REVISTA ESPAÑOLA DE FISIOLOGIA, 45 (2), 151-156, 1989

Effect of Age on the Orientation of the Auricular Activation Vector in Pig

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(Received on November 21, 1988)

M. D. RUBIO, R. SANTISTEBAN, P. TOVAR, J. IBAÑEZ and F. CASTEJON. *Effect of Age on the Orientation of the Auricular Activation Vector in Pig.* Rev. esp. Fisiol., 45 (2), 151-156, 1989.

The effects of cardiac maturation on the orientation of the auricular activation mean vectors (ÂP and SÂP) in Landrace X White Belgian pigs has been analyzed. The magnitudes of ÂP and SÂP vectors undergo a significant increase between 5 and 20 days of age. On the contrary, physical maturation does not appear to have any effect on the sequence of auricular activation in pigs, since in all the age groups analyzed, the same orientation for P vectors on the horizontal plane and in space was maintained. Both vectors indicated that the auricular activation front was predominantly directed towards the left, caudally and ventrally. It should be noted that in a high percentage of individuals of 1 to 5 days of age, the auricular activation vector goes towards the left and cranially.

Key words: ECG, P vector, Age, Pig.

The general direction of auricular activation is represented by a vector, the orientation of which on the horizontal plane (ÂP) and in space (SÂP) gives us information about the sinistro-dextral, cranial-caudal and dorso-ventral components of the activation.

In pigs, numerous data exist about the direction of the ventricular activation front (2, 4). However, information on the average direction of the auricular activation front is sparse.

Furthermore, since the mean spatial vector of auricular activation represents the algebraic sum of the dipoles originated by the passing of the activation wave through the auricular myocardium, the changes in its orientation could be representative of alterations in thickness of the auricular walls. It is therefore deemed necessary to analyse the orientation of the mean cardiac vectors of auricular activation and establish the possible influence that physical maturation has on them.

Materials and Methods

This study was carried out on 30 Landrace X White Belgian pigs, of both sexes

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(17 males, 13 females), apparently healthy and reared in intensive diet conditions. The experimental groups and ECG were as described (15).

All the registers were made with the animal in standing position, and in their customary environment, taking care that the extremities were all in line and observations were started when the animals showed no sign of excitement.

The direction of the electrical activity was symbolized by vectors. For that, the preferential direction which followed the auricular depolarization was indicated by the P mean vector (ÂP).

The magnitude of the P mean vector is calculated by measuring the positive or negative amplitude of the auricular activation wave obtained in each lead (I and aVF) and plotting them on the respective axes (X and Y). To determine the magnitude of P mean spatial vector the amplitude of P wave in lead V_{10} was considered and this value represented on a new axis (Z axis).

The magnitudes of the P mean vector on the horizontal plane (V) and in space (V') were determined by the equations given by VAN ARSDEL *et al.* (18).

It is possible to establish the ÂP position (left or right, and cranial or caudal) by dividing the horizontal plane in 360° (9) and determining the angles that it made with the X axis. The angle that the spatial vector (SÂP) makes with the Z axis shows, moreover, its position in dorso-ventral direction (9). Both angles can be determined geometrically (fig. 1).

In order to find out the influence of age, analyses of variance and, subsequently, a Q-test were carried out.

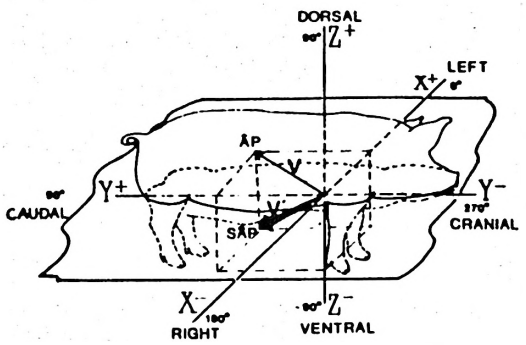

Fig. 1. *Representation of P vector on the horizontal plane (ÂP) and at space (SÂP).*

Results

The mean values obtained for the magnitude of the auricular activation vector on the horizontal plane (VÂP) and in space (V'SÂP) from each age analyzed are plotted in fig. 2. The lowest values were obtained at 5 days of age for both VÂP and V'SÂP (0.099 and 0.133 mV respectively). On the contrary, the highest value of VÂP belongs to the 20 days of age group (0.153 mV), and for V'SÂP to individuals of 4.5 months old (0.193 mV). For these parameters the analysis of variance indicates a very significant variation ($p \leq 0.001$) in the group of individuals for both magnitudes ($F[6, 203] = 10{,}367$ and $F[6, 203] = 12{,}387$ for V and V' respectively). The

