Clinical approach for the classification of congenital uterine malformations

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Abstract A more objective, accurate and non-invasive estimation of uterine morphology is nowadays feasible based on the use of modern imaging techniques. The validity of the current classification systems in effective categorization of the female genital malformations has been already challenged. A new clinical approach for the classification of uterine anomalies is proposed. Deviation from normal uterine anatomy is the basic characteristic used in analogy to the American Fertility Society classification. The embryological origin of the anomalies is used as a secondary parameter. Uterine anomalies are classified into the following classes: 0, normal uterus; I, dysmorphic uterus; II, septate uterus (absorption defect); III, dysfused uterus (fusion defect); IV, unilateral formed uterus (formation defect); V, aplastic or dysplastic uterus (formation defect); VI, for still unclassified cases. A subdivision of these main classes to further anatomical varieties with clinical significance is also presented. The new proposal has been designed taking into account the experience gained from the use of the currently available classification systems and intending to be as simple as possible, clear enough and accurate as well as open for further development. This proposal could be used as a starting point for a working group of experts in the field.

Keywords Uterine anomalies · Mullerian anomalies · Classification · Septate uterus

Introduction

Female genital tract anomalies are common deviations from normal anatomy with an estimated prevalence of 4–7% in the general population and even higher in selected populations such as recurrent aborters [1–3]. Their occurrence could be associated with a variety of clinical presentations ranging between life threatening complications, severe health problems in the adolescence, reproductive problems although in most of them they are asymptomatic [1, 4–16].

Due to their high prevalence and possible impact on the reproductive health of women, congenital uterine malformations of the female genital tract are a challenge for the therapeutic decision-making process. An efficient planning of the therapeutic strategy is based on their effective diagnosis and clear categorization, in view also of the numerous treatment options available for their management. The need for a reliable classification system is more than obvious [4].

The first attempt to classify female congenital anomalies goes back to the beginning of the 19th century; Strassmann described septate and bicornuate uterus and some subgroups of the disorders in 1907. However, the first classification system for categorization of congenital uterine malformations was that of the American Fertility Society (AFS) published in 1988, mostly based on the previous work of Buttram and Gibbons [17, 18]. Almost 15 years later, Acien et al. [19] proposed another option for the classification of
congenital female malformations using the embryological origin as the basis of the system. A newer version of this classification has been published recently [20]. Furthermore, Oppelt et al. [21] published a very detailed classification system based on the Tumor Nodes Metastases (TNM) principle in oncology and known as vagina, cervix, uterus, adnexae and associated malformations (VCUAM) classification system. It is also interesting that, apart from these alternatives for the classification of the female genital malformations in general, some other subdivisions for certain categories of anomalies have been published [22–27].

Although the AFS classification received wide acceptance and it is still the most broadly used system, it is associated with various limitations in effective categorization of the anomalies. It is also interesting that until none of the other available options was able to effectively replace the AFS system [4].

The European Academy for Gynaecological Surgery (EAGS), recognizing the need for an evidence-based updated classification of female genital tract malformations, has established a scientific project on that issue. As the first step of this project, a systematic re-evaluation of the current proposals has been done and, based on their criticism, the characteristics of the new classification system have been clarified [4]. The second and final step of the EAGS scientific project was to prepare a proposal for the new updated clinical classification of uterine anomalies to be used as the scientific background for a working group of experts in the field. This proposal, after extensive discussion, has been also adopted as the scientific basis for the development of a new classification system by the common working group meanwhile established by the European Society of Human Reproduction and Embryology (ESHRE) and European Society for Gynaecological Endoscopy (ESGE) under the working name CONUTA (CONgenital UTerine Anomalies). The development of the new system will run using the DELPHI procedure of consensus.

The updated new proposal for the classification of uterine congenital anomalies is designed having mainly clinical orientation and based on a critical review of the available data on female genital tract malformations with their extensive interpretation. Further subdivisions based on the cervical and vaginal anatomy, incorporating all the possible co-existent anomalies and their combinations, are feasible but they are not in the goals of the present article. Thus, the system is open for further development in order to be more comprehensive.

