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Review article: history of medicine

Historical background of current surgical management of paediatric ovarian masses

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Abstract. Ovarian masses are rare in paediatric population and surgery remains one of the key elements of treatment. Approaches to the operative management of ovarian lesions in children and adolescents changed over decades with the development of diagnostic imaging – especially ultrasonography and minimally-invasive surgical techniques. The aim of this study is to examine research focused on the history of diagnostic and surgical procedures, and to present the historical background of the current management of ovarian masses in children and adolescents. It describes the development of particular diagnostic and surgical techniques, how this evolution contributed to improvements in treatment and how it led to the current state of art. The article constitutes a literature review and mainly focuses on medical inventions between the 18th and 21st centuries, but it also mentions important issues from earlier periods.

Key words: paediatric surgery, paediatric ovarian masses, history of medicine, laparoscopy

Introduction

Ovarian lesions in the paediatric population are rare, and surgery remains one of the key elements of their treatment (1). Due to the diversity of their clinical presentation, both diagnosis and management require a balanced approach — minimizing the risk of inadequate procedures while also avoiding unnecessary interventions that could negatively affect ovarian reserve and, consequently, future fertility (2). Thus, the key question remains: what should be the extent of surgery in cases of ovarian masses in children? The development of imaging techniques — especially ultrasonography — and the availability of preoperative laboratory diagnostics made it possible to plan the optimal extent of surgery. At the same time, improvements in surgical techniques enabled these procedures to be performed in a minimally invasive way (3). This article presents a historical overview of the current standards for surgical management of ovarian masses in children. It mainly focuses on medical inventions between the 18th and 20th centuries, but it also mentions important issues from earlier periods.

Materials and methods

A literature review of publications on PubMed, Google Scholar and Embase was done, to collect articles for the study. We used the following keywords: history of laparoscopy, history of teratomas, development of ultrasonography, ovarian tumours in children. The review included only English-language publications.

Teratomas – historical background of the most common ovarian neoplasms of childhood

Teratomas are neoplasms originating from germ cells and can be located both in the gonads and extragonadal sites such as intracranially, in the sacrococcygeal region, retroperitoneally, or in the anterior mediastinum (4). Due to their morphological characteristics, these tumours have intrigued researchers for centuries. The earliest mentions of them referred to tumours located in the sacrococcygeal region of newborns, as these were visible to the naked eye. As James E. Wheeler mentions in the chapter of the book on the

history of teratomas (5), the first references to these tumours were found on clay tablets dating back to 650 BCE, presenting newborns with a "third limb" positioned between the other two. These images may represent the earliest historical accounts of teratomas (5).

The first author who precisely described and illustrated an ovarian teratoma was Johann Scholz. In 1658, he described the case of a woman suffering from lower left abdominal pain who eventually died. The autopsy revealed a tumorous lesion of the left ovary, with a visible mass of tangled hair—one of the most recognizable features of ovarian teratomas to this day (5).

Although few descriptions of these tumours were published in the 18th century, reports became widespread in the 19th century. At this time, teratomas even entered the Guinness Book of Records—for example, the teratoma with the highest number of teeth (over 300), the largest diameter (45 cm), and the most diverse mixture of hair (5). The first histopathological descriptions of teratomas appeared in 1843, when Otto Kohlrausch—a German surgeon and scientist—first demonstrated the presence of skin elements and sweat glands within an ovarian tumour (5).

In 1857, Lebert defined for the first time a dermoid cyst as "a cysts which show, under their internal surface, an organization similar to that of skin, able to form epidermis, papillae, dermis, sebaceous glands, sudoriferous glands, hair, subcutaneous adipose tissue, free sebaceous and greasy material, bones and teeth.". In 1898 Montgomery written "The best developed organ in the teratoma was the skin with its hairs and attendant sebaceous glands. This is a regular phenomenon in such tumors, and it is usually such a prominent feature as to give them the name dermoid." (6)

Lebert also published the first review on teratomas, analysing 129 cases of ovarian teratomas and 59 extragonadal teratomas. That same year, Pesha published the first description of an ovarian teratoma with malignant transformation (5).

The link between previously described "dermoid cysts," and other ovarian germ cell tumours was not studied and clarified until the second half of the 20th century. Theories about the origin of ovarian dermoid cysts have also evolved over time. Some authors suggested that their appearance is caused by displacement of some parts of the embryonic tissue at an early stage of development (5,7). Some of the earliest hypotheses suggested that they were a consequence of abnormal fertilization or ectopic gestation (5,7) were first disapproved by Baillie in 18th century and the discovery of ovarian teratoma in a 3-month-old infant in 1965 finally demolished it (5).

Nowadays, many researchers focus on the occurrence of ovarian teratomas in the paediatric population, as they represent the most common ovarian neoplasm in this age group. Their clinical features—such as size and characteristics—can be evaluated using imaging techniques, primarily ultrasonography, and sometimes computed tomography or magnetic resonance imaging (8).

