MRI Imaging in Congenital Mullerian Duct Abnormalities Using New Classification from the American Society of Reproductive Medicine (ASRM MAC2021)

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ABSTRACT

Infertility is a very important issue. One of the causes of fertility disorders is due to congenital abnormalities in the Mullerian ducts. Congenital abnormalities of the Mullerian ducts are deviations from normal anatomy which include the uterus, fallopian tubes and or the upper two-thirds of the vagina originating from the paramesonephric. Mullerian duct anomalies originate from disturbances that occur in the three phases of uterine development starting from organogenesis, fusion, or septal resorption. MRI is an imaging modality with a fairly high level of accuracy, making it an ideal modality in the diagnosis of congenital Mullerian duct anomaly. With the ASRM MAC2021 classification system, it is easier to assess and analyze anatomical structures to diagnose congenital abnormalities of the Mullerian duct. This research is a retrospective descriptive study conducted at RSUD Dr. Soetomo Surabaya and has ethical license. There were 52 subjects in this study who were obtained from 2018-2021.

In this study, the frequency according to the ASRM MAC2021 classification with the mullerian agenesis type was 36 patients (69%), cervical agenesis 4 patients (7.6%), unicornuate uterus 3 patients (5.7%), uterus didelphys 5 patients (9.6%), bicornuate uterus 1 patient (1.9%), septate uterus 1 patient (1.9%), longitudinal vaginal septum 1 patient (1.9%), transverse vaginal septum 1 patient(1.9%) %) and complex anomalies 0 patients (0%) from a total of 52 samples. To sharpen and facilitate the evaluation of congenital abnormalities, segmental descriptions are used in the results of the MRI examination.

Keywords: Infertility, MRI, Mullerian ducts, ASRM MAC2021

1.1 Introduction

Infertility is the inability to get pregnant after 12 months or more of marriage through regular sexual intercourse without using contraception. Infertility is classified into two parts, that was primary and secondary. Primary infertility occurs when the wife has never been pregnant at all, while secondary infertility occurs in women who have been pregnant. The World Health Organization (WHO) in 2012 stated that one out of every four couples in developing countries has experienced infertility (FT PAsaribu, 2020).

Mullerian duct abnormalities are deviations from normal anatomy which include the uterus, fallopian tubes and or the upper two-thirds of the vagina originating from the paramesonephric (Wu et al., 2021). Anomalies of the Mullerian ducts originate from disturbances that occur from the three phases of uterine development starting from organogenesis, fusion, or septal resorption (Bhayana and Ghasi, 2019).

The American Society for Reproductive Medicine (ASRM) classification is the most popular and widely used classification for approximately 25 years (Buttram et al., 1988). The new ASRM classification modified the categories to include three additional groups, namely longitudinal vaginal septum, transverse vaginal septum, and complex anomalies. ASRM Classification of Mullerian Anomalies 2021(ASRM MAC 2021) classifies mullerian anomalies into nine categories. This different with the AFS classification, the anomaly categories are no longer numbered but are identified with descriptive terminology, that was Mullerian agenesis, Cervical agenesis, Unicornuate uterus, Uterus didelphys, Bicornuate uterus, Septate uterus, Longitudinal vaginal septum, Transverse vaginal septum and Complex anomalies (AFS, 2021).

Magnetic resonance imaging (MRI) is an imaging modality with a fairly high level of accuracy, making it an ideal modality in the diagnosis of anomaly in the Mullerian duct (Narang, Cope and Teixeira, 2018). In addition, MRI is also a non-invasive modality that can visualize the involvement of nearby organs such as the ovaries, kidneys, lower urinary tract, and also musculoskeletal abnormalities (Maciel et al., 2020).

1.2 Methods and Materials

1.2.1 Study Design

This study was a descriptive study with a retrospective design using medical records and MRI examination results from patients with congenital Müllerian duct abnormalities who were examined at Dr. Soetomo Surabaya, Indonesia from 2018-2021.

