ORIGINAL ARTICLE

COMPARATIVE MORPHOLOGY OF THE PIG`S RECTUM AND HUMAN`S RECTUM VIA 3D RECONSTRUCTION

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ABSTRACT

The aim: To define an ability to use pig as biomodel for experimental and clinical studies in order to develop new approaches of treatment of the rectal pathology.

Materials and methods: For the research two groups were used. I group includes 50 humans (27 females and 23 males), II group includes 8 vietnamese pot-bellied pigs. After magneresonance Imaging the 3D reconstruction of rectum was made.

Results and conclusions: Topography, structure, age and gender peculiarities of pig`s and human`s rectum in comparative aspect are described in this article. With the help of modern methods, namely 3D reconstruction, the structure of the pig`s and human`s rectum was reconstructed. The morphological parameters, such as size of anorectal and rectosigmoid angles, the length of the rectum and its parts, were determinated.

The 3D reconstruction demonstrated that size of anorectal and rectosigmoid angles, the length of the pig`s rectum are morphologicaly identical to the same parametres of human`s rectum. Thus, it is proved that pigs can be used as biomodels in experimental and clinical studies for development the new methods of treatment the rectal pathology in humans.

KEY WORDS: anorectal angle, rectosigmoid angle, biomodel

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INTRODUCTION

The significant progress has been made in the treatment of rectal diseases via using the modern techniques over recent years. The result has been reduction of frequency of complication such as purulent-inflammatory complications, an anal incontinent and relapses [1, 2, 3, 4]. Despite modern advances in surgical treatment of rectal pathology, a sufficiently high frequency of unsatisfactory treatment results remains, such as: relapsing fistulas of the rectum are observed in 35 – 40,2% of patients, purulent-inflammatory complications 13 – 20% of patients, there is an anal incontinent in 19 – 23% of patients [5-9]. Such results show that need to revise the date of rectum structure and the improvement of biological model to develop new approaches in rectum treatment. Nowadays laboratory rats are a traditional model of experimental researches. But considering the size of rat`s rectum, the process of defecation, the rats are not appropriate model for formation surgical skill during practical classes, conducting manipulation, especially for creation modern surgical approaches for prevention and treatment rectal diseases. Modern experiences of leading medical institutions in Europe, the USA and Japan publish researches in the field of xenotransplantation, reconstruction of mechanism of human diseases at the molecular level, such as Duchenne Muscular Dystrophy, cystic fibrosis with using of pigs as biomodels. [10-14]. Swine as a biomodel is anatomically and physiologically more similar to humans, especially regarding cardiovascular system, immune system, respiratory system, skeletal muscle, metabolism, etc. [15]. The pig as a biological model is actively used in researches of medical industry, namely medical technologies (instruments, apparatus etc.).

In this regard, the actual task is to determine the feasibility of the use of pigs as biomodels of various diseases and the use of this animal in the medical field generaly.

THE AIM

To define an ability to use pig as biomodel for experimental and clinical studies in order to develop new approaches of treatment of the rectal pathology.

MATERIALS AND METHODS

The research was conducted in two stages. The first stage provided for clinical study. Healthy people were attracted (I group – 27 females and 23 males), adults, who agreed to participate in a clinical study. After anoscopy and rectoroscopy, the pathology of the rectum was excluded. The magneto-resonance tomography was made with the subsequent 3-D reconstruction and morphometry.

All clinical procedures were carried out in compliance with the main provisions of GCP (1996), the Council of Europe