**Proposed uterine classification: key concepts**

The new proposed system has the following general characteristics: (a) the main classes are based on the uterine anatomy and embryology and express main anatomical variations of uterine anatomy coming from the same embryological origin; (b) the main sub-classes are further anatomical variations of the main classes expressing different degrees of uterine deformity.

**Design of the new system: main concepts**

The first and fundamental starting point in the design of the new proposal for a classification system was, initially, to select the basic characteristic for patients’ grouping. Thus, anatomy of the female genital tract is thought to be the most appropriate basic characteristic for the systematic categorization of the women with congenital anomalies in a new classification system for the following reasons: (1) by definition, congenital anomalies of the female genital tract are miscellaneous deviations from normal anatomy [4], (2) clinical presentation and prognosis of the patients seems to be correlated with the type and the degree of anatomical deformity of the genital tract [2, 4–16, 28–32] (3) anatomy is the basis of the AFS classification system which is successfully adopted as the main classification system for more than two decades, indicating the real value of the anatomy in that respect [4, 17].

The second point in the design of the new proposal is to decide if there is a “key” organ in the anatomy of the female genital tract that could be used by priority to build up the main groups of the system. Thus, uterine anatomy was selected as the key characteristic for the main groups of the system for the following reasons: (1) frequency should be taken into account in the design of the system and the vast majority of the congenital malformations of the female genital tract are, no doubt, uterine ones [1–3, 33, 34]; (2) uterine anatomy is the basis in the design of the AFS classification system and it is thought to be one of the advantages of this system explaining, also, its wide acceptability; the adoption of the same characteristic by the new system will facilitate the clinicians to smoothly move from the old to the new system [4, 17].

Although uterine anatomy has been selected as the main characteristic in the design of the new classification system another crucial point was to choose if there is another supplementary characteristic that could be used in the design of the patients’ grouping. Uterine congenital malformations are the result of very discrete disturbances in the embryologic development of the Müllerian (or para-mesonephric) ducts during fetal life thus explaining their pathogenesis [9, 35, 36]. Due to its independent importance, embryological origin of uterine anomalies has been adopted as a secondary basic characteristic in the design of the main groups of the new proposal. The incorporation of embryology as an additional basic characteristic helps to create (1) more uniform classes avoiding transitional unclassified or cases with unclear classification and, (2) more “clear” classes since each class has a common pathogenesis due to the fact that, usually, very discrete embryological disturbances underlie to each patients’ group.
In general, two options are available for the classification of uterine anomalies: the first is to go from the normal uterus (as class 0 or I) to the more deformed types, e.g., uterine aplasia/dysplasia (as class VI), and the other one is to go from the more severe forms (uterine aplasia/dysplasia as class I) to the normal uterus (as class VI), an approach followed in the ASRM classification system. In the new system, the first way of classification is adopted, with normal uterus being class 0, since: (1) it seems to be more reasonable to start from less affected to more affected cases and (2) the scientific society is familiar mainly with this practice followed also in the categorization of cancer, endometriosis, etc.

As already mentioned, each main class is further divided into sub-classes. The mode of classification adopted in sub-classes is to go from the less severe forms to the more severe ones and the numbers are the alphabet of the Latin language (a, b, c). It should be noted that, for the needs of simplicity, an extremely detailed further sub-classification is avoided in order to stay away from too many sub-divisions, which seems not to be very functional. Thus, sub-classes include variations of the same embryological anatomical entity with clinical different significance.

The main classes and the subclasses of the new system are presented in Table 1 and are as follows (Fig. 1):

| Main class | Uterine anomaly | Main sub-classes |
|------------|-----------------|------------------|
| Class 0    | Normal uterus   |                  |
| Class I    | Dysmorphic uterus | a. T-shaped   |
|            | T-shaped uterus | b. Infantilis |
|            | a. Partial sepsate uterus | a. Partial |
|            | b. Complete     | b. Complete    |
| Class II   | Septate uterus  |                  |
| Class III  | Dysfused uterus |                  |
|            | Partial disfused uterus | a. Partial |
|            | b. Complete     | b. Complete    |
| Class IV   | Unilaterally formed uterus | a. Rudimentary horn with cavity (Communicating or not) |
|            | Communicating horn without cavity/Aplasia (no horn) | b. Rudimentary horn without cavity (bi- or unilateral) |
| Class V    | Aplastic/dysplastic uterus | a. Rudimentary horn with cavity (bi- or unilateral) |
| Class VI   | Unclassified malformations | b. Rudimentary horn without cavity (bi- or unilateral)/Aplasia |

