Original article

Typification the tendinous cords of the left valve complex of sheep hearts (*Ovis aries* Lin.)

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Abstract

Forty *Santa Ines* sheep (*Ovis aries* Lin.) hearts were examined with the purpose of studying the present types of *chordae tendineae* in the left valve complex. The study was performed at the State University of North Fluminense Darcy Ribeiro, Morphology sector of the Agricultural Science Animal Health Center Laboratory. Hearts were initially kept in 10% formalin solution and later dissected to undergo removal and plannification of left atrioventricular complex. With the removal of the left atrioventricular complex began the observation and characterization of the cord. After the analysis we observed the presence of eight types of cuspidal *chordae tendineae* present in the left valve complex, they were classified as type I, II, III, IV, V, VI, VII and commissural kind.

Keywords: heart, *chordae tendineae*, tendinous cords, sheep.

1 Introdutcion

The presence of tendinous cords (TC) (SCHALLER, 1999; WORLD..., 2005) and papillary complex in the heart's ventricular chambers of domestic mammals allows the normal blood flow. When a contraction happens in the ventricular myocardium, the papillary muscle also contracts, pulling the TC and, consequently, the valve structures, preventing the blood return to the atrium (GUYTON and HALL, 1997; BICHARD and SHERDING, 1998; SWENSON and REECE, 1996; GETTY, 1986).

These anatomical elements are part of the cardiovascular system, which must be healthy to sustain the animal's health (PINHO, VOGEL and MALISKA, 1995), allowing its activities (DARKE, BONAGURA and DONALD, 2000). On the other side, there is the possibility of the forming elements of the valve complex to suffer all sorts of pathologies, compromising the well being of the animal (CARLTON and McGAVIN, 1998; BIRCHARD and SHERDING, 1998; DARKE, BONAGURA and DONALD, 2000; JONES, HUNT and KING, 2000; RADOSTITS, GAY, BLOOD et al., 2002; SLATTER, 2007).

Cardiology came to be of great importance in animal's health, as a consequence of the constant science advancements. One can realize the necessity of studies that seek to know the regarding characteristics of animal's cardiac anatomical structures (POGLIANI, STOPIGLIA, MARIANA et al., 2003).

By such motives, and due to scarce literature on the subject, the present work has the objective to perform the typification of the left valve complex TC's of *Santa Inês* sheep's hearts (*Ovis aries* Lin.) with the purpose to subside the Veterinary Medicine practice.

2 Literature review

It is understood of TC as a set of fibromuscular cords that originate on the subventricular and subatrial papillary muscle, and insert itself on the ventricular face of every atrioventricular valve (AV) of the AV valve (GETTY, 1986).

They were described since the beginning of the 20th century by the Animal's Anatomy Pioneers as Montané and Bourdelle (1913), Martin (1915), Bourdelle and Bressou (1938), Montagna (1964), Ellenberger and Baum (1977), and this definition is used today, been seen on the works of Dyce, Sack and Wensing (2004), Miller and Holmes (1984), Machado and Peduti Neto (1991), Riella (1996), Karlsson, Glasson, Bolger et al. (1998), Appolinário, Costa, Oliveira et al. (1999), Costa, Appolinário, Morais-Pinto et al. (1999), Riella, Souza, Bolfer et al. (2002), Lesnau (2001), Rodriguez, Langer, Harrington et al. (2004), Hoçoya (2005), Smodlaka, Henry, Schumacher et al. (2008), Lourenço (2008), Esteves, Araújo, Ambrósio et al. (2009) and Tenani, Melo and Rodrigues (2010).

The TCs were also classified in types and orders as its insertions and branches, respectively. Concerning the branches Montané and Bourdelle (1913), Martin (1915), Montagna (1964) and Miller and Holmes (1984) have observed and classified its branches in orders primary, secondary and tertiary according with the branch succession found in each TC.

In animal anatomy, the first systematic study related to the TC's classification regarding its insertion on the AV valve was the Machado and Peduti Neto (1991) study. They verified that the TC on the left valve complex of swine's hearts, describing five types: Type I, Type II, Type III, Type IV and the Commissural cord.

Appolinário, Costa, Oliveira et al. (1999) quoted the occurrences of atypical TCs on the left valve apparatus of dogs of no known breed. Watching the right valve complex of no known breed dogs, Costa, Appolinário, Morais-Pinto et al. (1999) related the existence of a special kind of *chordae tendineae*, and in another work Costa, Morais-Pinto, Appolinário et al. (2000) described the occurrence of anomalous TCs on the same side.

