IV. PEDIATRIC SURGERY

MODIFICATIONS OF TESTICULAR OXYGEN SATURATION (SpO_2) IN EXPERIMENTAL ORCHIOPEXY

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Abstract
When performing orchiopexy in undescended testicle, an essential demand for the gonad functionality and viability is the absence of tension in the spermatic cord. Currently it is not fully known the relation between spermatic cord elongation and testicular perfusion; this paper aims to study the above mentioned aspects by determining oxygen saturation (SpO_2) in the testicles as compared with the spermatic cord elongation.
Key words: orchiopexy, spermatic cord elongation, testicular oxygenation.

Introduction
Testicular migration anomalies are mentioned in the literature since Galen and Vesalius, the empty scrotum representing an important source of anxiety accompanied by disorders of behavioral development and body scheme. On birth, both testicles must be placed in the bursae (in 3-4% of cases, this is not occurring). If this is not the situation, one may wait at most a year (the incidence drops to 1%), and after that, during the second year of life, surgical descent of the testes should be performed (electronic microscopy studies reveal anatomopathologic modifications in the undescended testicle as early as from 1 year of age). Surgical orchiopexy must be performed by a surgeon trained in pediatric surgery, familiarized with child's delicate anatomic structures. There is no use to wait if testicular ectopia is accompanied by inguinoscrotal hernia, and the surgery must be performed immediately. Any testis that remains outside the bursa has a high risk of malignant transformation, the higher retention in the abdomen, the more frequent occurrence.

Regarding strictly aspects of therapeutic conduct in undescended testis, we mention that palpable testis in the inguinal canal or in the pubis area can be brought in the bursa by simple surgical procedures.

In infant, all the testes disposed distally of the internal orifice of the inguinal canal and half of the abdominal testes can be descended by simple orchiopexy, when using proper technique. Because of the reduced size of inguinal region and scrotum, testis descent is performed without great difficulties, retroperitoneal mobilization of spermatic vessels being rarely necessary. Even though at this age the vaginal process is an extremely delicate membrane and its mobilization from the elements of funiculum difficult, the orchiopexy is possible and safe for experienced surgeons. Although surgical risk is higher for the small child, as far as pathological changes in the undescended testis concerns, the orchiopexy should be performed before the age of two years.

In newborn and suckling babies, even high abdominal testes can be brought in scrotum, while post puberty, due to the increase of inguinal, pubian and scrotal regions size, the simple orchipoexy sometimes fails even under the circumstances in which the testicles are disposed in the inguinal canal.

In the case of testis retained in a high position in the abdomen, performing classic orchiopexy is limited by the length of spermatic vessels so that the testis can be descended only by vascular microsurgery techniques. Orchiopexy techniques in two operating sequences or with the previous section of spermatic vessels - Fowler-Stepens technique – can be successful in certain situations, but carry the risk of testicular atrophy. In 5% of the cases, the very short vascular pedicle does not allow the performing of conventional orchiopexy techniques. Under these circumstances, the microsurgery techniques are used.

The term "orchiopexy" is derived from the Greek word pexis - fixation, even though the essential sequences of operation are the hernial sac resection, spermatic vessels dissection and supra-pubian transposition of cord elements, procedures by which the testis is brought in the scrotum. The orchiopexy it is not a surgical intervention without difficulties, requiring a proper technique, experience and a lot of patience. Postoperatory testicular atrophy, in some older statistics, reaches up to 35%, while the most optimistic statistics mention postoperatory testicular atrophy in 1-2% of the cases. Only after hernioraphy performed before the age of one year, the testicular atrophy is mentioned in 2% of the cases.

Correctly performed orchiopexy means to respect the following principles:

- Taking into account that most of the undescended testes are placed in the inguinal canal, the incision must offer a good approach of it;

- The spermatic cord will be dissected cleanly, as higher as possible, without harming its elements;
- To obtain an adequate length of spermatic cord, the resection of the rest of the peritoneovaginal canal is absolutely necessary;
- If the testis presents modifications in consistency, sizes and aspect, testicular biopsy will be performed;
- Tunelization of the scrotum descent route must be the shortest possible;
- The testis will be descended in the scrotum as lower as possible, on the same side (homolateral orchiopexy), in a pocket created between skin and dartos;
- When performing the testicular descent it is vital to avoid the torsion of spermatic cord;
- *An essential demand for the gonad functionality and viability is the absence of tension in the spermatic cord;*
- To avoid the subsequent ascend or torsion, the descended testis will be fixed to dartos with unresorbable suture material passed through albugineae;
- Rebuilding of the inguinal canal will be performed so that to not weaken the abdominal wall architecture, but also to not hamper the blood circulationin the descended testicle.

