INTRAOPERATIVE EVALUATION OF BOWEL VIABILITY

COMPARATIVE EXPERIMENTAL STUDY THROUGH THREE METHODS

Summary:
Background: The intraoperative assessment of intestinal viability when dealing with ischemic bowel remains a challenge. The purpose of this study was intraoperative assessment of bowel viability in strangulated intestinal obstructions. The accuracy of this assessment allows avoiding useless intestinal resections and consequently the secondary morbidity and mortality.

Study design: This is an experimental study using the canine experimental model. Bowel viability was assessed in four dogs before and after mesenteric arterial ligation in a 10 cm (length) segments of jejunum and colon. We have used three methods: visual- traditional method, computerized analysis of test with fluorescein and measurement of the oxygen saturation of intestinal segments by pulse oximetry. Determination of the bowel ischemia after vascular ligatures was made at intervals of 10, 30 and 60 minutes. The last determination being made at 24 hours postoperatively by relaparotomy.

Results: The analysis of results reveals a high degree of subjectivism for the visual assessment of the degree of bowel ischemia, which could cause severe decisional errors. By assessing the standard deviation of the results obtained through the three methods, similar results were found through computerizing fluorometry and pulse oximetry.

Conclusions: This experimental study showed that the pulse oximetry and fluorometry represent efficient and objective methods in assessment of the ischemic modifications at the intestinal wall in strangulated intestinal obstructions. Pulse oximetry is the preferred alternative for objective intraoperative assessment of intestinal viability because is easy to interpret and repeat, is well tolerated and help preserve bowel of doubtful viability.

Key-words: intraoperative pulse oximetry, intestinal viability, dog.
Background

In the case of mechanic occlusions by strangulation (hernias and strangulated eventration) and by intestinal volvulus, it is produced a significant ischemia at the level of the intestinal wall as a result of the consecutive vascular disorders. Assessment of bowel viability in cases with bowel ischemic lesions continues to remain one of the important intraoperatively moments. The accuracy of this assessment allows avoiding useless intestinal resections and consequently the secondary morbidity and mortality.

The accepted methods for intraoperative assessment of the intestinal vascularization are represented by the clinical criteria, the Doppler ultrasound, the test with intravenous fluorescein and intestinal surface pulse oximetry (1,2,3,4).

Some of these methods have the disadvantage of the subjective assessment, while others are laborious (5).

Purpose of the study

In this study we made a comparative evaluation of three intraoperative assessment methods of the bowel viability represented by the visual method, the computerized analysis of the perfusion with fluorescein and intestinal transserosal pulse oximetry.

Materials and method

The experimental study was performed using the canine experimental model. The batch taken to study included four mongrel dogs to which we assessed the degree of tissue perfusion of some unharmed intestinal segments, of approximately 10 cm, located in the small intestine and the colon.

The animal’s preparation

The immobilization of the animals was made in dorsal decubitus, followed by local preparation, consisting of hair removal at the level of the abdominal wall and tegument disinfection with betadine.

It was used general anesthesia in order to create an optimum intraoperative comfort. For this we preferred the narco – neuroleptic- analgesic anesthesia type. The used anesthetics were acetylpromazine in dosage of 0.04 mg x kg, ketamine in dosage of 5 mg x kg, sodic tiamilal in dosage of 10 mg x kg and halothane 1%.

The anesthesia was well tolerated and the awakening was very good. The anesthetic and operating technique was identical for all the dogs.

The bowel ischemia of the studied intestinal segments was obtained through the ligature of the convergent vascular arcades and of the ones located at the level of the proximal and distal ends of each intestinal segment. The assessment of the tissue perfusion was made before and after the ligature of the vascular arcades.

The bowel viability assessment was made using three methods represented by:
- visual assessment of the color, pulsation and motility modifications;
- computerized analysis of the test with fluorescein (fluorometry) (4,5,6);
- bowel surface pulse oximetry (1,2,6,7).

The intraoperative bowel pulse oximetry was made using a Minimon 7133 B (Kotron Instruments Ltd. England) monitor having a digital type sensor.

Experimental study

To all the dogs taken into study the determination of the bowel viability by the three methods was made initially and then after applying the vascular ligatures at intervals of 10, 30 and 60 minutes, the last determination being made at 24 hours postoperative.

The visual assessment of the bowel viability was made after the infiltration of the mezentery with xilocaine 1% and after having rapped the loops in compresses with warm physiologic serum.

The results of the visual assessments of the color modifications, motility and pulsation of the intestinal loop were classified in five stages;
- normal = ischemia degree 0 %;
- minor = ischemia degree 5 %;
- moderate = ischemia degree 15 %;
- increased = ischemia degree 30 %;
- severe = ischemia degree 45 %.

The data obtained as a result of assessments through pulse oximetry represent a percentage value of the oxygen saturation of the intestinal surface on which the digital sensor was placed - % SaO₂. After making the computerized analysis of the fluorescein test we obtained values that represent a percentage ratio of the ischemic surface form the whole examined area.

With the help of the Spearman rank test were made correlations between the three intra-operating assessment methods of the bowel ischemia.