1.2.2 Data collection

Researchers identified medical records and history data of congenital Mullerian duct patients who had performed MRI examinations at Dr. Soetomo Surabaya from 2018-2021. Evaluation of the MRI findings was performed by a senior experimental radiologist(average 10 years of experience).

1.2.3 Imaging Protocol

All congenital Mullerian duct patients do examination pelvic MRI using a 1.5 T MRI machine, GE brand, type Brivo MR 360 software workstation AW volume share 5 GE or MRI 3 T brand Siemens Magnetom Skyra software syngiovia serial number 10496180. A total of 52 patients with congenital Mullerian duct obtained from 2018-2021 at Doctor Sutomo General Hospital Surabaya. Age range of research subjects between 13 to 43 years. Evaluation. To evaluate the anatomy, non-fat suppressed T1 and T2-weighted were performed. T2 weighted can provide soft tissue contrast which is important for the anatomic evaluation of the uterine zone, identification of a rudimentary uterus, and characterization of cysts. Evaluation of the uterine fundus can be performed with a non-fat suppressed coronal oblique T2-W. Meanwhile, to measure the length of the vagina can be done T2-W non-fat suppressed sagittal. Renal and urinary tract anomalies that may be associated can be evaluated on coronal T2. T1-W with and without fat suppressed is important for the detection of hematometrocolpos which can sometimes be seen in Mullerian anomalies. In addition, T1-W can also distinguish between fat and blood. If inflammation is found, diffusion weighted can be helpful for evaluation. Generally IV contrast is not needed (Rivas et al., 2021).
From the results of the imaging performed, it is necessary to carry out an in-depth evaluation. The segmental description helps for a more detailed evaluation to more easily classify the abnormality as well. This segmental evaluation consists of the uterine horns, external fundal condules, internal contours, endometrial canals, uterine septations, rudimentary horns, cervix, vagina, ovaries, kidneys, ureters, spine, and presence or absence of endometriosis or infection (Rivas et al., 2021).

1.2.4 Imaging Interpretation Techniques

From the results of the MRI examination, a segmental description was carried out to assist in a more detailed evaluation and to make it easier to classify abnormalities as well. This segmental evaluation consists of the uterine horns, external fundal condules, internal contours, endometrial canals, uterine septations, rudimentary horns, cervix, vagina, ovaries, kidneys, ureters, spine, and presence or absence of endometriosis or infection (Rivas et al., 2021).
Then the examination data was concluded using the new ASRM MAC 2021 classification. Some tips and special notes for MRI evaluation of Mullerian duct abnormalities according to the ASRM classification: (Cristina Maciel, 2020).

a) Mayer-Rokitansky-Küster-Hauser syndrome
- Small uterine remnants (unilateral or bilateral) are often missed on MRI
- Report presence/absence of endometrium in rudimentary horns or hypoplastic uterus
- Report vaginal length (measurement in the sagittal plane)
- The ovary is generally in an ectopic location in the abdomen
- Look for bony malformations

b) Unicornuate uterus
- The rudimentary little horn is often overlooked or misrepresented
- Check whether the rudimentary horns communicate or not
- Report presence/absence of endometrium in the rudimentary horn
- Describe the extension of the attachment between the rudimentary horn and the hemi-uterus: separated/connected by fibrous bands/fused
- Note the topographical relationship between the rudimentary horn and the ipsilateral ureter relevant for planning surgery

c) Septate uterus
- Report septal length and thickness
- Report septal composition: fibrous/muscular/muscular + fibrous

d) Vaginal septum characteristics
- Transverse: low, middle, high
- Longitudinal: obstructing, non-obstructing
- Long, thick
- Presence/absence of penetration

e) Maldescent ovarian
- Diagnostic criteria: the upper pole of the ovary is above the pelvis, as defined by the pubic symphysis sacral promontory line; the upper pole of the ovary is at or above the branches of the iliac arteries
- May be uni- or bilateral
- When the ovaries are not in their normal location, look above the pelvic brim. Paracolic gutter is a common location. Very rarely the ovary may be located in the inguinal canal

f) Kidneys and ureters
- Assessment of renal abnormalities: renal agenesis, pelvic kidney
- Look for ectopic ureters
- Look for ureteral remnants in patients with renal agenesis

g) Complications associated with obstructive anomalies
- Acute: haematocolpos, haematometra, haematometrocolpos, haematosalpinx, pyohaematocolpos, pyometra, pyosalpinx
- Long term: endometriosis, pelvic adhesions

