

## FAST RIB RETRACTOR FOR INTERNAL CARDIAC MASSAGE IN DOGS – THE VENTURA RETRACTOR

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### ABSTRACT

Cardiorespiratory arrest is a common affection in small animal practice. Thus, internal cardiac massage has not been addressed with adequate instruments for its realization, which implies slower thoracic inlet through the use of Finochietto retractor. In this way, the aim of this article was to disclose the project of a rib retractor that could decrease the thoracic opening time, properly allowing internal cardiac massage. Ten canine corpses, with corporal mass between tree and 60 kg, were employed, with non-related to thoracic injuries *causa mortis*. Mechanical efficiency calculation was also accomplished. The Ventura Retractor was capable of decreasing the thoracic opening time, making it easier to execute, thanks to its simple and mechanically efficient design, which can concur to outliving.

**Keywords:** Small animals. Cardio-respiratory arrest. Retractor. Cardiac massage.

## INTRODUCTION

Trauma is the leading cause of death in small animals (WINGFIELD, 1998). Recently, some studies reported that the trauma is exceeded by infectious diseases and cancer, but still with a high incidence (BENTUBO et al., 2007; FIGHERA et al., 2008). Often the evolution of such aggression is cardiac arrest, in which among the therapeutic options, is the internal cardiac massage. To do so, a skill and experienced surgeon will need a retractor to promote the spreading of the ribs while the internal cardiac massage is performed (AGUIAR, 2011). The instrument that is widely employed is the Finocchieto retractor, invented by Enrique Finocchieto in 1930 (INVENT.AR, 2006). This instrument has become very common and it is widely used in general thoracic surgery, the most used in veterinary thoracic surgery. It consists of a simple machine classified as crank-shaft, producing large opening force. As a handle is turned, the pinion moves the rack at 1.2 cm at every turn and, consequently, away from the ribs (BUECHE, 1983; PROVENZA, 1985; BONJORNO; BONJORNO, 1993). Due to the high strength required for its function, the chest retractor must have higher resistance and must have no sharp edges, preventing damages to soft and hard tissues, like a “V” design, which seems to cause only micro fractures with no clinical meaning due to the better distribution of forces (KNECHT et al., 1985; BOARON, 2004). Similarly, it may provide mechanical advantage for the surgeon as well (KNECHT et al., 1985; MERKLEY; WAGNER, 1996). Even 86 years after its creation, the Finocchieto retractor is still employed for thoracotomies, and some modifications have been done to suit new surgical techniques, although the same structure of rack and handle remain (ROUX et al., 1995; HALL, 1996; JAIN, 1996; KOLE, 1996; QAQISH et al., 1997; GUNDRY et al., 1998; HAR-SHAI et al., 1998; LAZZAR; KIDWELL, 1998; VAN DE WAL et al., 1998; MASSETTI et al., 1999; GILINOV, 2003). Despite not being his original purpose, it has also been used for ribs spreading in emergency thoracotomy, facilitating the access to the heart and the onset of the internal cardiac massage (ALZAGA-FERNANDEZ; VARON, 2005; BENSON et al., 2005).

This study aimed to evaluate a rib retractor that would provide better mechanical efficiency, resulting in shortening the time required to open the chest to perform internal cardiac massage, the Ventura retractor.

## MATERIAL AND METHODS

The Ventura retractor is a device composed of two long shafts and a bar rack. It was built in 318 austenitic stainless steel alloy, suitable for retractors (MERKLEY; WAGNER, 1996). This spreader is designed based on a first class lever, whose mechanical efficiency was calculated using the formula:

$$F \cdot AB = F_d \cdot AC$$

in which F is the resulting force, the segment AB is the fulcrum to resistance or resistance arm,  $F_d$  is the driving force and AC represents the core power or effort arm (BONJORNO; BONJORNO, 1993; BUECHE, 1983). This calculation is the output of a lever, in Newtons (N) of its power-to-fulcrum-resistance. Thus, the mechanical efficiency is increased as the power arm is longer than the resistance arm (BONJORNO; BONJORNO, 1993; BUECHE, 1983). This interrelationship is explained by the mechanical efficiency of the lever, a first class one, detailed in Fig. 1.

