REVIEW ARTICLE

Uterine Fibroids (Leiomyoma, Myoma)

Zorancho Petanovski[1], Asim Kurjak[2]

Received on: 25 October 2022; *Accepted on:* 05 November 2022; *Published on:* 26 December 2022

Abstract

Uterine fibroids (leiomyomas, myomas) are the most common tumor formations of the uterus. These are tumors with benign potential and the occurrence of malignancy or finding of leiomyosarcoma is rare. Fibroids can occur in any part of the uterus. They can appear on the cervix and the corpus in the broad ligament. The general classification of fibroids is based on their localization and is divided into intramural, submucosal, and subserosal fibroids. The appearance of uterine fibroids on ultrasound is determined by the structure of the tumor itself. Therefore, there are several types of classifications that aim to localize the tumor itself preoperatively. The most commonly used one now is by the International Federation of Gynecology and Obstetrics (FIGO) PALM-COEIN (polyp, adenomyosis, leiomyoma, malignancy and hyperplasia, coagulopathy, ovulatory dysfunction, endometrial, iatrogenic, and not yet classified) classification. From what has been stated so far, it can be seen that ultrasound is essential in the detection of fibroids, their number, dimensions, and topography in terms of the body of the uterus, but also important information about the relationship between the tumor and the cavity of the uterus. Three-dimensional (3D) ultrasonography improves the image of leiomyoma, volume, and localization. With 3D saline infusion sonohysterography (SIS) ultrasonography, it is possible to make a solid presurgical score et sub mucous leiomyoma in terms of treatment choice and certainly a prognosis in terms of preserving the reproductive potential of the uterus.

Keywords: International Federation of Gynecology and Obstetrics, Three-dimensional saline infusion sonohysterography ultrasonography, Three-dimensional ultrasonography, Uterine fibroids (Leiomyomas, Myomas).

Donald School Journal of Ultrasound in Obstetrics and Gynecology (2022): 10.5005/jp-journals-10009-1948

This paper has been previously published as Zorancho Petanovski, Asim Kurjak: uterine fibroids (Leiomyoma and myoma). In: Petanovski Z, Kurjak A. 3D-4D Ultrasound in Gynecology. Jaypee Brothers, New Delhi, 2022, pp 21-37.[1]

Introduction

Uterine fibroids (leiomyomas, myomas) are the most common tumor formations of the uterus. Leiomyomas are the result of the growth of fibrovascular cells from the myometrium. Histologically, fibroids contain muscle and connective tissue. These have a pseudocapsule that is richly vascularized.[2] Certain factors from that vascularized pseudocapsule raise the level of estrogen, which in turn increase the level of certain growth factors resulting in the growth of the tumor itself.[3,4] The peak prevalence of uterine fibroids is the 4th decade of a woman's life due to the cumulative effect of estrogen, progesterone, and fibroid growth factors during the female reproductive period,[5] with a presence of over 70% in women over 50 years of age. These are tumors with benign potential and the occurrence of malignancy or finding of leiomyosarcoma is rare, with about 0.2%.[6]

Ultrasound Characteristics of Uterine Fibroids

The appearance of uterine fibroids on ultrasound is determined by the structure of the tumor itself. The muscle tissue from which the uterine fibroid is made gives echogenicity to the tumor, similar to that of the myometrium. Leiomyomas generally have a whorled appearance of solid masses, with a clear edge of demarcation of the tumor to the surrounding tissue due to displacement of myometrial fibers resulting in pseudocapsule. Vascularity may vary in abundance, but the peripheral circular pattern is consistent in all leiomyomas.

[1]Department of Gynecology and Obstetrics, IVF Centre, Re-Medika, Skopje, Republic of North Macedonia; Faculty of Medical Sciences, Goce Delchev University, Stip, Republic of North Macedonia

[2]Department of Obstetrics and Gynecology, School of Medicine, University of Zagreb, Zagreb, Croatia; University of Sarajevo, Sarajevo, Bosnia and Herzegovina; Sarajevo School of Science and Technology, Sarajevo, Bosnia and Herzegovina

Corresponding Author: Zorancho Petanovski, Department of Gynecology and Obstetrics, IVF Centre, Re-Medika, Skopje, Republic of North Macedonia; Faculty of Medical Sciences, Goce Delchev University, Stip, Republic of North Macedonia, Phone: +38972443114, e-mail: zpetanovski@yahoo.com

How to cite this article: Petanovski Z, Kurjak A. Uterine Fibroids (Leiomyoma, Myoma). Donald School J Ultrasound Obstet Gynecol 2022;16(4):282–297.

