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Evidence-Based Anatomy and its Role in Clinical Medicine: A Review

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ABSTRACT

Introduction: anatomy is one of the basic sciences on which the foundations of clinical and surgical sciences are built. Sound anatomical knowledge is important for surgeons to provide optimal patient care.

Methods: in this review, we explore the transformative role of evidence-based anatomy in contemporary medicine. We elucidate how evidence-based approaches have expanded our understanding of anatomical variations and clinical implications. We also discuss the practical applications of evidence-based anatomy in clinical practice, education, and surgical innovation. Evidence-based principles (EBP) were first used in medicine under the label "evidence-based medicine" (EBM), which is defined as "the conscientious, explicit and judicious use of current best evidence in making decisions about the care of individual patients. Our review aims to provide clinicians, educators, and researchers with a nuanced understanding of evidence-based anatomy's significance and implications.

Results: by synthesizing empirical evidence and clinical insights, we strive to foster interdisciplinary collaboration and drive continuous improvement in patient care and medical education. practice, offering valuable insights into anatomical variations, clinical correlations, and surgical interventions.

Conclusion: Tthrough a meticulous examination of empirical evidence and research findings, we have elucidated the pivotal role of evidence-based approaches in shaping clinical decision-making, surgical techniques, and educational practices.

Introduction

serves as the cornerstone of clinical and surgical sciences, providing a fundamental understanding of human structure and function. Over centuries, anatomists have meticulously documented anatomical details, laying the foundation for modern medical practice. The advent of evidence-based approaches has revolutionized the field, enabling clinicians to integrate empirical evidence into diagnostic and therapeutic decision-making.

In this review, we explore the transformative role of evidence-based anatomy in contemporary medicine. We elucidate how evidence-based approaches have expanded our understanding of anatomical variations and clinical implications. Through a comprehensive analysis of recent research findings and advancements, we discuss the practical applications of evidence-based anatomy in clinical practice, education, and surgical innovation.

Our review aims to provide clinicians, educators, and researchers with a nuanced understanding of evidence-based anatomy's significance and implications. By synthesizing empirical evidence and clinical insights, we strive to foster interdisciplinary collaboration and drive continuous improvement in patient care and medical education.

Discussion

Anatomy is one of the basic sciences on which the foundations of clinical and surgical sciences are built. Sound anatomical knowledge is important for surgeons to provide optimal patient care. Most of the human anatomy has been well described and established without doubt. Our ancestral anatomists have worked with dead bodies and documented the various details. Their efforts and commitment need to be appreciated, as they laid the groundwork. Da Vinci[1] established the symmetry of the human body; Vesalius published a book based on human dissection and disproved most of Galen's assertions, which were based on animal research; hence, he is rightfully called the father of modern anatomy. Henry Gray[1] is known for his book on human anatomy and illustrations. India has contributed to anatomical knowledge through Sushruta and Charaka Samhita. Sushruta[2], rightfully called the father of surgery and applied anatomy, has described various organs such as the lungs, stomach, etc.

The next level of detailing anatomy was observing variations during surgeries that were essential for the surgeons. Eventually, the subject of anatomy gained importance as evidence started developing in terms of documenting anomalies and variations

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in patients and cadavers in the form of case reports, series, and research studies. Microscopy, immunohistochemistry, and electron microscopic studies enabled the visualization of the ultrastructure of human anatomical structures and their relationship to molecular mechanisms. Radiological, ultrasound, CT scan, and MRI-based studies conducted gave real measurements and a large sample size. Research was conducted on preservation techniques to suit various needs for education at the undergraduate and faculty levels. Comparative anatomy studies uncovered the processes of evolution. Various literature such as Journal of Anatomy, Anatomical Record, Morphological Anatomy, Clinical and Radiological Anatomy, and Surgical Anatomy publish experimental studies and invited reviews that reveal structure, function, gene expression, development and evolution, and clinical and surgical importance, respectively.

Hence, evidence is being progressively developed from all parts of the world. A compendium of human anatomical variations, where all the variations found related to all structures have been documented, needs to be updated. Experimental and observational studies have been documented from various regions of the world with different settings of race, region, culture, gender, and sample sizes. Also, different statistical methods have been used with a wide range of results. How is this going to be generalized and implemented in clinical practice? This led to the development of new research studies such as systematic reviews and meta-analyses. These are considered the highest levels of analytical research that give conclusive evidence regarding a particular anatomical structure or process. Systematic reviews are systematically conducted research with predefined criteria to select published and non-published literature (overcoming confounding variables) and analyze it to synthesize conclusive evidence related to a particular research question[3]. Meta-analysis is a statistical analysis of various studies to derive a quantitative estimate of a research question[4].