Objectives

Although is known that the tension in the spermatic cord should be avoided when performing orchiopexy (risk of subsequent gland atrophy), the relation between spermatic cord elongation and testicular perfusion it is not fully known, the present paper aiming to study these aspects.

Material and method

To perform the experiment, we studied a lot of 10 adult male dogs of different sizes, in which, by the means of a pulsoximeter, we have measured the variations in oxygen saturation at the site of penetration of vesselsin the testicular parenchyma, depending on the elongation degree of spermatic cord.

Under conditions of general anesthesia isolation and disinfection of scrotal teguments was performed. By a longitudinal incision that included the vaginal tunica (fig. 1), we opened the left scrotal bursa and exteriorized the testis suspended by the spermatic cord (fig. 2).

Fig. 1. The longitudinal incision of the scrotum.

Fig. 2. The testis suspended by the spermatic cord.

We passed a thread through albuginea on the free testicular margin for anchorage, with a marker, we established two marks on the spermatic cord at 2 cm distance and we placed the pulsoximeter sensor at the terminal side of the spermatic cord (fig. 3). We recorded the oxygen saturation, then we performed an elongation of the cord, so that the distance between the marks to increase by 1 mm (a 5% elongation), and after a minute, we measured the oxygen saturation; we repeated the process after each 1 mm elongation until the oxygen saturation could not be recorded (fig. 4). The same measurements were performed in the right testis, repeating the process in each specimen (a total of 20 testicles).

Fig. 3. Establishing two marks on the spermatic cord at 2 cm distance.

Fig. 4. SpO_2 determination.

Results and discussions

Values of oxygen saturation, cardiac frequency and elongation are detailed in the following table:

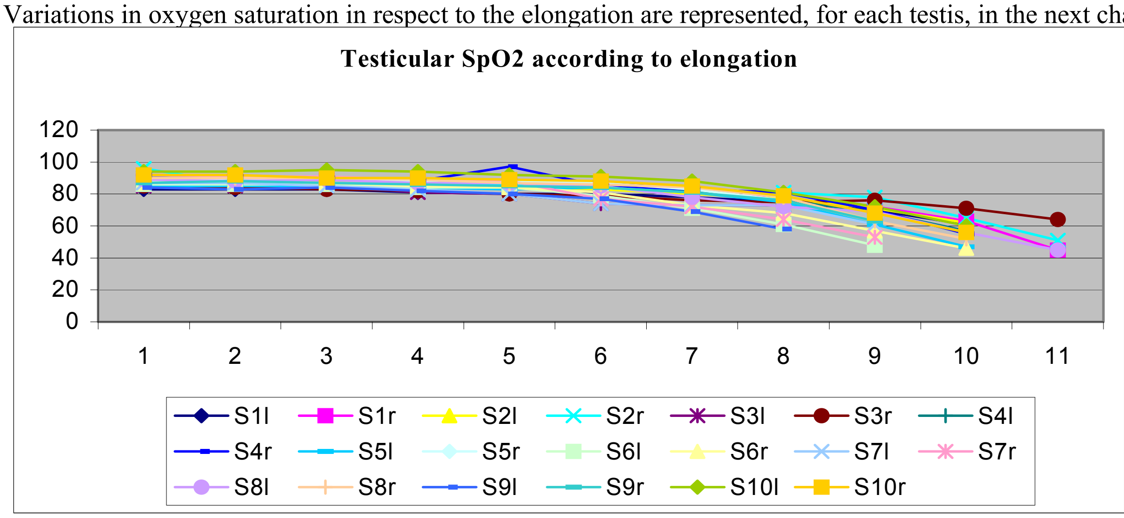
Elong.	S1l	S1r	S2l	S2r	S3l	S3r	S4l	S4r	S5l	S5r	S6l	S6r	S7l	S7r	S8l	S8r	S9l	S9r	S10l	S10r
0%	83	88	87	96	85	85	90	92	85	88	86	87	87	92	89	90	84	87	94	92
5%	83	88	87	87	85	84	90	91	85	90	86	88	87	91	88	90	83	88	94	92
10%	83	89	85	86	85	83	90	90	85	89	86	87	85	91	89	90	84	87	95	90
15%	81	88	85	86	81	82	89	88	84	88	84	85	83	89	87	89	82	86	94	90
20%	80	86	85	86	80	80	88	97	83	88	84	84	80	88	87	87	80	85	92	89
25%	80	84	83	84	74	79	88	85	84	87	79	81	74	77	85	86	77	84	91	88
30%	78	81	80	82	73	76	82	83	81	83	71	73	73	72	78	84	69	81	88	85
35%	75	77	77	81	73	75	76	81	75	76	61	68	73	64	72	78	58	76	81	79
40%	70	72	71	78		76	69	70	61		48	57	61	53	69	63		63	72	68
45%	61	63	62	65		71	57	55	47			46			56	52			60	56
50%		45		51		64									45					