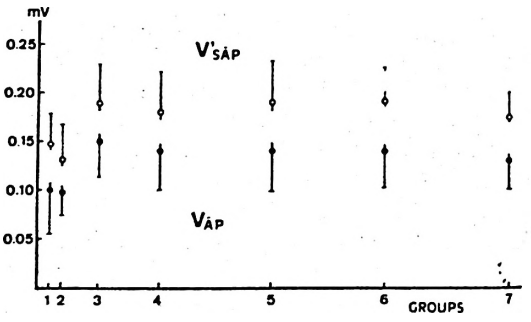

Fig. 2. *Representation of V and V' vectorial magnitudes (media ± SD) for each age analyzed.* Groups 1 to 7 refer to different steps of maturation; 1 = 1 day; 2 = 5 days; 3 = 20 days; 4 = 45 days; 5 = 3 months; 6 = 4.5 months; 7 = 6 months.

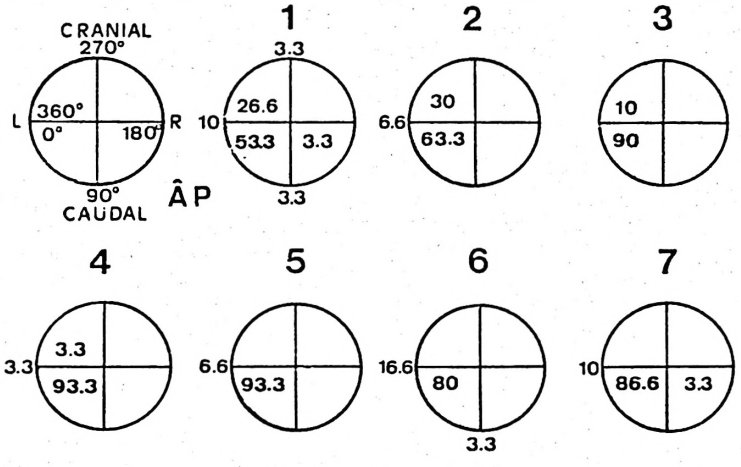

Fig. 3. *Percentage of each of the possible orientations of the auricular activation vector (ÂP) on the horizontal plane in each age group analyzed.*
The shaded area shows the most frequent orientation. Numbers 1 to 7 as in fig. 2.

Q-test carried out subsequently permitted the confirmation that differences in the ÂP magnitude (V) appear when the 1-day and 5-day groups are compared with the remaining groups, and also between the 20-day and 45-day groups. In relation to the SÂP magnitude (V') significant differences between pigs of 1 and 5 days old and the remaining older ones were observed.

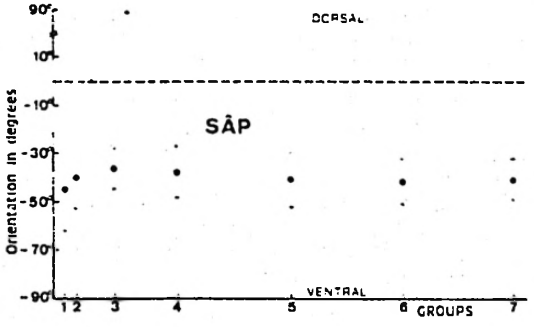

Fig. 4. *P spatial vector orientation (media ± SD) in dorso-ventral direction for each age analyzed.*
Numbers 1 to 7 as in fig. 2.

The percentages obtained for the different orientations of the P mean vector in the horizontal plane (ÂP) are represented in fig. 3. In spite of a considerable percentage of sinistro-craneal orientation in younger individuals (1 to 20 days old), in all groups analyzed there is a predominance of the sinistro-caudal orientation with values ranging from 53.3 % (1 day) to 93.33 % (45 days and 3 months).

The plot of the SÂP mean values in dorso-ventral direction (fig. 4) indicates that the vector takes a ventral direction in all groups analyzed with values ranging from −35° in group of 20 days to −44° in 1 day old pigs.

Discussion

In the first two age groups it was observed that both ÂP and SÂP magnitudes (V and V') were significantly lower than those of the older age groups, and these parameters experience an increase parallel to the physical maturation, coinciding

with the results obtained for the P wave amplitude (14). This increase becomes more obvious between 5 and 20 days of age. These results are contrary to those found in ovines (17) in which a progressive decrease in V and V′ values is observed with age.

The results obtained for ÂP orientation indicate that in a considerable percentage of 1 to 5-day old individuals the auricular activation front spreads towards the left and cranially. This orientation that already disappears in 3 month-old individuals, could be attributed to the cardiocirculatory alterations undergone after birth (8). Nevertheless, a sinistro-caudal orientation predominates in all individuals and is maintained from birth until 6 months of age, coinciding with data given for other species (16-18).