Definitions

(a) **Class 0** incorporates all cases with normal uterus giving the opportunity to classify congenital malformations of the other parts of female genital tract apart from the uterus in the fully developed classification system [25, 26, 37–53].

(b) **Class I** incorporates all cases having a uterus with normal outline but with abnormal lateral wall’s shape of the uterine cavity. The Greek term “dysmorphia” is used to describe the cavity with this abnormal morphology. Class I is further subdivided into two categories: (a) T-shaped uterus characterized by a correlation of 2/3 uterine corpus and 1/3 cervix and (b) uterus infantilis characterized by an inverse correlation of 1/3 uterine body and 2/3 cervix. It should be noted, however, that both subclasses have almost the same appearance in hysterosalpingography (HSG) and magnetic resonance imaging (MRI) and differential diagnosis could be done mainly by hysteroscopy and biopsy of the endocervix and endometrium.

(c) **Class II** incorporates all cases with normal fusion and abnormal absorption of the midline septum. Thus, *septate uterus* is characterized as any uterus with a normal outline and with an inner indentation at the midline level (septum) that divides the cavity. A septum is defined as any indentation at the midline level exceeding at least by 50% (half) the uterine wall thickness and reaching up to the full division of the cavity and/or the
cervix and/or the vagina into two distinct parts. It should be noted that in definitions, the use of absolute numbers (e.g., indentation of 5 mm) is avoided since the “normal” uterine dimensions as well as uterine wall thickness are not known and they could be different from one patient to another. Thus, it seems more justified to define uterine deformity as proportions of each patient’s uterine anatomical condition [54].

Class II is further divided into two sub-classes according to the degree of the uterine cavity deformity (uterine corpus, including or not the cervix): (a) partial septate uterus is characterized by the presence of any septum partially dividing the uterine cavity above the level of the internal cervical oss; (b) complete septate uterus is characterized by the presence of a septum fully dividing the uterine cavity up to the level of the internal cervical oss. Cases with cervical (e.g., bicornuate uterus) and/or vaginal defects [55–61] can be further sub-classified with the addition of cervical and/or vaginal congenital anomalies in the fully developed system.

(d) Class III incorporate all cases of fusion defects. The term dysfusion comes from the addition of the Greek origin “dys” to the English “fusion” to describe the abnormal fusion of the two uterine sides during embryologic development. In this main class all cases of formerly described didelphys and bicornuate uterus are included. This enables us to create a more embryological clear category without “transitional” cases [62].

Thus, a dysfused uterus is characterized as any uterus with an abnormal outline at the level of uterine midline. As can easily be imagined, it is also associated with an inner indentation at the midline level (septum) that divides the cavity. An abnormal uterine outline is defined as any fundal indentation exceeding half of the uterine wall thickness at the midline level and reaching up to the full separation of the uterus into two distinct hemi-uterus (formerly didelphys uterus).

Class III is further divided into two subclasses according to the degree of the uterine body deformity (uterine corpus, including or not the cervix): (a) partial dysfused uterus is characterized by an outer form indentation at the level of uterine midline partially dividing uterine corpus above the level the cervix; (b) complete dysfused uterus is characterized by an outer form indentation at the level of uterine midline fully dividing uterine corpus up to the level of the cervix. Cases with cervical (double cervix/formerly didelphys uterus) and/or vaginal defects (e.g., didelphys uterus with obstructing or not vaginal septum) [22, 63–72] could be sub-classified in the fully developed system with the addition of cervical and/or vaginal congenital anomalies.