Ten corpses of dogs with corporal mass ranging from three to 60 kg, whose cause of death were not related to chest injuries, were used for the evaluation of the speed of opening the chest. The corpses were positioned in right lateral recumbency and underwent thoracotomy in the fourth intercostal space. After sectioning the pleura, the retractor was placed and then opened. Ventura retractor was used in the left thoracotomy and the opening time was recorded. Then, recumbency was inverted and a second thoracotomy was performed in the fourth intercostal space, in which the Finocchieto retractor was used and the time measured. The same corpse was used to evaluate the two retractors in order to eliminate the variable of tensile strength of tissue from a corpse to another. Similarly, the Ventura retractor was evaluated before the Finocchieto retractor to avoid any influence that could facilitate the displacement of the ribs to the proposed instrument.

For taking the time, the retractor was placed next to the operator. When the retractor was handled the stopwatch was fired, and stopped when the ribs reach their maximum separation. It was determined that the operator would always be the same and experienced in the use of the Finocchieto retractor, emergency thoracotomy and internal cardiac massage.

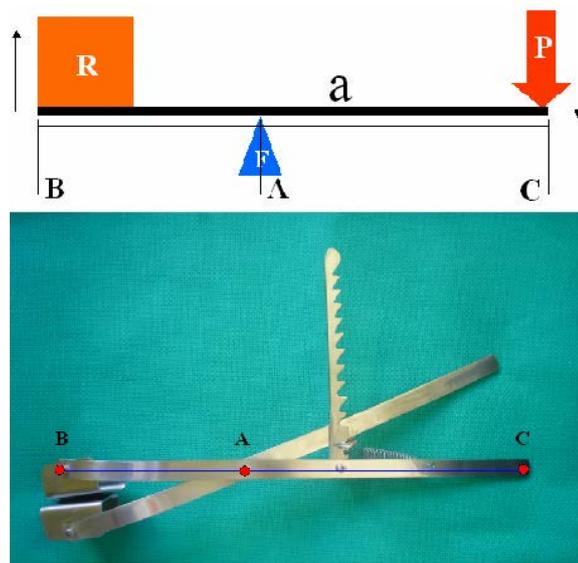
Data were analyzed by the statistical package GraphPad InStat, by applying the Mann-Whitney test, and the critical level of significance of 0.01% ( $p < 0.0001$ ).

## RESULTS AND DISCUSSION

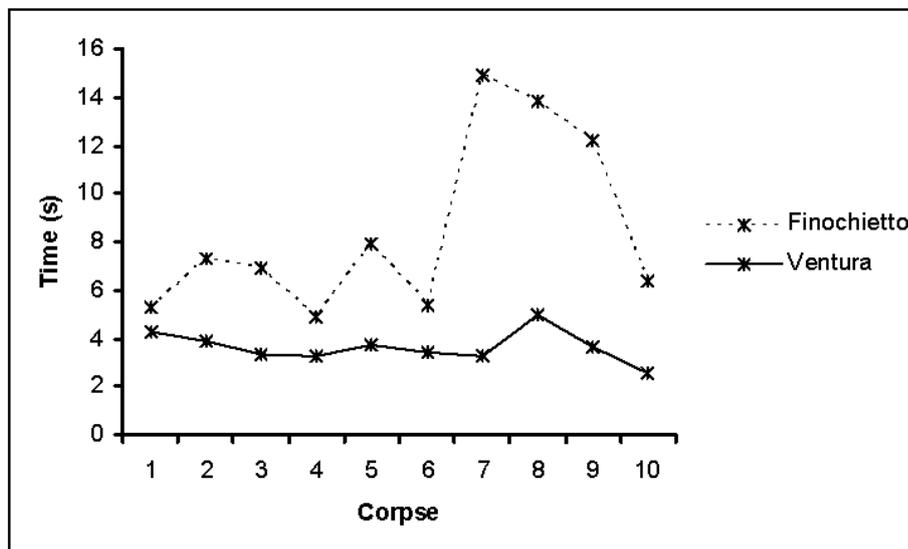
The average time of rib spreading with the Ventura retractor was  $3.555 \pm 0.6516$  seconds, while  $7.115 \pm 3.721$  seconds were required to promote the same operation with the Finochietto retractor ( $p < 0.0001$ ) (Table 1 and Figure 2). The calculation of mechanical efficiency resulted in power increase of the applied force, at the order of 70% (Figure 1).