Implications of Evidence-Based Anatomy (EBA): Evidence-based principles (EBP) were first used in medicine under the label "evidence-based medicine" (EBM), which is defined as "the conscientious, explicit and judicious use of current best evidence in making decisions about the care of individual patients"[5].

The evidence developed by research provides data to clinicians and surgeons in their daily practice. The spectrum of variations is used in diagnosis, investigations, and therapeutics. The difference between an abnormality and a normal variant has been distinctly classified before calling a variation an abnormality. Many abnormalities, like Rokitansky sinuses in the gall bladder and Riedel's lobe of the liver, which were once considered abnormalities, are now considered normal variants. That is the effect of functional and progressive research over time, which gives clarity to the issues raised.

New abnormal variants are still being identified that have not been documented before. Even after 500 years of research, there is an evolution of new mechanisms and variations. Over time, changes in factors influencing the development of organs, like the environment, the use of chemicals in everyday life, and lifestyle habits, show up as new problems to be solved.

The implications of EBA can be demonstrated at various levels of patient care. For example, in clinical examination, variations may lead to misrepresentation of signs and symptoms, leading to a different diagnosis and causing complications. If an appendicitis is missing because of its variant position, then the diagnosis may be missed, leading to complications such as abscess and rupture, which could be life-threatening. Hence, being aware and ruling out variable positions is a must. In angiograms and basic X-rays, many normal features may appear as abnormalities that need to be resolved considering other parameters such as history, clinical examination, second opinions, or higher investigations. For example, a metopic suture should not be confused with a fracture, and a lobe of the azygos vein should not be misdiagnosed as something pathological and unnecessarily treat the patient, though not required. Vascular abnormalities need special mention as they are many and are required during the interpretation of the investigatory findings and the planning of treatment for them.

Kowalczyk and Majewski[6] have listed common operative procedures whose outcome may be altered due to variations, such as gall bladder removal, hernia repair, thyroid and pancreatic surgeries, axillary and breast, hepatobiliary, spleen, colon, and gastric surgeries.

Many procedures require a pre-operative investigation to plan the procedure accordingly and avoid complications, thus promoting patient safety. In many vascular patterns, the percentage of the normal pattern is way less than the percentage of variations, such as in the circle of Willis, the common hepatic arterial system, the facial artery, etc. Also, the variation percentages differ according to race, culture, geographical region, and gender.

Organ transplants have given a new dimension to EBA, leading to the development of surgical classification of the liver based on vascular pattern and bronchopulmonary segmentation, which have transformed surgical procedures from lobectomies to segmentectomy, leading to the salvaging of healthy tissue with precision.

Anatomical morphometry is the basis for prosthesis development and standardization of various structures like the head of the femur and the condyles of the tibia, contributing to patient care. EBA is in the field of anthropometry, where the morphometry of various systems is being used to identify or predict the

gender, age, and height of the individual, which gains importance in forensic medicine.

Evidence based on resin casts, especially in luminal structures such as blood vessels, bronchial trees, ventricles, etc., has made the visualization of the same very realistic. Plastination by itself has led to the development of dry preservation of anatomical specimens without the messy wet preservation; this has also helped develop evidence of deeper structures and evaluate the assumptions of anatomy.

Three-dimensional anatomy is gaining importance in terms of the spatial orientation of organs and structures to better understand anatomy by allowing different kinds of information to be made visible, which otherwise is difficult to visualize and assess. Multidimensional computational anatomy is a new venture that tries to compute the spatial organization of organs and develop statistical models that would help derive predictive models for problem solving[7]. Artificial intelligence has an important role to play in the incorporation of these details to include all variabilities in origin and shape for the development of simulation models and robotic surgical instrumentation.

Teaching and learning anatomy through evidence:

The cadaver dissection has a remarkable educational impact on students in terms of acquiring knowledge and skills and helps to incarnate their attitude towards death[8]. The cadavers can act as 'silent mentors' by imbibing humane attributes like compassion, care, and empathy among medical professionals[9]. Ethical etiquettes followed in the dissection hall will help students develop teamwork, respect, and overcome emotional confrontation[10,11]. With the introduction of various methodologies in teaching anatomy, such as the flipped classroom, 3D images reconstruction, videos, and anatomy tables, in order to give a holistic approach to anatomy, evidence in the form of educational research articles is being published. The systematic reviews of the same will help in establishing good teaching practices.

