MODERN AND TRADITIONAL METHODS OF COMPARATIVE ANATOMY OF THE PIG`S RECTUM AND HUMAN`S RECTUM

Plakhotnyi R.O., Kerechanyn I.V., Kovalchuk N.V., Radomska N. Y., Shmargalov A.O.

Privet Higher Educational Establishment «Kyiv medical university», Kyiv, Ukraine
Dr.kerechanyn@kmu.edu.ua

Abstract

Background: The rectal pathology is the one of the popular surgical diseases that leads to disorders of life style and as result to disorders of vital activity. Knowledge of morphology of the rectum is the base for understanding the etiology, techniques for diagnostic manipulations, treatment method, including a surgical intervention. This scientific work is aimed 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. The rectum of pigs and human were studied via traditional methods (description morphological and histological) and modern methods such as 3D reconstruction.

Results: Topography, macroscopy, microscopy of pig`s and human`s rectum in comparative aspect are described in this article. With the help of traditional methods such as macroscopy and microscopy and 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. Macroscopy and microscopy discovered comperative structures of rectum of pig and human.

Conclusion: 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.

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.

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, purulent-inflammatory complications, there is an anal incontinent patients.

Such results show that need to revise the date of rectum structure and the improvement of biological model that is more similar to human`s rectum shape, size, to the process of defecation and for the formation of surgical skill, 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 magnito-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 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 and 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).

Histological research was made according to tradiotional methodic via microscope and camera Leica EC4. 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

As result of our scientific work is discovered that mucous coat of pig`s rectum and human`s rectum is covered with simple cuboid epithelium, that gradually changed with stratified epithelium. The columnar zone of anal canal is covered with stratified cuboidal epithelium, but inermedial zone and anorectal line is covered with stratified squamous epithelium. Also the lymphoepithelial nodules are founded in mucous coat, that carry function of immune homeostasis of the human`s rectum same as a pig`s rectum. Proper lamina of mucous coat contents solitary lymphatic nodules and vessels.

Muscular lamina of mucous coat is made up of two layers: internal formed with circularly located myocytes and solid external layer. Submucous base of rectum is consist of soft connective tissue. Muscle coat of human`s rectum same as pig`s rectum consists of longitudinal and circular layers.

Via using morphometry, the parameters of the rectum such as anorectal angle and the rectosigmoid angle, lenth of rectum and its part of the I clinical group and experimental animals of the II group were defined.

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^{0}C (females of I group), 130±0,4^{0}C (males of I group) and to 140±1^{0}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 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).

Via 3D reconstruction is defined that anorectal angle of rectum is equal to 140-150^{0}C, thus anorectal angle of rectum of males of I group is equal to 140±3^{0}C, and anorectal angle of females of I group is equal to 148±2^{0}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^{0}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^{0}C, hat according to us is explained of animal posture (tetrapod type).

Conclusions

Due to the microscopic research and 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.

References

1. Amgad E. Salem, Elham A. Mohamed, Hosam M. Elghadban, et al. Potential combination topical therapy of anal fissure: development, evaluation, and clinical study. Drug Deliv. 2018; 25(1):1672-1682. doi: 10.1080/10717544.2018.1507059.
2. Amy E. Foxx Orenstein, Sarah B. Umar, et al. Common Anorectal Disorders. Gastroenterol Hepatol (NY). 2014; 10(5):294-301.
3. Clark SJ. Benign anal disease. JAAPA. Available from: 2016; 29(11):23-29. doi: 10.1097/01.JAA.0000502857.05728.98.
4. Bongoni AK, Kiermeir D, Schnider J, et al. Transgenic expression of human CD46 on porcine endothelium: effect on coagulation and fibrinolytic cascades during ex vivo human-to-pig limb xenoperfusions. Transplantation. 2015, 99(10):2061-9. doi: 10.1097/TP.0000000000000746.
5. Cooper DK, Matsumoto S, Abalovich A, Itoh T, et al. Progress in clinical encapsulated islet xenotransplantation. Transplantation. 2016; 100:2301-2308. doi:10.1097/TP.0000000000001371.
6. Frohlich T, Kemter E, Flenkenthaler F, et al. Progressive muscle proteome changes in a clinically relevant pig model of Duchenne muscular dystrophy. Scientific reports. 2016; 6:33362. doi:10.1038/srep33362.
7. Kemter E, Wolf E. Pigs pave a way to de novo formation of functional human kidneys. Proc Natl Acad Sci U S A. 2015; 112(42):12905-12906. doi:10.1073/pnas.1517582112.
8. Kleinwort KJH, Amann B, Hauck SM, et al. Retinopathy with central oedema in an INS C94Y transgenic pig model of long-term diabetes. Diabetologia. 2017; 60(8):1541-1549. doi:10.1007/s00125-017-4290-7.
9. Kurome M, Leuchs S, Kessler B, et al. Direct introduction of gene constructs into the pronucleus-like structure of cloned embryos: a new strategy for the generation of genetically modified pigs. Transgenic research. 2017; 26(2):309-318. doi: 10.1007/s11248-016-0004-z.
10. Panychkyn YuV, Skyba IA, Zakharova VP, Beshliaha VM, Solomon VV, Ruzhyn YuA, ta in. Osobennosty metodyky provedenyia doklynycheskoho eksperymenta po ymplantatsyy okkliudera yz β-tsyrkonyevoho splava na svyniakh kak byolohycheskoi modely. Sertse i sudyny. 2015; 4:25-30 (In Ukrainian).
11. Kristi L. Helke, Paula C. Ezell, Raimon Duran-Struuck, et al. Biology and Diseases of Swine. Laboratory Animal Medicine. 2015 : 695–769. doi: 10.1016/B978-0-12-409527-4.00016-X. PMCID:PMC7149938.
12. Eickmeyer SM. Anatomy and Physiology of the Pelvic Floor Phys Med Rehabil Clin N Am. 2017; 28(3):455-460. doi: 10.1016/j.pmr.2017.03.003.
13. Narayanan SP, Bharucha AE. A Practical Guide to Biofeedback Therapy for Pelvic Floor Disorders. Curr Gastroenterol Rep. 2019; 23;21(5):21. doi: 10.1007/s11894-019-0688-3.
14. Forootan M, Darvishi M. Solitary rectal ulcer syndrome: A systematic review. Medicine (Baltimore). 2018; 97(18):e0565. doi: 10.1097/MD.0000000000010565.