**Table 1** – Time of rib spreading measured with retractors of Finochietto (F) and Ventura (V), in seconds, and data of mean and standard deviation for both groups.

Corpse	Finochietto (F)	Ventura (V)	Comments
1	5.31	4.26	
2	7.32	3.85	
3	6.91	3.36	
4	4.89	3.26	F: cranial rib fracture
5	7.90	3.74	
6	5.34	3.44	F: cranial rib fracture
7	14.88	3.28	
8	13.83	4.99	
9	12.17	3.67	F: cranial and caudal rib fracture
10	6.36	2.56	F: cranial and caudal rib fracture
Group	Finochietto	Ventura	
n	10	10	
Minimum	4.890	2.560	
Maximum	14.880	4.990	
Standard deviation	3.721	0.6516	
Mean	7.115	3.555	



**Figure 1** – Schematic representation of a first class lever (above), the same principle used in the construction of Ventura retractor (below). AB, segment from the fulcrum to the resistance (resistance arm); AC, segment from the fulcrum to the power (effort arm); R, resistance; F, fulcrum; W Power; a, lever. The black arrows indicate the direction of movement when power is applied.



**Figure 2** – Distribution of values (in seconds to each corpse) of rib spreading obtained with the retractors of Finochietto and Ventura.

There was no mention in literature about a retractor whose main purpose was the rib spreading to internal cardiac massage. In general, the Finocchietto retractor is used routinely for prompt access to the heart (ALZAGA-FERNANDEZ; VARON, 2005; BENSON et al., 2005). On the other hand, the Finocchietto retractor is moved by rotating a crank, in which a given

turn opens the instrument only 1.2 cm (PROVENZA, 1985). This slower opening requires a great ability of the operator in order to retract the ribs as quickly as possible.

The Finocchio retractor has undergone changes over the years to attend needs that arise due to the development of new surgical techniques (GILINOV, 2003; HALL, 1996; JAIN; KOLE, 1996; LAZZAR; KIDWELL, 1998; MASSETTI et al., 1999; QAQISH, 1997; ROUX et al., 1995). However, none of them were directed to its application for an emergency thoracotomy.

The Finocchio retractor is widely used in chest surgery, so that the Ventura retractor was also tested for this purpose (GUNDRY et al., 1998; HAR-SHAI et al., 1998; VAN DE WAL et al., 1998). In 20 surgical procedures in the chest, all involving cardiovascular surgery, the Ventura retractor maintained adequate rib spreading, which implies that this device can be used in this way as well.

The valves of the Ventura retractor are secured by mobile pin joints, allowing adjustments according to the inclination that the ribs adopt during its retraction. Thus, a larger contact surface between the valve and the rib and soft tissue is obtained, reducing the pressure on those structures, preventing rib fractures and soft tissue injuries (HAR-SHAI et al., 1998). The results show that the Ventura retractor did not cause rib fractures in corpses, either soft tissue injury when applied during chest surgeries. It is likely that its "V" conformation improves the distribution of forces resulting only in non-relevant micro fractures (BOARON, 2004).

