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A New Criterion for the Vitality of Organs is the Junction Phenomenon of the Contralateral Arterial Flows

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Abstract--- Relevance: *The detected phenomenon of the junction of contralateral arterial flow is of particular importance for the creation of various blood flow models in necrosis and ischemic pathology, for the assessment of the vitality of organs in various operations, for the prevention of necrosis, stitches and anastomoses failure, paresis, ischemic enteritis and colitis.*

Target: *Develop an effective clinical criterion for determining the viability of organs in surgical pathology during surgery and without surgery.*

Materials and method: *Retrospective study was carried out (level of evidence - "2"). 941 patients had a new criterion for organ viability based on a change in the spectrum of arterial arcs. All patients were divided into two groups, the first group with the viability of the organs (464 people), and the second group - patients with non-viable organs in various surgical pathology (477 people).*

Conclusion: *We proposed and developed a new clinical method for determining the viability of the small intestine without operational intervention. The gut is considered viable in the presence of contralateral intramural blood flow during ultrasound in mirror reflection. During the operation, a new clinical method for preventing the failure of intestinal stumps was developed by applying purse-string suture in the junction of contralateral intramural vessels; at the same time the threads of the purse-string suture are carried out over visible intramural vessels. The phenomenon of the junction of contralateral arterial flows proved to be effective in surgery, and can also be used in other areas, for example, with drip irrigation.*

Keywords--- *Junction of Contralateral Arterial Flows, Determination of the Viability of the Intestine, Ultrasound Examination.*

I. RELEVANCE

To date, there are the unresolved problems of determining the vitality of organs, the prevention of ischemic complications, the incapacity of sutures, the anastomoses and the intestinal stumps in surgery. The late diagnosis may cause the patient's death and a high mortality rate continues to be an issue. The improvement of the results of surgical treatment remains the subject of scientific researches and discussions [1,2,3].

The ischemic lesions caused by the ileus are accompanied by the high mortality rate (75-100%) [4,5]. Due to the development of ischemic lesions, the most common cause of postoperative peritonitis is the incapacity of the

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anastomosis sutures (34-80, 5%). The next two reasons for it are the intra-abdominal abscess complicated by a breakthrough into the free abdominal cavity (23.9%) and the necrosis of wall of the hollow organs (11.6%) [6].

In surgery the vitality of organs is determined clinically and instrumentally at the current stage. The criterion of the vitality is the color of the serous membrane, the frequency of the intestinal peristalsis and the pulsation of blood vessels [7,8,9]. There are the instrumental methods of determining of the viability, these are the pH measurement, the thermal thermometry, the pigmental endoscopic anatomy of seminal tract washout, the transilluminational endoscopic anatomy of seminal tract washout, the fluorescence analysis, the laser Doppler flow metry, the computerized tomography and the ultrasonic method. [9,10,11,12].

Since the risk of complications and mortality rate is high, the modern effective methods of determining the vitality of intestine are not enough for its preservation and recovery of the patients.

Target

To propose and create the effective clinical criterion of the vitality of organs in surgical pathology during the surgery and without operative treatment.

II. MATERIALS AND METHODS

In this research based on the changes of the spectrum of arterial arcs 941 patients in health (464 people) and disease (477 people) have showed a new criterion of the vitality of organs in this research (table1).

Table 1: The Surgical Diseases

Nosology:	A number of patients
Strangulated ileus	37
Duodenal ulcer	51
Acute cholecystitis	260
Arterial sclerosis	129
Total number:	477

The diagnostic methods of the tissue vitality including x-ray, ultrasonic, cytological and morphological researches were held to all the patients.

In determining of the vitality of organs at the junction of the contralateral flows (in the projection of arterial arcs of the various vessels), the authors obtained contralateral blood flow with its mirror reflection below the basal line with the presence of systolic peaks, constant multidirectional signals, with signs of arterial blood flow on spectral echograms with a diastolic component having a height of at least 1 mm high and no more than 2/3 of the systolic component [13].