Ultrasonography

Development of the surgical management of paediatric ovarian tumours was strongly connected with the development and evolution of ultrasonography. The earliest references to this modality date back to the 1940s of the 20th century, when German researchers Gohe i Wedekin reported the potential utility of ultrasound wave reflection in the diagnosis of tumours, abscesses, and effusions (9). Meanwhile in 1947 Austrian neurologists attempted to visualise cerebral ventricular system by ultrasound; however, these attempts were impeded by artefacts predominantly caused by cranial bone interference (10). Subsequent investigations concentrated on the application of ultrasonic wave reflection to distinguish neoplastic tissues from normal ones, although the quality of the examination was poor, mostly due to insufficient technology (11). The development of ultrasonography was certainly accelerated and enhanced by the constructing of the first digital computer in 1945, which contributed to the creation of the first ultrasound device, that converted reflected ultrasound waves into a monitor-displayed images in 1951 (9).

First mentions about the use of ultrasonography in paediatric patients involved transfontanelle imaging of cerebral ventricular system (12), evaluation of the urinary system and detection of pathological lesions within the abdominal cavity (13). Doppler ultrasound technology became accessible in 1980 (13). The first official ultrasound training course for physicians

specialising in paediatric care was conducted in May 1980 at the Children's Hospital in Michingan (13). Presently, ultrasonography constitutes fundamental radiation-free diagnostic modality and is used in virtually all fields of medicine. Specifically, in the context of paediatric ovarian lesions, ultrasonography is the preferred initial radiological examination owing to its accessibility, safety profile, cost-effectiveness, and diagnostic efficacy. The identification or absence of radiological indicators of malignancy, correlated with clinical presentation enables to estimate the risk of malignancy of diagnosed lesion with high probability and permits to plan the optimal extension of surgical intervention (14).

Surgical treatment of paediatric ovarian masses – how the surgical approach changed over decades

Examining studies from the early second half of the 20th century it can be concluded that the predominant surgical approach for paediatric ovarian masses was laparotomy. This involved a wide abdominal incision, thorough inspection of the peritoneal cavity, and macroscopic evaluation of the lesion. It was before the ultrasound era and physicians had no imaging modality other than plain radiograph which in some cases revealed calcifications within ovarian lesions (15-16). Decision regarding the extent of surgical excision were made intraoperatively. In cases of lesions without suspicion of malignancy, the procedure typically involved removal of the lesion along with the ipsilateral ovary and fallopian tube – an operation referred to as unilateral salpingo-oophorectomy (15-18). In contrast, for lesions with features suggestive of malignancy the procedure often included excision of both gonads, both fallopian tubes and sometimes uterus – a bilateral salpingo-oophorectomy with hysterectomy (15-18). In a 1964 study, Parsons emphasized that every ovarian lesion should be opened immediately after the excision, during surgery, and that every solid component should be submitted to the histological examination (18).

Currently, mini-invasive, ovarian-sparing surgery is preferred for lesions initially assessed as benign, while laparotomy remains the method of choice in cases with suspected malignancy (19-21). Nevertheless, since benign tumours constitute the vast majority of paediatric ovarian neoplasms, the use of minimally invasive techniques has significantly increased in recent decade (21).

Laparoscopy as the surgical method, which revolutionized the face of surgery

Laparoscopy is a surgical approach with many scientifically proven advantages, such as better visualization of peritoneal cavity, reduced postoperative pain, shorter hospital stay, faster recovery, and good cosmetic effect - which is particularly important in paediatric surgery, as the wound grows with the patient (22).

Laparoscopy was first introduced in 1901 by George Kelling, a gastroenterologist from Dresden, who inserted air into the peritoneal cavity of a dog and then visualized it using a paediatric cystoscope (23). On the other hand, Swedish internist Christian Jacobaeous was the first to describe a laparoscopy procedure performed on a human body in a patient with ascites – draining ascitic fluid from the peritoneal cavity and introducing air into it (24). He was also the first to perform thoracoscopy, which is why he is considered a pioneer of this surgical technique. He also published a paper describing the first 17 laparoscopies he performed (24). In the United States in 1911, Bertram M. Bernheim introduced a proctoscope into the peritoneal cavity and, using light from a headlamp, performed an endoscopic inspection of the peritoneal cavity, visualizing the stomach, gallbladder, and liver (24). On the other hand, Heinz Kalk, a gastroenterologist from Berlin, improved laparoscopic instruments that he used for diagnosing the gallbladder and liver (25). In 1937, American J.C. Ruddock described over 500 laparoscopic biopsy procedures, mostly from the liver. He was also the first to use electrocoagulation during his procedures (25). A milestone in the development of laparoscopy was the construction by Hungarian internist Janos Veres of a special needle used for insufflating gas into body cavities. (25,26). This instrument, known as the Veres needle, is still used in surgery today and is one of the methods for starting a laparoscopy procedure.

