 days for a same mating/insemination date. It is quite possible that the young rabbits born early are also those who keep them as long cord. We have not seen, failing to note the precise dates of birth of each litter.
Finally, the mass of young rabbits at birth could be correlated to the time of the fall of the cord and be delayed in the smallest as seems to be the case for children. (Sarwono et al.,1991)

CONCLUSION

While several factors can influence the fall of the umbilical cord date in farmed rabbit, our observation showed that naturally cord falls between 6 and 15 days. The healing of the umbilical area is well advanced to 4 days of age and appears to be complete by the age of 6 days.

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