To preserve the vitality of intestine after the operative treatment, the prevention of the incapacity of intestinal stumps were held by putting in a purse-string suture with the intestine's ligation, retreating 0,5-1,0 cm from the junction of the contralateral intramural vessels. The purse-string suture was put in in the area of the junction of these vessels and the thread of the pouch was carried out over the visible intramural vessels [15]. (pic. 1 a, b).

The optometry for the recording of the hemodynamic parameters in order to determine the vitality of organs was held using the device and method of Z. M. Sigal [24]. The electrocardiographs as "ELKAR-6" or EK1T – OZM with

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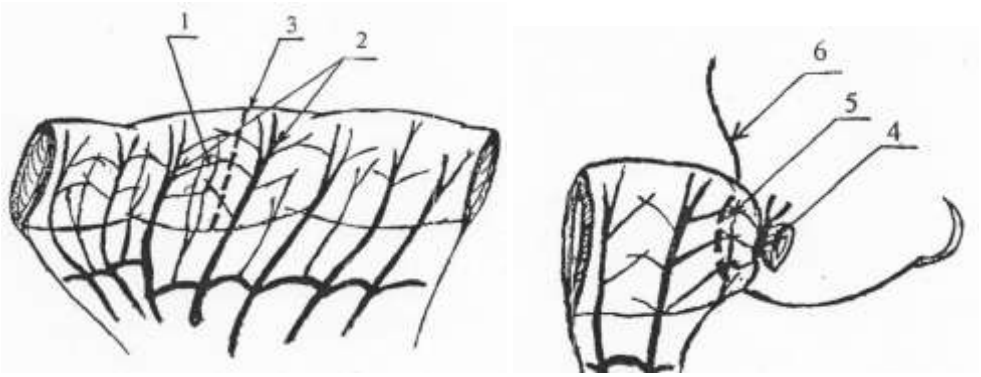
amplification of the electrical signals 10 and 20 mm/mV were used as the graphic recording devices. The speed of the paper tape 5 mm/sec was used to record simultaneously the hemodynamics parameters and motor skills parameters. The topographic monitoring was held by fixing the recording device, by superposing it to the studied area during the research.



a) b)

Pic. 1: a, b. The prevention method of the incapacity of intestinal stumps: 1 - the junction of vessels 2 - 0,5-1,0 cm from the junction of the vessels, 3 - a place of the resection of vessels, 4 - the mobilization of the intestine, 5 - a putting in of a purse-string suture in the junction of the contralateral intramural vessels, 6 - the thread of the pouch over the visible intramural vessels.4

The statistical processing of data was carried out in the program "Statistica". ROC-analysis has been performed to determine the area under the curve of sensitivity and specificity, positive and negative likelihood ratio, indicating their 95% confidence intervals. According to Oxford classification [16] of the conclusiveness of scientific evidence, the level of conclusiveness of the research can be estimated as «2», and the recommendations on the results of the research can be classified as «B». All researches in patients were held with their full awareness and consent with the written voluntary informed consent of the patient to perform an invasive research, intervention, operation in accordance with the articles 30, 31, 32, 33 of the «Fundamental Principles of Legislation of the Russian Federation concerning the security of residents» dated 22 July 1993 No. 5487-1.

III. CONCLUSION

Using the original methods of the intravital pigmental transilluminational endoscopic anatomy of seminal tract washout, angiotensometry, Z. M. Sigal discovered a new phenomenon of the interaction of arterial flows in intra-organ and extra-organ vessels [17-21]. The blood supply of organs and tissues is carried out by two sources. The blood circulation of the head is provided by the right and left internal carotid and vertebral arteries that are found in the circle of Willis. The external carotid arteries appear in anastomoses on the face, tongue, and thyroid. The interaction of arterial flows in the abdominal cavity is carried out in the perigastric arcs between the branches of mesenteric arteries and in the arcade vessels. On the extremities, the phenomenon of interaction was found in deep and superficial arterial arcs. This is registered in the experiment and clinic in pictures, films, and ultrasonic monitoring.