A general subcategory of Class III is dysfused “septate” uterus. In these cases, fusion defects come together with absorption defects. A dysfused “septate” uterus is defined as any dysfused uterus in which the width at the midline uterine fundus’ level exceeds by 50% that of the uterine wall thickness (e.g., if the uterine wall thickness is by mean 10 mm as dysfused “septate” uterus is characterized as any thickness in the midline indentation >15 mm). The necessity of creating this distinct subcategory comes from the fact that these cases can be

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**Fig. 1** Schematic representation of uterine anomalies’ classification

| 0. Normal uterus | I. Dysmorphic uterus | II. Septate uterus |
|------------------|---------------------|-------------------|
| ![Image](image1) | ![Image](image2) | ![Image](image3) |
| ![Image](image4) | ![Image](image5) | ![Image](image6) |

| III. Dysfused uterus | IV. Unilaterally formed uterus | V. Aplastic / dysplastic uterus |
|----------------------|-------------------------------|--------------------------------|
| ![Image](image7) | ![Image](image8) | ![Image](image9) |
| ![Image](image10) | ![Image](image11) | ![Image](image12) |

| VI. Unclassified cases |
|------------------------|
| ![Image](image13) |

*Make a drawing*
partially treated by hysteroscopic septum resection. Furthermore, this subcategory is included in the class of dysfused uterus since: (1) by definition, any abnormal outline defect is included in this category (accuracy of definition); (2) the result of hysteroscopic treatment is a “clear” dysfused uterus; and (3) during hysteroscopic treatment to avoid complications (uterine rupture), underlining of the abnormal external outline is clinically important.

(e) Class IV incorporates all cases of unilateral formed uterus with aplasia or dysplasia of the other uterine half. It is a formation defect, but the necessity of classifying it separately from full aplasia comes from the presence of a fully developed functional uterine hemicavity, which does not exist in cases of aplasia. A more simple subdivision is also chosen for Class IV compared to that in the ASRM classification system; it is divided into two sub-classes based on the presence/absence of a cavity in an existing rudimentary horn, since the presence of the cavity is the most important factor for certain complications such as ectopic pregnancy in the rudimentary horn or hematocavity [73–78]. Furthermore, treatment is only indicated in cases of patients having a rudimentary horn with cavity (laparoscopic removal) [79, 80].

It should be noted that the name of this class is derived from the normally developed horn, whereas the name of the subclasses are attributed to the characteristics of the abnormally developed horn.

(f) Class V incorporates only cases of uterine aplasia/dysplasia (formation defect) and is thus designed as a “clear” category [21, 50, 81–92]. As already mentioned, cases with cervical, vaginal or adnexal aplasia/dysplasia (having different embryological origin, clinical presentation, prognosis and treatment) can be classified in separate categories or sub-categories of the fully developed new classification system. The term “dysplasia” has a Greek origin, and it means abnormally developed uterus, which fits in cases with non-functional developed parts of the uterus. As a synonym, the term “dysgenesis” can be used; this also means abnormal formation.

Class V is further divided into two subclasses based on the presence/absence of a cavity in an existing rudimentary horn, avoiding an extremely detailed subdivision [21, 45, 85, 91, 93, 94]. This criterion is chosen because this seems to be a clinically significant parameter for patient’s management: the presence of a cavity could be combined with complications such as “hemato-cavity” [37, 95] and gives the possibility to restore anatomical continuity after neovagina formation with isthmo-neovagina anastomosis [37, 85, 94].

(g) Finally, Class VI is reserved for still unclassified cases. Modern imaging technology (ultrasound and/or magnetic resonance imaging) can provide objective estimation of uterine anatomy for the needs of differential diagnosis between the six groups. However, rare anomalies, subtle changes or combined pathology may likely not to be allocated correctly to one of the six groups [96]; for these cases, in order to keep the groups “clear”, a sixth class is created.

Comments on the proposed classification of uterine anomalies

In the presented classification system, arcuate uterus is deleted as a separate entity, since by definition (ASRM classification) it has no clinical significance [17]. Furthermore, all these years a great confusion has existed between arcuate and septate uterus (which are the anatomical borders), and some terms such as small septae have been also used to describe cases of arcuate (?) uterus with clinical significance in prognosis [23, 97, 98]. Hence, for the needs of clarity of the new system, only septate uterus has been included as a different class coming from an absorption defect.