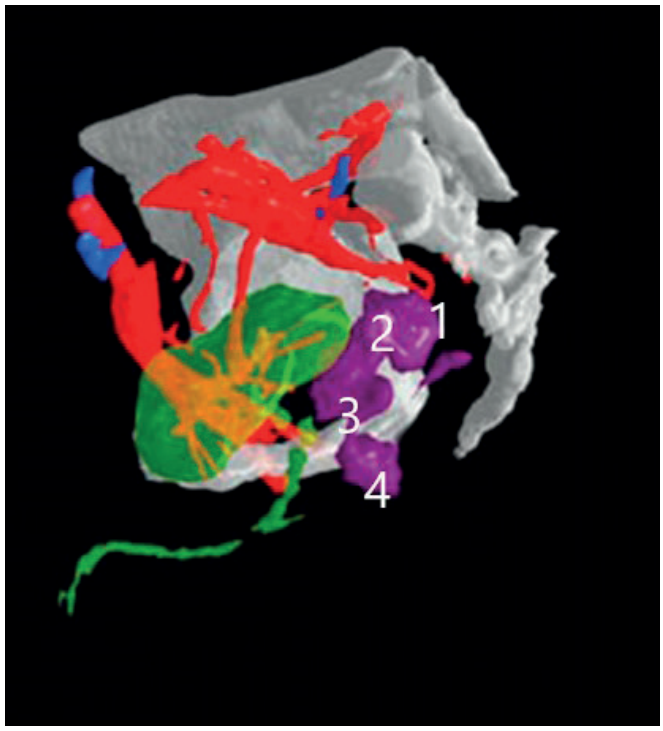

Fig.1. Lateral view of male pelvis.
1- Rectosigmoidal angle. 2- Pelvis part of rectum. 3- Anorectal angle. 4- Anal canal.

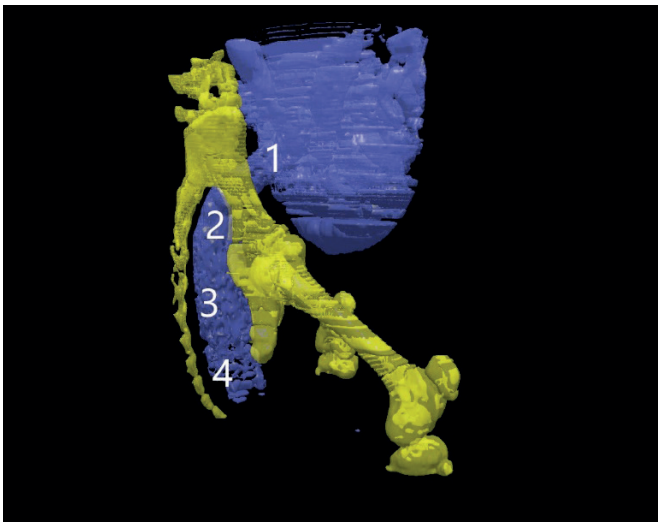

Fig. 2. Lateral view of pig`s pelvis.
1- Rectosigmoidal angle. 2- Pelvis part of rectum. 3- Anorectal angle. 4- Anal canal.

Convention on Human Rights and biomedical (04.04.1997), the Helsinki Declaration of the World Medical Association on the Ethical principles of conducting scientific medical research involving the person (1964-2013), the order of the Ministry of Health of Ukraine №690 (23.09.2009), №616 (03.08.2012).

The second stage of research was the experimental stage with using of vietnamese pot-bellied pigs as a subresearch animal. The experiment used 8 castable males of 5 month age and an average weight of 11-11.3 kg. Conditions of maintenance of experimental animals conform to current norms of Ministries of agrarian policy of Ukraine. The feeding of animal was corresponded to needs in high-quality and biologically active substances. The eperiment was carried out in a specially equipped veterinary laboratory, provided by all necessary equaipment for interventions and individual observation of animals. The high-qualified employers of Scientific center "Vetmedservis" were involved in the work with animals. For all animals after the confirmation of animal health by veterinarian the blood test and anoscopy were done. After sedation to the group of animals the magneresonance imaging was held. The study was conducted in compliance with the current legislation of Ukraine, the Council of Europe Convention on the Protection of vertebrate animals used in experiments and other scientific purposes (18.03.1986), the EU Directive №609 (24.11.1986).

For 3D reconstruction the graphical Wacom manipulator was used. Via the superfacial rendering the anatomical structures of every slide were marked with different color. This methodic allowed to clearly present their shape, interlocation, relative dimensions, etc. In addition, this made it possible to accurately conduct morphometry – to determine the dimensions, angles, length.

RESULTS AND DISCUSSION

Due to the using morphometry, the parameters of the rectum such as anorectal angle and the rectosigmoid angle, of the I clinical group and experimental animals of the II group were defined (Tabl. 1).

The noteworthy feature, that 3D remodeling can not display structural elements of mucous coat of rectum, we use rectosigmoid angle and anorectal angle as points of the start and finish of rectum.