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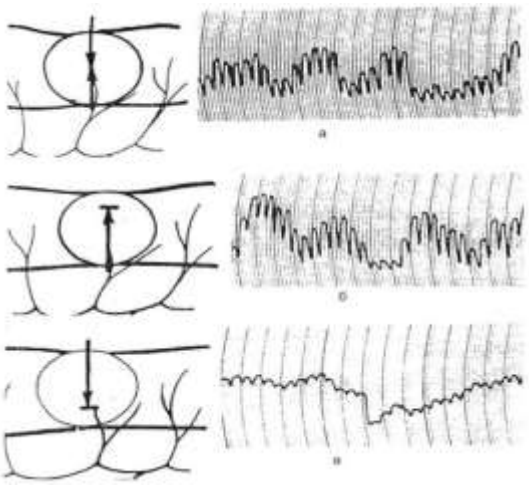
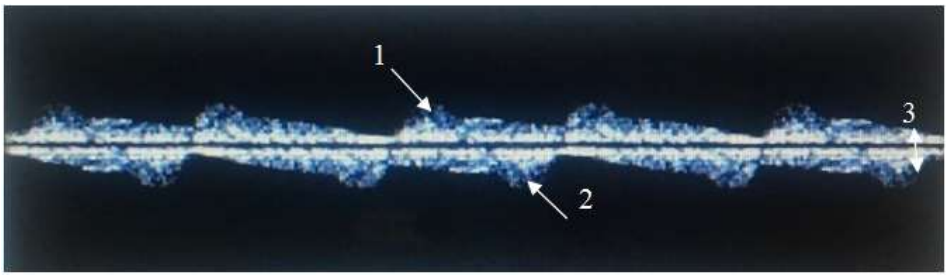
One of the functions of the interaction of oppositely directed arterial flows is to achieve the uniformity of the blood supply of individual links. The next function is to compensate for the energy depletion of the flow. The paired blood supply was found along with the paired organs. The orthograde and retrograde oppositely directed flows were found in different areas along with resultant directions. (pic. 2).



Pic. 2: Arterial Flows of the Intact Small Intestine: a - Total, b - Mesenteric, c - Antimesenteric

To detect timely surgical pathology, it is necessary to know the spectral blood flow in the normal arterial arcs. In patients, while ultrasonic examination in the projection of normal arterial arcs of parenchymal branches of the renal artery, a two-directional spectrum of the curve has been obtained, which corresponds to the collision of flows into the artery. The blood flow spectrum below and distal to the arterial arcs changes its direction, taking a unidirectional movement with saving or increasing in the blood flow speed (pic 3).



Pic. 3: The Junction of the Contralateral Arterial Flows at the Level of Normal Arterial Arcs of Parenchymal Branches of the Renal Artery: 1 – a Systolic Component, 2 – a Diastolic Component, 3 – a Junction of the Contralateral Arterial Flows

Using the ultrasonic monitoring of intramural vessels in the projection of arterial arcs of the viable small intestine, one obtained a multidirectional blood flow that corresponds to the junction of the interaction of contralateral arterial flows. This interaction can be observed in the projection of the arcade vessels of the intestine. The normal blood flow at the level of the arcs of the intestinal arteries is characterized by a mirror image of the arterial flow below the baseline. In the normal arterial arc, both of these flows are the same in terms of the intensity of the spectrum, but they are located at the same point of the vessel. The echogram of the intramural vessels of the

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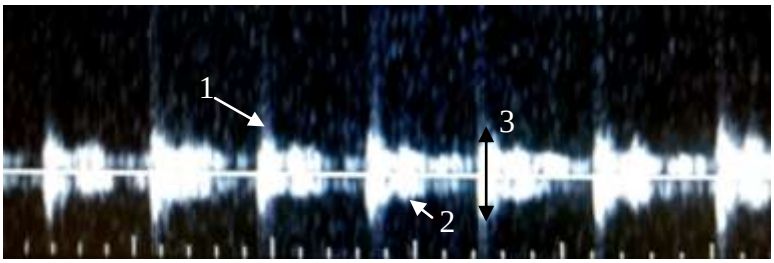
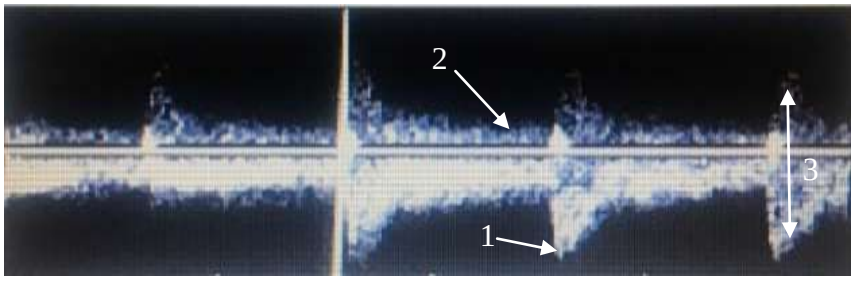
small intestine of a healthy patient shows the presence of the bidirectional blood flow which is symmetrical on both sides of the basal line (pic. 4).