1.3 Results

1.3.1 Results Profile description of patients with Mullerian duct disorders based on age distribution.

Research subject data were categorized into the age groups of children (<10 years), adolescents (11-19 years), adults (20-60 years) according to the age range classification according to WHO. The age range of the research subjects was between 13 and 43 years, with an average age of 24 years with a standard deviation of 6.63. Based on the findings of congenital abnormalities of the Mullerian duct, there were 11 patients (21.2%) in the adolescent age group and the frequency of adult patients was 41 people (78.8%). researchers also try to analyze the distribution patient Mullerian duct based on age with Chi Square. From the data, it was found that the Chi Square significance with a P value of 0.336, in Chi Square it would be considered a significant relationship if the P value < 0.05. It is clear that there is no significant correlation and relationship in the distribution of ASRM patients by age. (Ludwin and Ludwin, 2015)

1.3.2 The findings match the segmental description on the MRI analysis results

Uterine horn, Fibrous band, Midline triangular

Interine horn, fibrous band, midline triangular were observed in 36/52 cases. In some cases evaluated for the presence or absence of uterine horns, fibrous bands and midline triangular. In addition, an analysis of the signal intensity images from MRI of the uterine horn, fibrous band, midline triangular was also carried out, the result was that there were more isointensity signals in 34/52 cases. For the location of the position towards the ovary, it is divided into cranio cauda and anterior position where from the cases we examined, it was found that more were in the cauda ovary by 29/52, in cranial position 1/52 cases, and in the same position it was found in 6/52 cases

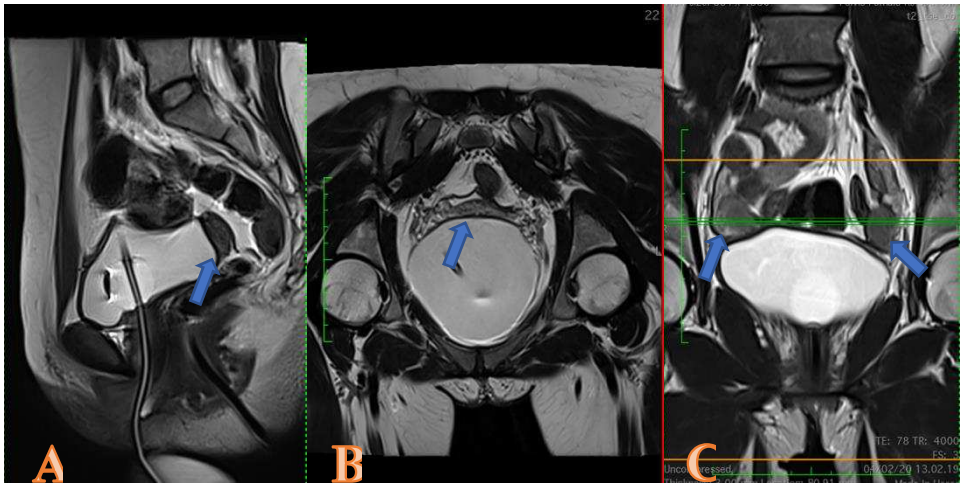

Fig. 1. a 29-year-old female patient with MRKH type I. (a) sagittal MRI T2 showing midline triangular soft tissue without cavities, (b) axial MRI T2 showing isointense fibrous band (c) coronal MRI T2 showing bilateral hyperintense rudimentary uterine remnants

Vaginal and ovary

The ovaries were evaluated for the presence or absence of MRI images in cases of Mullerian duct anomaly, the results showed that 52/52 cases were clearly easy to evaluate. Evaluation of the vagina then we assess whether or not it looks from the MRI picture. In addition, we also evaluate the presence or absence of obstruction/septa in the vagina from the MRI picture. The results of the vaginal evaluation found septal abnormalities in 2/52 cases with 1 patient being divided into longitudinal septal vaginal type, 1 patient transverse vaginal septum