In dorso-ventral direction the SÂP orientation indicates that the auricular activation front spreads in a slightly ventral direction which has also been observed in other species (5, 6, 10, 16, 17) that belong to the same electrocardiographic category. However, whilst in cattle the ventral direction is more accentuated with physical maturation (18), in pigs, as in ovines (17), the SÂP orientation is not affected by age and is maintained slightly ventral in all age groups studied by us.

The orientation of the P mean vector on the horizontal plane and in space also confirms the data given for pigs by other authors (1, 12, 13) who carried out their studies in animals of different breeds and ages, and with HAMLIN *et al.* (7) who indicate that during the final 45 ms of the auricular activation time a vector directed caudally and ventrally towards the left is originated.

It can be affirmed that in pigs the sequence of the auricular activation is already determined at birth, and the differences observed in any individuals during the first 20 days of life could be attributed to the cardiocirculatory changes after birth, but not to the physical maturation.

Resumen

Se analizan los efectos de la maduración cardíaca sobre la orientación de los vectores medios de activación auricular (ÂP y SÂP) en cerdos Landrace X Blanco Belga. Las magnitudes de ÂP y SÂP experimentan un incremento significativo entre los 5 y los 20 días de edad. Por el contrario, la maduración física no parece tener ningún efecto en la secuencia de activación auricular; puesto que, en todos los grupos de edad estudiados, se mantiene la misma orientación para los vectores de P en el plano horizontal y en el espacio. Ambos vectores indican que el frente de activación auricular se dirige predominantemente hacia la izquierda, caudal y ventralmente. No obstante, en un elevado porcentaje de individuos de edades comprendidas entre 1 y 4 días, el vector de activación auricular se dirige hacia la izquierda y cranealmente.

Palabras clave: ECG, Vector P, Edad, Cerdo.

References

1. Dukes, T. W. and Szabuniewicz, M.: *Can. J. Comp. Med.*, 33, 118-127, 1969.
2. Hamlin, R. L.: *Am. J. Physiol.*,, 198, 537-542, 1960.
3. Hamlin, R. L. and Smith, C. R.: *Am. J. Vet. Res.*, 21, 701-708, 1960.
4. Hamlin, R. L. and Smith, C. R.: *Ann. N. Y. Acad. Sci.*, 127, 195-203, 1965.
5. Hamlin, R. L., Himes, J. A., Guttridge, H. and Kirkham, W.: *Am. J. Vet. Res.*, 31, 1027-1031, 1970.
6. Hamlin, R. L., Ridgway, S. H. and Gilmartin, W. G.: *Am. J. Vet. Res.*, 33, 867-875, 1972.
7. Hamlin, R. L., Russell, R. B., Leverett, S. D. and Burns, J. W.: *J. Electrocardiol.*, 7, 155-162, 1974.
8. Heymann, M. A., Iwamoto, H. S. and Rudolph, A. M.: *Ann. Rev. Physiol.*, 43, 371-383, 1981.
9. Holmes, J. R.: *Equine Vet. J.*, 1, 1-3, 1969.
10. Muylle, E. and Oyaert, W.: *Equine Vet. J.*, 4, 129-136, 1972.
11. Muylle, E. and Oyaert, W.: *Zbl. Vet. Med. A*, 22, 474-484, 1975.
12. Nakano, M.: *Bull. Nippon Vet. Zootech. Coll.*, 22, 84-115, 1973.
13. Ohi, S., Fujiwara, K. and Sesaki, K.: *Bull. Coll. Agric. Utsunomiya Univ.*, 8, 87-96, 1973.
14. Rubio, M. D.: Evolución ontogénica de las variaciones electrocardiográficas de la especie

porcina (*Sus scrofa*). Tesis Doctoral. Facultad de Veterinaria, Córdoba, 1987.
15. Rubio, M. D., Castejón, F., Tovar, P., Ibáñez, J. and Santisteban, R.: *Rev. esp. Fisiol.*, 45, 145-150, 1989.
16. Santisteban, R.: Estudio electrocardiográfico en bovinos Holstein-Frisia. Tesis Doctoral. Facultad de Veterinaria, Córdoba, 1984.
17. Tovar, P. and Santisteban, R.: *J. Vet. Med. A*, 34, 13-17, 1987.
18. Van Arsdel, Wm. C., Krueger, H. and Bogart, R.: *Am. J. Vet. Res.*, 24, 956-963, 1963.