Pic. 4: The Junction of the Contralateral Arterial Flows in the Normal Intramural Arteries of the Small Intestine: 1 – a Systolic Component, 2 – a Diastolic Component, 3- the Junction of the Contralateral Arterial Flows

The specific criteria of changing the spectral curve were identified for such pathological processes as strangulated ileus, duodenal ulcer, acute cholecystitis, renal and radial artery thrombosis. The systolic peak of the spectral curve sharpened and took a less flat form with a decrease but saved the diastolic component and the bidirectionality of the blood flow in the projection of arterial arcs and contralateral arterial flows of various organs (pic. 5).



Pic. 5: The Junction of the Contralateral Arterial Flows at the Level of Arterial Arcs of Parenchymal Branches of the Renal Artery in Stenosis of the Renal Vein: 1 – a Systolic Component, 2 – a Diastolic Component, 3- the Junction of the Contralateral Arterial Flows

In this article, one has studied the peripheral resistance index of the vessel in the surgical pathology (Table 2).

Table 2: The Parameters of the Peripheral Resistance Index in the Junction of the contralateral arterial flows in Normal and Pathological Vessels

Objects	x±dx y±dy	Sx Sy	Comparative effect Δ±dΔ; SΔ	T P
1 2	0,45±0,2 0,56±0,3	0,005 0,0075	0,14±0,2 0,03	0,31>0,05
1 3	0,5±0,3 0,76±0,2	0,0075 0,005	0,34±0,2 0,03	0,72>0,05
1 4	0,64±0,5 0,7±0,3	0,0125 0,0075	-0,09±0,4 0,07	0,1>0,05
1 5	0,65±0,2 1,1±0,1	0,005 0,0025	0,5±0,2 0,03	2,01<0,05
1 6	0,7±0,2 1,3±0,1	0,005 0,0025	0,59±0,16 0,03	2,68<0,05

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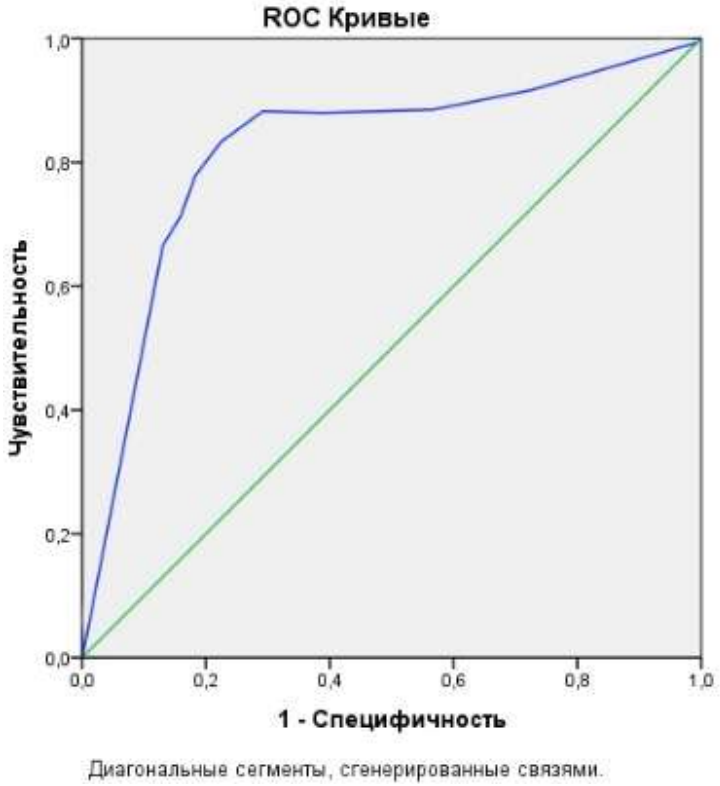
1 – normal state, 2 – strangulated ileus, 3 – duodenal ulcer, 4 – acute cholecystitis, 5 – renal artery stenosis, 6 – radial artery stenosis.