S1……S10 = number of subject.

r = right testicle.

l = left testicle.

Variations in oxygen saturation in respect to the elongation are represented, for each testis, in the next chart:



It can be seen that there is not a linear variation of oxygenation in respect to the elongation of the spermatic cord. Up to 30-35% elongation, the oxygenation is relatively constant, followed by an interval in which oxygenation drops down dramatically (up to 65-70% elongation), after that becoming undeterminable, indicating the interruption of testicular perfusion. By inducing tachycardia (due to the pain caused by elongation in the case of an insufficient anesthesia) maintenance of the same oxygenation is possible even in greater elongation.

To explain this behavior of oxygenation level in respect to the spermatic cord elongation, we studied the disposal of spermatic artery in this site. We discovered the spermatic cord following the above mentioned procedure, and after that, at the profound orifice of inguinal canal, we isolated the spermatic artery from the rest of cord elements and catheterized it (fig. 5), then we performed an arteriography using iopamiro 370 (fig. 6).

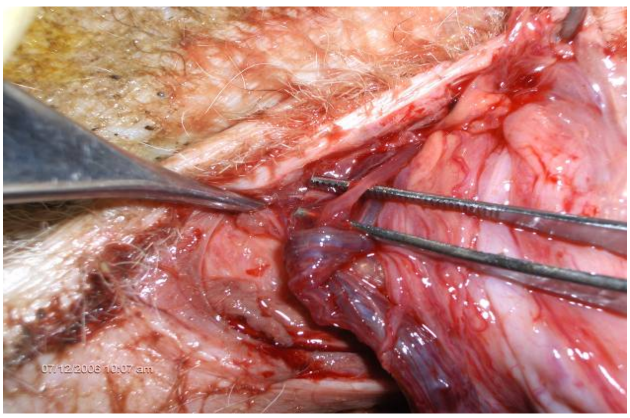


Fig. 5. The spermatic artery.

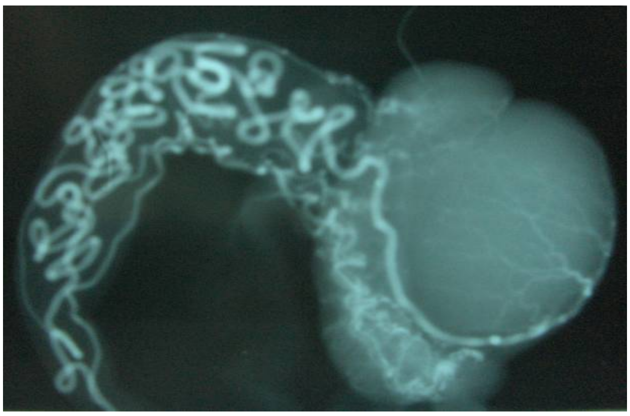


Fig. 6. The arteriography of the spermatic artery.

Sinuous disposal of artery in the spermatic cord is observed, so that by its elongation it is possible in a first phase to maintain the oxygenation close to the normal level by unfolding the artery without affecting its caliber.

Conclusions

1. Testicular oxygenation does not vary linearly in relation with the spermatic cord elongation:

- recording a plateau phase;
- followed by an unlinear descending slope.

2. Elongations of 30-35% of the spermatic cord have no significant impact on the tissue perfusion.

3. A good oxygenation can be achieved even in greater elongation by increasing the cardiac frequency.

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