Students should be aware of common variations, as it will help them in clinical examination, interpretation of preliminary investigations, and OPD minor procedures. Awareness of congenital anomalies during neonatal examination, absence of certain arteries (e.g., dorsalis pedis artery absent in 10%) during clinical examination of pulses, variant positions of the appendix presenting with different signs, etc. will go a long way toward providing a more effective learning experience.

The incidence of surgical errors can be prevented by training residents and faculty in a simulated environment before operating on the living. Research studies have proven the effectiveness and quality of the special embalmed cadavers in laparoscopy and robotics training. 3D visualization techniques such as augmented reality (AR) and virtual reality (VR) are attracting faculty and students towards a revolutionized method of learning anatomy[12]. For postgraduate training, AR and VR simulators, inclusive of normal and variants of anatomy, if constructed in a way similar to real anatomy, provide a good, simulated environment for an immersive and engaging learning experience. Evidence-based anatomy in the form of systematic reviews and meta-analyses will contribute by developing evidence on the effectiveness of AR/VR and its impact on student training.

Evidence-based anatomy has a massive role to play, as technology inclusion has become the new way of health care revolution. In this era of quality healthcare and the continuous search for medical excellence, a sound knowledge of anatomical structures and their variations is primary for the outcome of the patients we treat[13].

With innovations and new challenges being faced, anatomical research should be conducted in a precise, methodical manner, avoiding or removing confounding variables for unbiased, accurate results. This will lead to good systematic reviews, which will provide conclusive evidence. Anatomists have an innovative role to play in producing evidence of the impact of various techniques in teaching anatomy.

Conclusion

In conclusion, evidence-based anatomy represents a foundation of contemporary medical practice, offering valuable insights into anatomical variations, clinical correlations, and surgical interventions. Through a meticulous examination of empirical evidence and research findings, we have elucidated the pivotal role of evidence-based approaches in shaping clinical decision-making, surgical techniques, and educational practices.

As the landscape of medicine continues to evolve, evidence-based anatomy remains indispensable for clinicians, educators, and researchers alike. By embracing evidence-based principles and fostering interdisciplinary collaboration, we can harness the transformative potential of anatomy to advance patient care, surgical innovation, and medical education.

References

1) Omar Habbal, The Science of Anatomy: A Historical Timeline Sultan Qaboos University Med J. 2017; Vol. 17 (1):18–22.
2) Rajgopal L, Hoskeri GN, Bhuiyan PS, Kishore KS. History of Anatomy in India. J Postgrad Med 2002; Vol. 48: 243-245.
3) Henry BM, Tomaszewski KA, and Walocha JA. Methods of Evidence-Based Anatomy: A Guide to Conducting Systematic Reviews and

Meta-Analysis for Anatomical Studies Annals of Anatomy, 2016; Vol. 20(5):16–21
4) Haidich AB. Meta-analysis in medical research. HIPPOKRATIA 2010, 14 (Suppl 1): 29–30.
5) Sackett DL, Rosenberg WM, Gray JM, Haynes RB, Richardson WS. Evidence based medicine: what it is and what it isn't. BMJ. 1996 Jan 13;312(7023):71-2.
6) Kowalczyk KA, Majewski A: Analysis of surgical errors associated with anatomical variations clinically relevant in general surgery. Review of the literature. Trans Res Anat. 2021, 23:1-6.
7) Makoto Hashizume, Perspective for Future Medicine: Multidisciplinary Computational Anatomy-Based Medicine with Artificial Intelligence. Cyborg and Bionic Systems, 2021.1-3.
8) Hyung-Joo Chang, Hyun Jung Kim, Im Joo Rhyu, Young-Mee Lee, and Chang-Sub Uhm. Emotional experiences of medical students during cadaver dissection and the role of memorial ceremonies: a qualitative study. BMC Medical Education (2018); 18(255): 2–7.
9) Guo *et al*., Cultivation of humanistic values in medical education through anatomy pedagogy and a gratitude ceremony for body donors. BMC Medical Education, 2020; 20(440): 1-10.
10) SK Ghosh. The practice of ethics in the context of human dissection: Setting standards for future physicians. Annals of Anatomy, 2020, 232: 1–11.
11) Prakash, Prabhu L V, Rai R, D'Costa S, Jiji P J, Singh G. Cadavers as teachers in medical education: knowledge is the ultimate gift of body donors. Singapore Med J. 2007; 48 (3):186–190.
12) Moro C, Stromberg Z, Raikos A, and Stirling A. The effectiveness of virtual and augmented reality in health sciences and medical anatomy. Anat Sci Educ. 2016; Vol. 10: 549–559
13) Yammine K. Evidence-based anatomy. Clinical Anatomy. 2014 Sep;27(6):847-52.

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