Due to the table of the peripheral resistance index of the flows, there are the significant statistical differences between the renal and radial artery stenosis and the normal state.

Based on the obtained data, the ROC-curves were constructed and a comparison of the methods on the investigation of the vitality of organs was held in identifying the phenomenon of the junction of the contralateral arterial flows (table 3). Given that the area under the ROC-curve is an integral measure of the diagnostic efficiency, one can say that the ultrasonic method showed the good predictive capabilities in the diagnosis of the vitality of organs based on the phenomenon of the junction of the contralateral arterial flows (thus, it solved the main task) (pic. 6).

Table 3: ROC - Analysis of the Diagnostic Methods for the Phenomenon of the Junction of the Contralateral Arterial Flows

Criteria	Ultrasound investigation	Histology	X-ray
AUS (an area under the curve)	0,86±0,021	0,90±0,22	0,70±0,13
Perceptibility	90%	83%	71%
Specificity	85%	95%	70%
Accuracy	87%	91,4%	70,6%



Pic. 6. a ROC-curve of the ultrasonic duplex scanning reflecting the prognostic capabilities of the method

In the formation of the stump of the distal end of the crossed empty intestine, we proposed [14] to the empty

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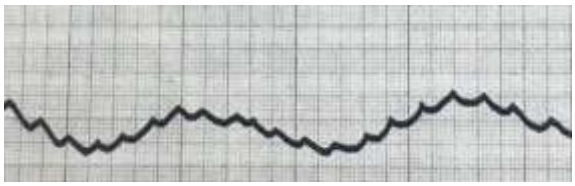
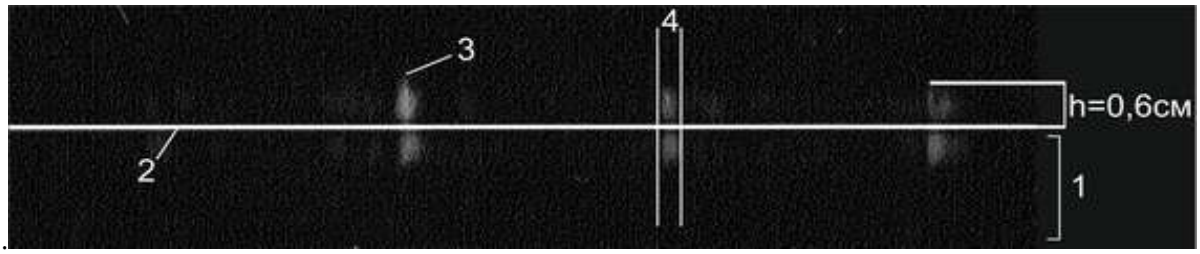
intestine and suture it with a UKL-40 device, retreating from the junction of the contralateral intramural vessels 0,5-0,8 cm, the pouch suture was putting in the junction of the contralateral intramural vascular vessels, the thread of the pouch suture was carried out over the visible intramural vessels. Our method of the formation of an enteric stump significantly reduced the probability of the incapacity of sutures of the small intestine stump (pic. 7).