Lesnau (2001) studied anatomy of the left AV valve complex of the Mink *Balaenoptera acutorastrata* whale (Lacépède, 1804). Classifying the TC's according to Machado and Peduti Neto (1991), confirming the five kinds described.

Riella, Souza, Bolfer et al. (2002) classified the TC's present on the left AV valve in horses as its insertion. Pointed five classes, including two kinds of distinct Commissural cords of those studied by Machado and Peduti Neto (1991).

Rodriguez, Langer, Harrington et al. (2004) in a study with sheep hearts, proposed another classification to the TC, based on the TC orders and not on its kinds. On the principle of classification, you can mention Esteves, Araújo, Ambrósio et al. (2009).

Hoçoya (2005) describe swine's TC's that presented a great number of branches, organizing itself in as intertwined architecture, forming a "net" structure on the valve leaflet.

Riella (1996) and Karlsson, Glasson, Bolger et al. (1998) performed a study of the valves composing the left AV valve, however it does not indicate the typification of the TC's. Besides other works with animal's hearts as Smodlaka, Henry, Schumacher et al. (2008) that described the seal's (*Phoca hispida*) general anatomical aspects, Soares, Oliveira and Balardi-Artoni (2010) studies the ostrich's (*Strutio camelus*) heart anatomical aspects. And Lourenço (2008) performed a wide analogy between the dog's heart with the human heart, detailing the TC's frequency, but not its kinds.

3 Materials and methods

Forty *Santa Inês* sheep (*Ovis aries* Lin.) hearts were collected of healthy animals after slaughtering or necropsy of an animal with no cardiac pathologies. They were taken to the Anatomy Laboratory of the State University of North Fluminense Darcy Ribeiro (UENF) of Morphology and Pathological Anatomy sector of the Agricultural Science Animal Health Center Laboratory.

In the Anatomical Laboratory the hearts were prepares according to Rodrigues (1998), and identified individually. The dissection technique used on the left valve complex was as Queiroz, Almeida, Rocha et al. (2009), and the typification of the TC's according to Machado and Peduti Neto (1991).

4 Results

With the observation and the analysis of the forty *Santa Inês* sheep hearts, were identified eight types of TC's, which have been classified as: cords of Types I, II, III, IV, V, VI, VII and commissural cord.

The Types I, II, II, IV and the commissural type found on the present work were those described by Machado and Peduti Neto (1991).

New types were found and described as follows: the TC Type V (Figure 1) was the one that originated in the papillary muscle and was destined to the smooth and rough area of the ventricular face of the AV valve, characterized as a thin filament that, initially presented itself as single, and later branched itself into two thinner fillings that would be inserted in the smooth and rough area of the valves.

The TC Type VI (Figure 2) was that one originated on the papillary muscle fixed in the smooth area and in the edge of the ventricular face of the valve. Consists of a main thicker filament, inserted in the smooth area of the valve, of which originates a thin filament inserted in the same edge.

It was considered the TC Type VII (Figure 3) that TC originated in the papillary muscle that concerned only the rough area of the valve's ventricular face. It is characterized as a single filament that next to the valve, before its insertion on it, emitted thin branches that were restricted only to the rough area.

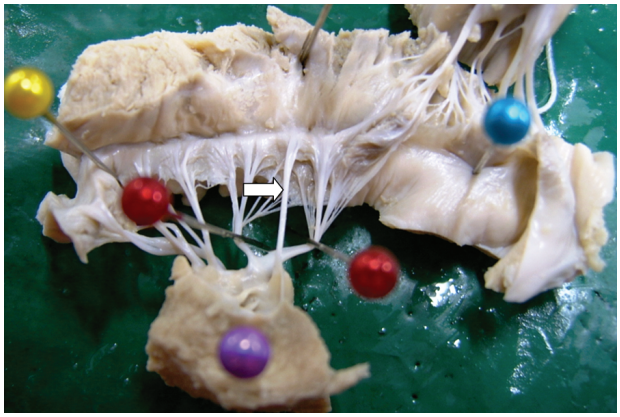

Figure 1. Santa Inês sheep left heart valve complex. It is evident the tendinous cord Type V localized between the two red pins (white arrow).

Figure 2. Santa Inês sheep left heart valve complex with tendinous cord Type VI localized between the two yellow pins (white arrow).