An effort has been made to have clear and accurate definitions based on uterine anatomy. The degree of uterine cavity deformity has been chosen for the sub-classification of dysfused and septate uterus; any deformity reaching up to the cervix is defined as complete and any other as partial. However, another important criterion, which could be taken into account, is patient’s prognosis. Thus, it is extremely important in the fore coming studies to have a clear reference to the uterus anatomical situation in order to decide what is clinically important and what not.

Imaging techniques for the diagnosis of uterine anomalies

Anatomy is the basis of the new system. Thus, diagnosis of uterine anomalies should be based on diagnostic modalities that could determine the anatomical status of the female genital tract on a more objective way [99]. The ideal diagnostic method should provide objective and measurable information on the anatomical status of the uterus in a non-invasive way.

The available diagnostic methods that can be used in the investigation of the patient are as follows:

1. **Gynecological examination (GE).** It should be noticed that gynaecological examination is very important in the diagnostic work-up of the patients with congenital malformations. Vaginal malformations (aplasia, septum) and some cervical malformations could be diagnosed objectively mainly with inspection. Furthermore, palpation through the vagina and/or the rectum (in cases of...
vaginal aplasia) could provide useful but not always objective information.

2. **Two-dimensional ultrasound (2D US)**. This mainly transvaginal approach provides objective and, importantly, measurable information for the cervix, the uterine cavity, the uterine wall and the external contour of the uterus. It is very popular and accessible, non-invasive, but its accuracy highly depends on the experience of the examiner and on the examination methodology followed [100–102].

3. **Sonohysterography (SHG)**. Compared to 2D US, this method has the additional advantage of offering a better imaging of the uterine cavity, thus enhancing the accuracy in identifying the anatomy of the female genital tract and especially that of the uterus [103–110].

4. **Hysteroscopy (Hys)** is the gold standard for the examination of the cervical canal and the uterine cavity. However, as it does not provide information on the myometrial layer, hysteroscopy alone could not be used for the differential diagnosis between different groups. Nowadays, with the use of normal saline as distension medium and the miniaturization of the rigid scopes, hysteroscopy has become a minimally invasive screening tool, well tolerated by the patients and feasible for gynaecologists [34, 111, 112].

The combination of 2D US, SHG and hysteroscopy is proposed as the current standard, one “stop”, evaluation protocol for the screening and diagnosis of uterine anomalies.

1. **Three-dimensional ultrasound (3D US)** provides an ideal, objective and measurable representation of the examined organs [113–120]. It provides information on the cervix, the uterine cavity, the uterine wall, the external contour of the uterus and the other structures with the exception of tubes. Theoretically, it seems to be an ideal method for the diagnostic approach of the uterus.

2. **Magnetic resonance imaging** seems to be a very useful diagnostic tool, since it can provide detailed information on the anatomical status of the female genital tract [114, 121–124]. Contrary to the visualization in ultrasound, in MRI myometrium is not seen as a homogeneous smooth muscle mass but is divided into two different structural and functional entities: the internal myometrium or junctional zone (JZ), ontogenetically related to endometrium and functionally important for reproduction, and the outer myometrium which is seen as a larger hypodense zone [125–128]. It should be noted that MRI is expensive, and its validity in the diagnosis of congenital malformations is under investigation. Until now, it has not been used as a primary diagnostic tool but was applied mainly for the investigation of complex anomalies [117, 129–132].

3. **Hysterosalpingography** has been and is still frequently the primary and only non-invasive diagnostic tool used for the diagnosis of uterine’s cavity deformations. It cannot provide any information on the uterine wall and the external contour of the uterus [3, 133–135]. In order to overcome this serious limitation, Ott et al. [136] proposed the use of the angle formed by the hemi-cavities for the needs of differential diagnosis. It should also be noted that the quality of HSG is highly dependent on the examiner: both the examination performance and image interpretation have to be done preferably by a gynaecologist, which is not always feasible in daily practice: for example, in cases of double cervices to catheterize both of them and during the examination to pull the uterus for the best imaging of the uterine cavity [137]. Obviously, ultrasound provides superior quality information than HSG.