Pic. 7: Patient B., PMG in the projection of a purse-string suture in the junction of the contralateral intramural vessels

Clinical example № 1: Patient A., 56 years old, was admitted to the clinic with complaints of pain all over her stomach, which periodically took on a cramping character. While primary ultrasonic examination to the left of the navel, the expanded loops of the small intestine, reduced peristalsis, free fluid between the loops, and a lack of blood flow in the intestinal wall was revealed. In the study of the blood flow, the contralateral intramural blood flow is not detected. There are no constant multidirectional signals. There is no diastolic component (pic. 8)



Pic. 8: A preoperative Doppler ultrasonogram of the intramural vessels of the patient A. with a diagnosis of small intestine obstruction. 1- The contralateral intramural blood flow by mirror image, 2- a basal line, 3 – a systolic peak, 4 – a systolic component. The systolic peak signals are not constant. There is no contralateral blood flow or diastolic component. The small intestine is not viable.

According to the survey radiography and CT scan of the abdominal cavity, the signs of intestinal obstruction were detected. The blood analysis showed an increase in the number of white blood cells to 10,3x109/l (leukocytosis), the total protein - 90 g/l (hyperproteinemia).

The patient was urgently operated on. A section of the intestine was resected with the end-to-end anastomosis. The surgeon's report: the strangulated small intestine obstruction. The histological examination of the excised part of the intestine: the strangulated small intestine obstruction with the signs of necrosis of the resected intestine.

Conclusion: resected intestine is not viable.

A month later, the patient was reexamined. According to the survey radiography and CT scan of the abdominal cavity, the intestine is free of pathologies. There were no changes in the blood analysis (white blood cells - $4,5x10^9$/l, total protein - 71g /l). The patient is healthy.

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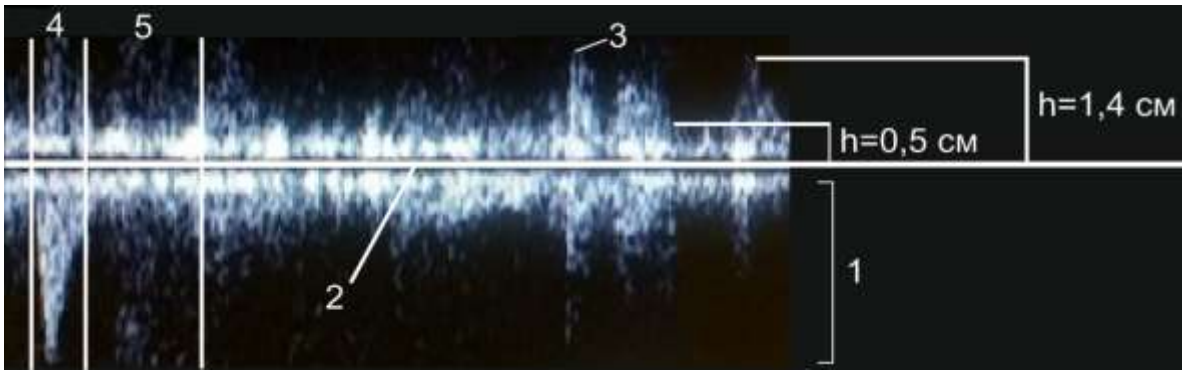
Clinical example № 2: Patient B., 47 years old, was admitted to the clinic with complaints of pain in the lower abdomen, vomiting. The ultrasonic examination of the blood flow revealed the contralateral intramural blood flow by its mirror image below the basal line, with the presence of the systolic peaks, constant multidirectional signals, with the signs of arterial blood flow on the spectral echograms with a diastolic component of the height 0,5 cm, which is not less than 1 mm and not more than 2/3 of the systolic component (pic. 9).



Pic. 9: A preoperative Doppler ultrasonogram of the intramural vessels of the patient B. with the chronic enteritis. 1 - the contralateral intramural blood flow by mirror image, 2 - the basal line , 3 - a systolic peak, 4 - a systolic component, 5- a diastolic component. The signals are constant and multidirectional. The systolic component is 1,4 cm, the diastolic component is 0,5 cm. The small intestine is viable.

According to the survey radiography and CT scan of the abdominal cavity, the signs of intestinal obstruction were detected. The blood analysis showed an increase in the number of white blood cells to $9{,}4x10^9$/l (leukocytosis), the total protein - 87 g/l (hyperproteinemia).