According to the 3D reconstruction during our research, it was determined that rectosigmoid angle is located at the level of the second sacral vertebra in both groups and equal to 131 ± 0,7 °C (females of I group), 130 ± 0,4 °C (males of I group) and to 140±1 °C (I group).

Detected that distance between anorectal angle and rectosigmoid angle, means pelvic part of rectum is equal to 130±3 mm (males of I group) and 133±2 mm (females of I group), 170±5 mm (I group). The length of anal canal

Table 1. Morphometrical parametres of rectum

Object	Anorectal angle, °C	Length of anal canal, mm	Length of pelvic part of rectum, mm	Rectosigmoid Angle, °C
Adult human, female	148±2	43±3	130±3	131±0,7
Adult human, male	140±3	44±3	133±2	130±0,4
Pig, male	155±2	38±2	170±5	140±1

of males of I group is equal to 43±3 mm and 42 ±3 mm famales of I group. Pelvic part of rectum of pig (II group) is equal to 38±2 mm. The total length of rectum is equal to 173±3 mm (females of I group), 177±5 mm (males of I group), and 208±7 mm (II group) (Fig.1, Fig.2).

The results coincide with the data of literature [16]. Thus, the length of the human`s rectum according to different authors is equal to 12-20 cm, which depends on the location of thepoint of measurements. If the upper limit of the measurement point is the promontorium of the sacral bone, than the length of rectum is 20 cm. If the scientists were guided by the second sacral vertebrate, the length is 18 cm [17]. The proctologists considered [insert 1-2 sources L-ri], that more practicaly to divide the rectum into five departments and to take as initial point of measurement the anocutaneus line: rectosigmoid part (15 to 18 cm), upper ampular division (12 to 15 cm), middle ampular division (7 to 12 cm from the anus), the lower ampular division (up to 6 cm from the anus), and the perineum department or anal canal (length from 1.5 to 4 cm) [18-20].

As a result of anatomist`s researches, it was determined that the length of the anatomical anal canal is about 2 cm (distance from the rectocutaneal line to the pectineal line. Surgical anal canal includes not only the anatomical anal canal (the upper border is anorectal line), but the distal part of the rectum to the upper edge of the muscle ring (internal and external anal sphincters), which is clearly defined by the proctologist during the finger examination. The difference in identification between clinical and anatomists term can be explained with features of blood supply, inertia, venous and lymph nodes [21, 22, 23].

The diameter varies depending on the part, the diameter of the supraampular part is 4 cm, the ampula -7 cm, the diameter of the anus – 3 – 6 cm and it looks as fissure, the appearance of a slit at the level of the anus. This result is coincided with the data of literature.

In the foreign modern editions the term «anorectum» is used and its diseases are described as a number of non-tumor diseases, such as anococcycoccal pain syndrome, proctalgia, coccigodynia, characterized with pain sindrom accompanied with the presence of pain (sigle clinical manifestation, especialy at night) in the area of anus [24, 25, 26]. The anus can be located deep, to be conus-shaped in case of good developed peroneal muscles, or to be plane in case of prolate peroneal muscles (after delivery, ageing, etc.).

Via 3D reconstruction is defined that anorectal angle of rectum is equal to 140-150 °C, thus anorectal angle of rectum of males of I group is equal to 140 ± 3 °C, and anorectal angle of females of I group is equal to 148 ±2 °C. This difference is size can be explained with age changes of peroneal muscle tonus and delivery (femail`s perineum). At same time the location of anorectal angle was determined: in case of 150 °C rate, the anorectal angle was located below pubococcigeal line. Ar same time, the length and volume of anal canal was in norm, overwise it coud be reason of sphincter apparatus disorders. Not a single person from I group did not complain of encopresis or incontinence symptoms.

The anorectal angle of pig`s rectum (I experiment group) is equal 152±2 °C, that according to us is explained of animal posture (tetrapod type).

CONCLUSIONS

Due to the 3D reconstruction of the pig`s and human`s rectum structure, the morphologic similarity in the form and sizes is established. On the basis of this data we conclude that pigs can be used as a model for experimental and clinical researches in order to develop the newest methods for treatment of rectal pathology, including the development of surgical intervention methods.

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The Authors declare no conflict of interest.

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