The chest spreaders must have superior resistance due to stress they are subjected (MERKLEY; WAGNER, 1996). The Ventura retractor proved such resistance, the result of the choice of austenitic stainless steel alloy 318 and its mechanically simple and efficient design. A Finocchio retractor has a weight of 800 g, while the Ventura retractor presented final mass of 400 g. This difference denoted ease of handling and less interference in the surgical field.

Regarding the mechanical advantage for each Newton applied to the Ventura retractor, the resultant force is 1.705 N (BUECHE, 1983; BONJORNO; BONJORNO, 1993). This result indicates that the rib spreading requires less effort by the operator, due to the structure of simple machine (first class lever) instrument, which provides high mechanical efficiency.

Therefore, the rib spreading is easier and faster, forwarding the internal cardiac massage, since the mechanical advantage of Ventura retractor is above 70% (KNECHT et al., 1985).

## CONCLUSION

The results of this study allow to conclude that the Ventura retractor is effective, promoting the rib spreading with a high mechanical advantage and in less time compared to the Finochietto retractor. In cases of cardiopulmonary arrest, the precocity of thoracic inlet increases the chances of survival by reducing the required time to start cardiopulmonary resuscitation. It was also possible to determine that the Ventura retractor can be used to maintain rib displacement in thoracic surgery, with reduced interference in the surgical field.

## AFASTADOR RÁPIDO DE COSTELAS PARA MASSAGEM CARDÍACA INTERNA EM CÃES – O AFASTADOR DE VENTURA

### RESUMO

**A** parada cardio-respiratória é uma afecção comum na clínica de animais de companhia. Ainda assim, a massagem cardíaca interna ainda não foi contemplada com instrumentos adequados à sua realização, o que implica em um tempo demasiado para o afastamento de costelas devido ao emprego do Afastador de Finocchietto. Desta forma, o objetivo deste trabalho é divulgar o projeto de um afastador de costelas que diminua o tempo de acesso ao tórax, permitindo o início rápido da massagem cardíaca interna. Foram utilizados dez cadáveres de cães oriundos da rotina clínica de um hospital veterinário, com massa corporal entre três e 60 kg, sem lesões torácicas relacionadas à *causa mortis*. A eficiência mecânica do afastador proposto também foi avaliada. O afastador de Ventura foi capaz de facilitar e reduzir o tempo de afastamento das costelas, graças ao seu projeto simples e mecanicamente eficiente, o que poderá contribuir para a sobrevivência dos pacientes submetidos à massagem cardíaca interna.

**Palavras-chave:** Animais de companhia. Parada cardíaco-respiratória. Afastador de costelas. Massagem cardíaca.

## SEPARADOR RÁPIDO DE COSTILLAS PARA EL MASAJE CARDÍACO INTERIOR – EL SEPARADOR DE VENTURA

### RESUMEN

La parada cardiorrespiratoria es una enfermedad común en la clínica de mascotas. Aun así, el masaje cardíaco interior no está cubierto con instrumentos adecuados para su aplicación, lo que implica una pérdida de tiempo para la separación de las costillas debido al empleo del separador de Finocchietto. Por lo tanto, el objetivo de este trabajo es promover el proyecto de un separador de costillas que reduce el tiempo de acceso al pecho, lo que permite el rápido comienzo del masaje cardíaco interior. Se utilizó diez cadáveres de perros de la rutina clínica de un hospital veterinario, con una masa corporal de entre tres y 60 kg sin lesiones en el pecho relacionadas con la *causa mortis*. También se evaluó la eficiencia mecánica del retractor propuesto. El separador de Ventura fue capaz de facilitar y reducir el tiempo de separación de las costillas, resultado de su diseño simple y mecánicamente eficiente, lo que podrá contribuir a la supervivencia de los pacientes sometidos a masaje cardíaco interior.

**Palabras clave:** Mascotas. Parada cardiorrespiratoria. Separador de costillas. Masaje cardíaco.

### CONFLICT OF INTEREST

The author discloses that he possess the rights of the intellectual property from the patent of this retractor (P.I. 0.404.287-5 RPI 1794).

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