4. **Laparoscopy and Hysteroscopy**. The combined application of these endoscopic techniques is thought to be the gold standard in the investigation of women with congenital malformations and especially the uterine ones [138]. However, the diagnosis is mainly based on the subjective impression of the clinician performing them, and this is thought to be a limitation in the objective estimation of the anomaly [15].

The specificity and sensitivity of the above-mentioned methods in the investigation of patients with uterine malformations have been recently reviewed [3]. Based on their diagnostic accuracy, the diagnostic methods have been categorized into four categories:

- **Class Ia** — Those that are capable of identifying congenital uterine anomalies and classifying them into appropriate sub-types with an accuracy of >90%. Hysteroscopy plus laparoscopy, SHG and 3D US belong to this class.
- **Class Ib** — Those that are capable of identifying congenital uterine anomalies with an accuracy of >90% without being able to classify them into appropriate sub-types. Hysteroscopy alone belongs to this class.
- **Class II** — Those that are capable of identifying congenital uterine anomalies with an accuracy of <90%. According to the available data, HSG and 2D US belong to this class.
- **Class III** — This includes the investigations whose diagnostic accuracy in identifying congenital uterine anomalies is still not exactly known. MRI belongs to this class.

It seems, therefore, that a wide variety of diagnostic tests are available for the interpretation of the female genital tract anatomy with different diagnostic properties as well as variable diagnostic accuracy. Thus, based on the clinical presentation of the patient, the clinician should start with gynaecological examination. HSG cannot be considered as a first line diagnostic tool, and should be used under specific conditions only. Nowadays, transvaginal 2D US seems to be
the basic imaging method: it is simple, available in almost every outpatient clinic, and can give reliable, reproducible and measurable information on uterine anatomy for exact diagnosis and differential diagnosis between the different categories. Enlargement of the examination with SHG and ambulatory mini-hysteroscopy seems reasonable since they can provide additional information; they are office procedures with low risk and high patient satisfaction rates.

Further detailed information on uterine anatomy can be obtained with the use of 3D US. A disadvantage for its widespread use is that it is not available everywhere, is more expensive and can be used only by experienced personnel. MRI has comparable diagnostic accuracy with that of 3D US and provides supplementary information on the two structurally and functionally different zones of the myometrium. At the moment, its use is limited depending on the safety regulations of each country, and should be kept for cases where 3D US is necessary but unavailable or has failed to give an objective estimation of the female genital tract anatomy.

However, for the needs of patients’ grouping according to the new system, a clear and exact representation of the female’s genital tract anatomy is the desired result of a successful diagnostic work-up. Nowadays, endoscopic techniques (laparoscopy and hysteroscopy) should be kept mainly for the patient’s treatment or for the elucidation of extremely rare and unclassified cases [139].

Conclusion

Congenital malformations of the female genital tract are a common entity with an estimated prevalence of 4–7%. The need for a new updated classification has been already underlined since currently available systems are associated with various limitations in effective categorization of the anomalies. The EAGS has established a scientific project on this issue, aiming to critically evaluate the current situation and to prepare the scientific basis for a new system. This initiative has been adopted by the recently established common ESHRE/ESGE working group of experts (CONUTA group). Consensus for the development of a new classification system should be reached using the Delphi procedure.

A new clinical approach for the classification of uterine anomalies is proposed. Uterine anatomy is the basis of the new system. Embryological origin has been adopted as the secondary basic characteristic in the design of the main classes. The system is open for further development including further subdivisions based on cervical and vaginal anatomical varieties in order to be more comprehensive. The new proposed system takes into account the experience gained from the currently available classification systems mainly that of the AFS. It is simple, clear and accurate in its definitions. It could be used as the starting point for the working group of experts in the field.

Declaration of interest The authors report no conflicts of interest. The authors alone are responsible for the content and writing of the paper.

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