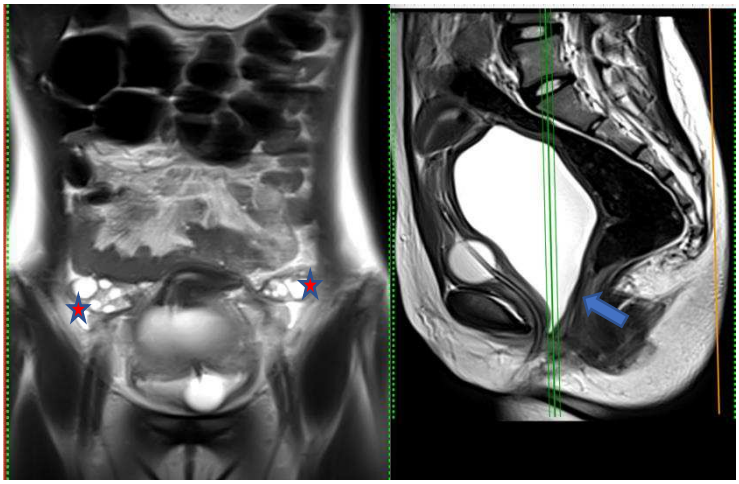

Fig. 2. a 15-year-old female patient with ASRM type transverse vaginal septum on MRI t2 coronal sagittal shows a hyperintense collection in the endometrial cavity, the upper two-thirds of the vagina and a thick septum separating the upper two-thirds of the vagina from the lower 1/3 with bilateral ovaries that still look normal .

Kidney anomaly

Evaluation of the kidneys needs to be evaluated because in some embryology we know that there are also abnormalities in the kidneys. From the evaluation we got 1 case that appeared where we found renal agenesis.

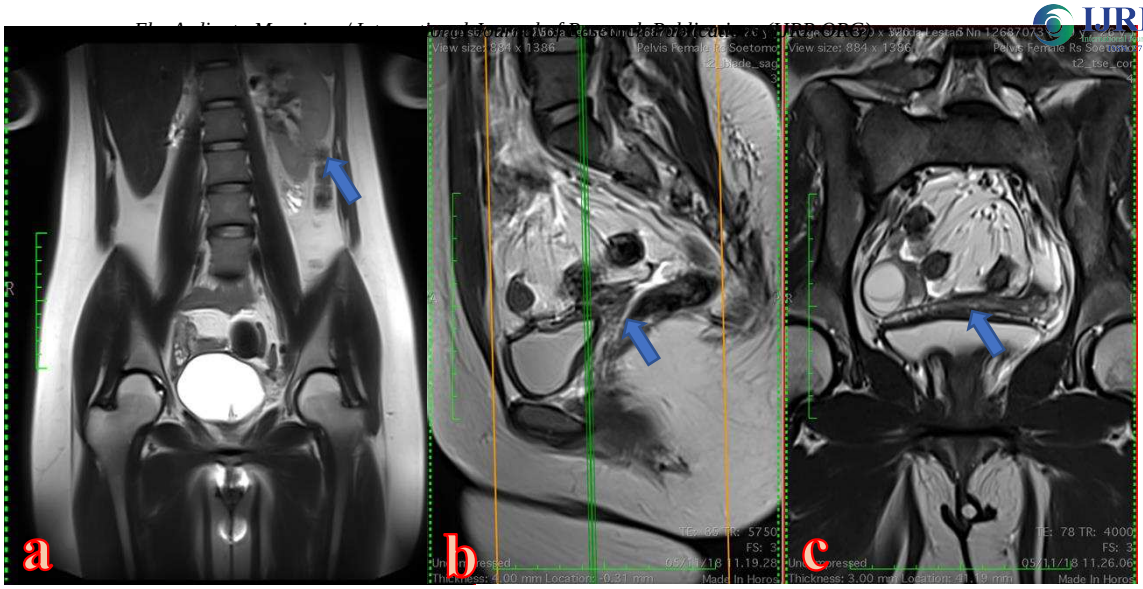

Fig.3. of a 28-year-old female patient with MRKH type 2. (a) Coronal MRI T2 shows normal left kidney in the fossa of the left kidney with no right kidney, (b) sagittal MRI T2 shows midline triangular soft tissue without cavities, (c) coronal MRI T2 shows isointense fibrous bands.