Results

The results of the comparative evaluation of the bowel ischemia before and after the vascular ligature of the four dogs included in the study are presented in the table1 as an arithmetic mean.
The visual assessment of the jejunum and of the healthy colon to all the four dogs from the studied experimental lot was normal, the ischemia degree being 0%. The values of the test with fluorescein varied between 0% and 0.11%. The saturation in oxygen of the healthy loops had values between 94% and 98%. These values are consistent to the data from the literature reported for the canine model. (7,8,9).

In an interval of 10 minutes from inducing the bowel ischemia by vascular ligatures, we find a moderate to high ischemia degree (18.75% – 26%) by visual appreciation. The values obtained by analysis with fluorescein at the two intestinal sites were of 8.7% respectively 9.3%, and through intestinal surface pulse oximetry SO2 were 88% respectively 89%. These values correspond to a minor degree of tissue hypoperfusion, the modifications at ultrastructural level being reversible. (10,11)

The determinations made in interval of 30 minutes from the ischemic interval, revealed the considerable increase of the degree of bowel ischemia. The fluorometry revealed increased values of 13.4% respectively 14.1%. In the same time, intestinal pulse oximetry reveals decreased values of intestinal saturation in oxygen, 81.5% at the small bowel and 80% at the colon. This results have the significance of an important ischemia followed by lesions with irreversibility tendency. The visual assessment of the bowel ischemia within a 30 minutes interval was above the instrumentally recorded values being assessed as increased to severe.

The records made within one hour and 24 hours revealed an ascending curve consistent to the increase of the severity of the bowel ischemia. At the same time we find a decrease of the evaluation differences between the three methods. The visual method revealed a severe bowel ischemia (over 45%). Through the determinations obtained by fluorometry and pulse oximetry the obtained values were of 19.2% respectively 20.8%, and SaO2 were under 65%, which allowed the interpretation of the bowel ischemia as being high.

Values of intestinal SaO2 under 65% were not recorded by the pulse oximeter sensor which explained the absence of those values from table 1.

The higher values of the ischemia degree recorded at the level of the colon segments in relation with the ones of the small intestine can be explained by the disposal of the vascularization at the colon level.

By calculating the standard deviation of the results obtained through the three methods it was found the increased subjectivity degree for the visual assessment of the degree of bowel ischemia.

Analyzing the standard deviation of the parameters obtained on each intestinal segment and using the Spearman’s test results we found an important correlation ($r=0.934$ and $p=0.001$) between the fluorescein and pulse oximetry method in assessing the degree of bowel ischemia.

The ways to obtain the bowel ischemia by ligature of the converging vascular arcades and of the proximal and distal located arcades at the ends of each bowel segment, can explain the recorded differences between the fluorescein and pulse oximetry method. By vascular obliteration and the subsequent ischemic modifications, in the ischemic bowel segment it is retained a quantity of fluorescein that is drained more slowly which explains

<table>
<thead>
<tr>
<th>Bowl segment</th>
<th>Method (%)</th>
<th>Time - minutes</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>0 min</td>
<td>10 min</td>
</tr>
<tr>
<td>Small bowel</td>
<td>Visual</td>
<td>0</td>
</tr>
<tr>
<td></td>
<td>Fluorescein</td>
<td>0</td>
</tr>
<tr>
<td></td>
<td>Oximetry</td>
<td>96,5</td>
</tr>
<tr>
<td>Large bowel</td>
<td>visual</td>
<td>0</td>
</tr>
<tr>
<td></td>
<td>fluorescein</td>
<td>0,11</td>
</tr>
<tr>
<td></td>
<td>oximetry</td>
<td>94</td>
</tr>
<tr>
<td>Standard deviation</td>
<td>visual</td>
<td>1,36</td>
</tr>
<tr>
<td></td>
<td>fluorescein</td>
<td>0</td>
</tr>
<tr>
<td></td>
<td>oximetry</td>
<td>0,57</td>
</tr>
</tbody>
</table>

* values under 65% was not registered by the sensor

Table 1. Results of evaluation of intestinal viability through three methods
the smaller values of the ischemia degree, registered in the first 30 – 60 minutes. The method of determination of the oxygen saturation of the ischemic bowel segments is not influenced from this point of view, making a true assessment of the ischemia degree.

Conclusions

The experimental study that was made shows that the pulse oximetry and the fluorometry represent efficient and objective methods in assessment of the ischemic modifications at the level of the bowel loops. Determining the bowel viability through easy technical pulse oximetry, easy to interpret and to repeat and at the same time it is well tolerated. (1,2,4,12)

The pulse oximetry is the preferred alternative to the visual assessment for estimation of the intraoperative bowel viability, because the visual method is subjective and submitted to an increased risk of mistaken evaluation. (1,2)

Intraoperative assessment of bowel ischemia by pulse oximetry avoids the risk of useless bowel resections.

References:
6. Tank P.H., Balasubramanian N.N., David W.P. - Assessment of standard clinical criteria and fluorescein dye technique for intraoperative prediction of small intestinal viability in dogs. Indian Journals of Veterinary Surgery 2003; 24(2); 83-88.