The patient was operated on. The intestine was found to be viable, and the pulsation of the mesentery vessels was preserved. The surgeon's report: the chronic enteritis. A biopsy of the small intestine was taken for histological examination. Conclusion of the histology – the chronic enteritis. The postoperative period proceeded smoothly, and the patient was discharged on the 15th day after the operation.

A month later, the patient was reexamined. According to the ultrasonic examination, there was revealed the fluid-filled intestinal loops with outlined echogenic mucous membrane. The surface of the mucous membrane is plicated. The thickness of the small intestine wall is 4 mm. No expansion of the small intestine loops was detected. They are pliable, elastic. The peristalsis is preserved, the free liquid between the loops is not determined. According to the survey radiography and CT scan of the abdominal cavity, the signs of acute intestinal obstruction were not detected. The ultrasound investigation of the intramural intestinal vessels revealed the contralateral intramural blood flow by it mirror image below the basal line with the presence of the systolic peaks, constant multidirectional signals, with the signs of arterial blood flow on spectral echograms with a diastolic component of the height 0.5 cm high and a systolic component - 1.4 cm. The mesentery vessels did not change. There were no changes in the blood analysis (white blood cells - $5{,}9x10^9$/l, total protein - 66g/l).

Conclusion: the small intestine is viable.

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IV. DISCUSSIONS

The open hemodynamic phenomenon in the researches of the collateral hemodynamics and a developing of the methods for the regional improvement of blood circulation are promising to use. Z. M. Sigal proposed and developed the methods based on a new hemodynamic phenomenon for determining the vitality of walls of the hollow organs, preventing the incapacity of the intestinal stumps, ventral hernia repairing, and surgical treatment of the liver cirrhosis. It is not excluded that the open hemodynamic phenomenon may have a potential value for a new method of the blood preservation, fluid maintenance, surgical interventions with the preservation of the contralateral flows, and the development of specific diagnostic criteria for the arterial insufficiency and focal pathology.

In clinical studies due to the ultrasonic monitoring, the specific criteria for low- and high- resistant blood flow were found in both normal and pathological conditions. In stenosis, the collision of the arterial flows is poorly defined and fraught with the irreversible ischemia, up to the death. Based on the obtained ultrasonic data, one can conclude that the bidirectional blood flow in the arterial arcs changes but remains in the inflammatory processes and the spectrum disappears with the threat of the ischemia in tissues and organs. Moreover, it is necessary to take account of the changes in the spectrum on one side of the baseline for the timely appointment of therapeutic treatment. The absence of the bidirectional flow in typical projections may be an indication for the surgical intervention on the kidneys and peripheral vessels. One can assess the effectiveness of the surgical treatment by restoring a bidirectional symmetrical spectrum in the projection of the arterial arcs. Based on the new phenomenon of the interaction of the contralateral arterial flows, the bionic models of the distribution of material and energy combinations in drip irrigation, water supply, oil supply, and power supply have been created [22].

Thus, both in the clinic and in the experiment, using original methods of the angiotensometry, the pulsomotorography and the ultrasonic monitoring, there was detected a new hemodynamic phenomenon of the junction of the contralateral arterial flows, which has practical therapeutic and diagnostic value in medicine.

V. CONCLUSION

1. We proposed and developed a new clinical method for determining the vitality of the small intestine without surgical intervention. The intestine is considered viable in the presence of the contralateral intramural blood flow during the ultrasound examination along its mirror image below the basal line with the presence of the systolic peaks, some different directional signals, with a diastolic component of the height at least 1 mm and no more than 2/3 of the systolic component [13].
2. During the operation, a new clinical method for preventing the incapacity of the intestinal stumps was developed by applying a purse-string suture in the area of the junction of the contralateral intramural vessels, while the threads of the pouch were carried out over the visible intramural vessels [14].
3. The phenomenon of the junction of the contralateral arterial flows has proved to be effective in surgery for determining the vitality of the organs, preventing the incapacity of the sutures of the anastomoses and intestinal stumps, the ischemic necroses, and perforative peritonitis, for diagnosing the intestinal obstruction. It can also be used in other areas, for example, in the drip irrigation [22].

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