1.3.3 Results an Overview of The Distribution of ASRM From The Data Obtained From 2018-2021

In this study, the frequency of patients with ASRM mullerian agenesis was 36 patients (69%), cervical agenesis 4 patients (7.6%), unicornuate uterus 3 patients (5.7%), uterus didelphys 5 patients (9.6%) , bicornuate uterus 1 patient (1.9%), septate uterus 1 patient (1.9%), longitudinal vaginal septum 1 patient (1.9%), transverse vaginal septum 1 patient (1.9%) and complex anomalies 0 patients (0%) from a total of 52 samples.

1.4 Discussion

MRI examination modality is widely used in the evaluation of congenital mullerian ducts. The sensitivity and specificity of MRI in correctly categorizing this anomaly are reported to be different and range from 100% to 28.6% and 100% to 66% respectively (Deutch, 2008). In the study by Mueller et al., MRI gave a good agreement rate (kappa = 0.8) with the clinical diagnosis of Mullerian duct anomaly. However, MRI still has drawbacks where the price is quite expensive and availability is difficult. In addition, artefacts due to patient movement, intestinal peristalsis, and breathing can result in evaluation difficulties (Rivas et al., 2021).
At the end of 2021, the American Society for Reproductive Medicine (Pfeifer, 2021) presented a new classification for mullerian anomalies based on the well-known classification of AFS. The categories were modified and expanded by adding three groups, that was longitudinal vaginal septum, transverse vaginal septum, and complex anomalies, resulting in nine categories. They further include detailed descriptive terms of the anomalies rather than using symbolic terms as used

in the ESHRE system, and even suggest other descriptions for the anomalies while emphasizing the most frequently used. The new system includes most of the anomalies described but exhibits their incompleteness, similar to other systems, as a consequence of possibly an unlimited number of variations. Thus, the system can be updated to include new anomalies.

The most frequent anomaly found in our study was Mullerian agenesis in 36 patients (69%) resulting from failure of development of the mullerian canals, resulting in the absence of the uterus, cervix, and proximal vagina in its most severe form, also known as Mayer-Rokitansky--Kuster-Hauser syndrome. It prevalence is very high among our patients. This is similar to the results of a study by Bernadette et al which reported a prevalence of 24% (Carrington, 1990). Arcuate uterus was considered the mildest form of failed mullerian septal resorption, but because it had no adverse clinical outcome it was considered a normal variant and consequently was not considered in our study. However, it must be differentiated from a septate uterus by evaluating the depth of the fundal myometrium protruding into the uterine cavity which must be less than 1 cm in size with an obtuse angle of >90° compared to >1 cm in length and <90° in a septated uterus (Pfeifer, 2021).