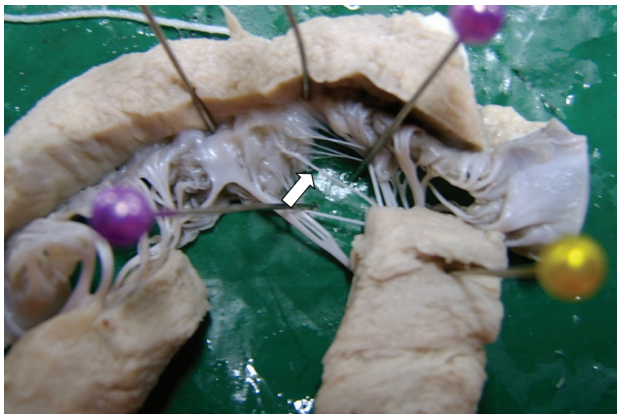

Figure 3. Santa Inês sheep left heart valve complex with tendinous cord Type VII localized between the two purple pins (white arrow).

5 Discussion

There is little uniformity in the specific works concerning the TC's and in relating to its classification, as Victor and Nayak (1994); Riella (1996); Karlsson, Glasson, Bolger et al. (1998), besides those authors emphasizing the valve's study and it's particularities and/or the quantity of TC present in the valve complex, without observing it's kinds.

Some other authors referred to the anomalous or atypical present in dog's hearts, as Appolinário, Costa, Oliveira et al. (1999); Costa, Appolinário, Morais-Pinto et al. (1999); Costa, Morais-Pinto, Appolinário et al. (2000). When referring specifically to the TC's morphological classification in animals, you can check Machado and Peduti Neto (1991), followed by Lesnau (2001)

Machado and Peduti Neto (1991) did the first TC classification proposal to animal anatomy, using the insertion points of these AV valves of the left valve complex, denominating them as: Type I, II, III, IV, and Commissural type.

Riella, Souza, Bolfer et al. (2002) classified the TC's found, using another denomination – Adherent Edge TC, which insert itself in the valve's edge and in the rough area, the same as the Type II cord of Machado and Peduti Neto (1991); The Free Edge TC, who has its insertion only on the valve's edge, correspondent to the Type III of Machado and Peduti Neto (1991); another type of TC, the Support Cord, has its insertion only in the rough area, not observed by Machado and Peduti Neto (1991)

Rodriguez, Langer, Harrington et al. (2004) approached the TC's classification, used the order denomination to classify them, however, denominated only two orders: first order, the cords that are inserted only on the valve's edge, classified and Type III cord by Machado and Peduti Neto (1991) and as the free edge cord by Riella, Souza, Bolfer et al. (2002); second order**,** the TCs that insert itself on the edge of the valve and in the rough area, classified as Type II by Machado and Peduti Neto (1991) and as adherent edge by Riella, Souza, Bolfer et al. (2002).

Alves, Wafae, Beu et al. (2008) did not use the types nor the orders already described, and as Riella, Souza, Bolfer et al. (2002), named not very precisely, indicating a classification in three types: TC of Ventricular Surface, which inserted itself in the edge of the valve, in the rough area, being able to help the smooth area, by its amplitude of possibilities in relation to the other authors, this cord can be of Type I or of Type II by Machado and Peduti Neto (1991), cord of the adherent edge by Riella, Souza, Bolfer et al. (2002), or the second order by Rodriguez, Langer, Harrington et al. (2004), if there is no insertion on the smooth area; TC of the Parietal Surface, inserting itself only in the edge of the valve, the same as the Type III cord of Machado and Peduti Neto (1991), free edge of Riella, Souza, Bolfer et al. (2002) and first order of Rodriguez, Langer, Harrington et al. (2004); and the Adherent edge TC, that has its insertion only in the smooth area, that follows the description of the Type IV cord by Machado and Peduti Neto (1991).

The description of the TC, adherent edge by Riella, Souza, Bolfer et al. (2002) differs from that used by Alves, Wafae, Beu et al. (2008), for Riella, Souza, Bolfer et al. (2002) classified the adherent edge cord as that inserted in the edge of the valve and in its rough area, and Alves, Wafae, Beu et al. (2008) as the cord inserted only in the smooth area.

The Type VII cord described coincides with the description proposed by Riella, Souza, Bolfer et al. (2002), for inserting itself only in the rough area.

Because of it, we suggest that the pattern proposed by Machado and Peduti Neto (1991) can be taken as a basic reference for new works of animal anatomy, for being the first work that organizes a classification of tendinous cords of the left valve complex in animals.

6 Conclusion

Through the TCs' classification types proposed by Machado and Peduti Neto (1991) and in the work conditions here presented, one can conclude that:

- The *Santa Inês* sheep hearts presented eight types of TC;
- Five types that coincide with the Landrace Swines; and
- Three new types of TC.

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