The two abovementioned procedures, which were described in the literature as well as dozens of

attempts of laparoscopic procedures that left no trace, contributed to the refinement of laparoscopy as a diagnostic method for imaging internal organs. They inevitably led to the undertaking of increasingly bold surgical actions using the endoscopic method, leading to the gradual evolution of laparoscopy from a diagnostic procedure to a therapeutic one. For instance, Raoul Palmer, a gynaecologist from Paris, performed a laparoscopy during which he removed ovaries – this was also the first laparoscopic procedure performed in the Trendelenburg position (a medical position in which the patient lies on their back, with the head, upper chest, and torso below the level of the lower limbs) (25). In the second half of the 20th century, British doctor Harold Hopkins developed the optics known as Hopkins optics, and the German instrument manufacturer Karl Storz cooperating with him, designed the first camera with a light source. (25,27). Kurt Semm, the head of the Department of Gynaecology and Obstetrics at the University of Kiel, also attempted to perform not only diagnostic but also therapeutic laparoscopic procedures. He constructed a device for CO2 insufflation and developed new techniques for controlling bleeding (25,28). Subsequent surgeons continued to attempt laparoscopic surgical treatments despite opposition from a significant part of the medical community (25,29). This led to the first laparoscopic appendectomy in 1980 and the first laparoscopic cholecystectomy in 1985 (29).

The first mentions of the use of laparoscopy in the paediatric population date back to the second half of the 20th century and concern procedures performed due to abdominal pain for diagnostic purposes (30,31). A study conducted among 112 girls confirmed the effectiveness and safety of the method in the paediatric population (30). Researchers from Milan described 147 laparoscopic procedures in children for oncological reasons, of which 22 cases involved the resection of ovarian tumours (31). Additionally, paediatric surgeons from Nantes described in 1993 28 female patients who underwent laparoscopy due to ovarian pathology. Only three of the described procedures were therapeutic, while the rest were diagnostic (32). Two years later, in 1995, paediatric surgeons from Utrecht (Netherlands) described a series of two newborns with ovarian cysts who were operated on using laparoscopic techniques (33). In 1996, Jawad and Al-Meshari described a series of 8 patients with ovarian disorders who were treated with laparoscopy (34). These procedures included: removal of a tumorous lesion, aspiration of fluid from an ovarian cyst, and detorsion of the ovary. Among these 8 laparoscopic procedures, only one case required conversion to laparotomy (34). Over the years, more and more studies were published on significantly larger groups of patients, proving the safety and effectiveness of laparoscopy in paediatric surgery, including the surgery of ovarian tumours in children (35-37). The approach to the extent of the surgery also significantly changed – as mentioned earlier, ovarian-sparing operations became the gold standard for treating benign tumors. (6,14,21).

Discussion

This literature review presents how scientific development and technological inventions contributed to the current state of the art in the diagnostic and treatment of ovarian masses in children and adolescents. Not only did they transform the field of surgery in the past, but they also initiated a time of constant development that continues to the present day. A significant factor not addressed in this article, but which significantly impacted operative treatment, is the development of paediatric anaesthesia and intensive care. We are likely on the brink of a new era in paediatric surgery, an era that began some time ago in adult general surgery – and that is robotic surgery (38,39). More and more publications are presenting its application in paediatric surgery – including in the surgery of ovarian tumours (38). Although the first mentions of the potential use of robotic surgery in children date back to the early 21st century, (40,41) in recent years this technique has become the subject of numerous studies and scientific papers. Additionally, new possibilities in both diagnosis and treatment are presented by the prospect of utilizing mixed reality – a combination of virtual reality with the real world (42,43). This technology allows not only for visualizing specific anatomical structures in 3D, but also for transforming imaging results into holograms, which can be located anywhere in the real space. (42-45). As a result, the

surgical team has an accurate view of the anatomy of a given area without the need to take their eyes off the surgical field. In this way, not only anatomical structures but also pathological changes, such as cancerous tumours, can be visualized. The use of holographic visualizations during surgery improves the comfort of the operator and allows for increased precision, often shortening the duration of the surgery (42).

Conclusions

The current diagnostic and management of ovarian tumours in paediatric population have been influenced by the development of imaging techniques, surgical techniques – which led to significant improvements both in the surgical instruments and the precision of operations, changes in surgeons' approach to the extension of surgery, as well as the development of laboratory and genetic diagnostics, and development in the field of paediatric anaesthesia and intensive care. It seems that technology is advancing at an incredible speed, unprecedented before. A challenge facing surgery today is how to use it in a way that, on the one hand, maximizes the optimization of treatment methods, while on the other hand, does not lose sight of the crucial subjectivity of the Patient among the technological innovations.

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