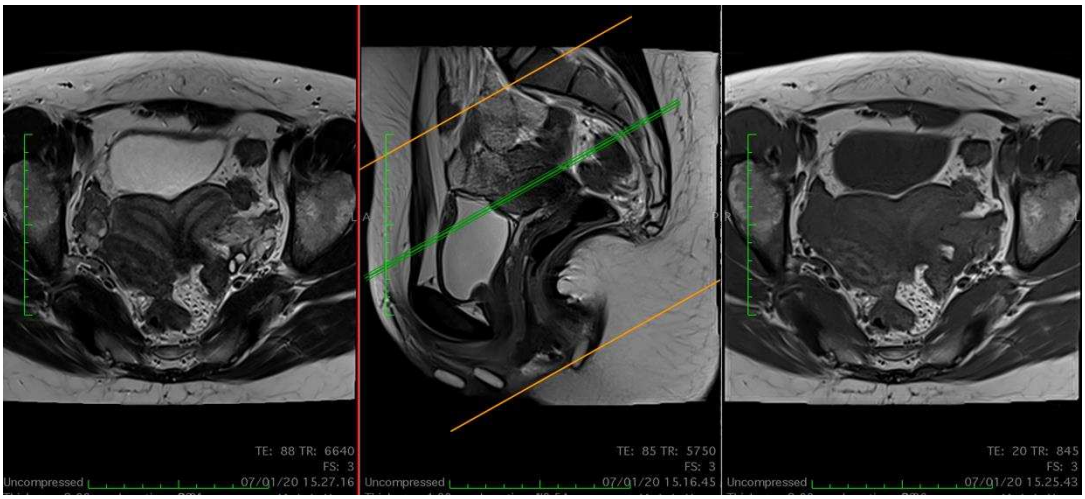

Fig. 4. T2WI MRI of coronal, sagittal, axial pelvis, Mrs V, 35 years showing partial uterine bicornu

The bicornuate uterus results from incomplete fusion of the mullerian ducts resulting in two separate, symmetrical uterine horns that appear to fuse in the lower and/or middle segments of the uterus. There will be two endometrial cavities communicating with each other by a single cervix (unicollis bicornuate). However, there may be non-degeneration of the fused segment of the lower uterus and cervix resulting in two separate uterine cavities and duplication of the cervix (bicornuate bicollis) (Robbins, 2015).

Uterus didelphys results from non-fusion of the mullerian ducts which gives rise to very distinct uterine horns with two separate endometrial cavities and two cervixes. It differs from a bicornuate uterus in that there is no fusion at all between the uterine horns and the cervix, although cervical fusion is small, especially inferior, (Robbins, 2015).

The relationship between renal anomaly and Mullerian anomaly is well known. In one study, 30% of patients with mullerian anomaly showed no kidney; the majority are associated with uterine didelphys (63%) and less frequently with uterine agenesis (15%) (Hall-Craggs, 2013). In a cohort of 115 patients with MRKH syndrome, 27.8% presented with accompanying renal or ureteral malformations, most of them (18%) presented with unilateral renal agenesis. Moreover, they found that in cases with uterine remains, one kidney was located ipsilateral to it (Preibsch H, 2014).

Several limitations were encountered in this study. One limitation is the retrospective nature of the study, which selected patients who were already diagnosed, which could introduce selection bias. This can impact prevalence rates and make comparisons of prevalence with prospective studies unreliable. Another possible limitation is the small sample size, which results in a small number of available cases for each disorder. Therefore, the performance of the classification system in this limited case may not necessarily represent its performance in general, such as the sample used

1.5 Conclusion

Research at RSUD dr. Soetomo from the period 2018 – 2021 shows that the most age distribution pattern in patients with Mullerian duct Anomaly is in the age group of 20-60 years. Symptoms due to Mullerian duct Anomaly are only known in adolescents and adults because they are asymptomatic at an earlier age, so there is no significant correlation of the incidence of congenital Mullerian duct abnormalities with a different age distribution (Chi Square: P value 0.336).

This study shows that the MRI modality is the best imaging modality in evaluating congenital Mullerian duct abnormalities using segmental descriptions so that they can find abnormalities in the uterus, cervix, vagina, ovaries to abnormalities in the kidneys and vertebrae and complications that occur, namely endometriosis.

Based on the classification of the American Society of Reproductive Medicine (ASRM MAC2021) at dr. Soetomo, from the period 2018 – 2021, it is known that the distribution pattern of the most cases is in the Mullerian Agenesis type (69%) followed by uterus didelphys (9.6%), cervical agenesis (7.6%), unicornuate uterus (5.7%) , bicornuate uterus(1.9%), septate uterus(1.9%), longitudinal vaginal septum(1.9%) and transverse vaginal septum(1.9%).

Acknowledgement

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Ethical clearance

This study was approved by the ethics committee of Dr. General Hospital. Soetomo, Surabaya, Indonesia (Ref.No : 0804/LOE/301.4.2/II/2022).

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Conflict of interest

Nil

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