Source of support: Nil

Conflict of interest: None

From an ultrasound point of view, according to Morphological Uterus Sonographic Assessment (MUSA), a consensus statement on terms, definitions, and measurements that may be used to describe and report the sonographic features of the myometrium using grey-scale sonography, color/power Doppler and 3D ultrasound imaging, uterine fibroids have the following characteristics:[7]

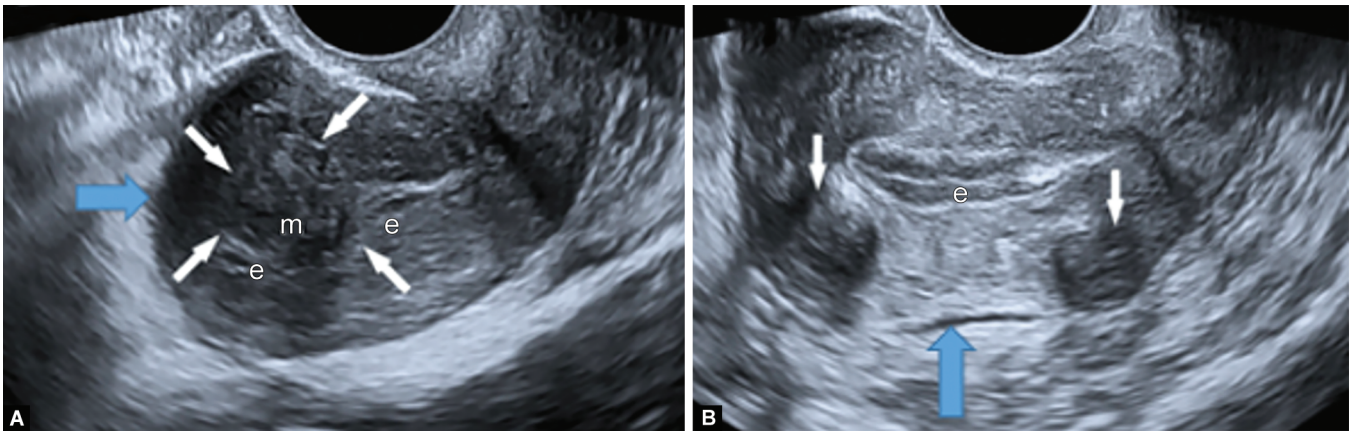
- A well-defined lesion is the serosal contour of the uterus lobulated or regular, and asymmetry of uterine walls in the presence of a well-defined lesion (Figs 1 to 4).
- Round, oval, lobulated shape of the lesion, a contour is a smooth and hypo or hyperechogenic rim (Fig. 5).
- Shadowing: Edge shadows, internal shadows (often fan-shaped shadowing) (Figs 6 to 8).
- Echogenicity: Uniform hypoechogenic usually; nonuniform: Hyper, hypo, or mixed echogenicity or even calcified or anechoic if degenerated (Figs 9 to 12).
- Vascularity: Circumferential flow (Figs 13 to 15).
- Junctional zone (JZ) thickness, regularity: Not-thickened; regular or not visible.
- Junctional zone interruption: Interrupted or overstretched JZ in areas with lesions of FIGO types 1–3 (Figs 16 and 17).

2D/3D Ultrasonography of Leiomyomas According to MUSA Definitions

Localization of Fibroids

Fibroids can occur in any part of the uterus. They can appear on the cervix and the corpus in the broad ligament. The general classification of fibroids is based on their localization and is divided into intramural, submucosal, and subserosal fibroids. Intramural myomas are located in the muscle part or myometrium of the uterus. If the tumor progresses in the uterine cavity, it is called submucosal myoma (Figs 18 and 19) and if it is just under the serosa, it is called subserosal myoma (Fig. 20).

The symptoms associated with fibroids depend on the location and size of the tumor mass. Myomas are often



Figs 1A and B: 2D ultrasonography of myoma: (A) Well-defined lesion-fibroid, intramural myoma (m—myoma, e—endometrium, white arrows—border of the myoma), the serosal contour of uterus is regular (blue arrow); and (B) Smooth serosal contour of the uterus

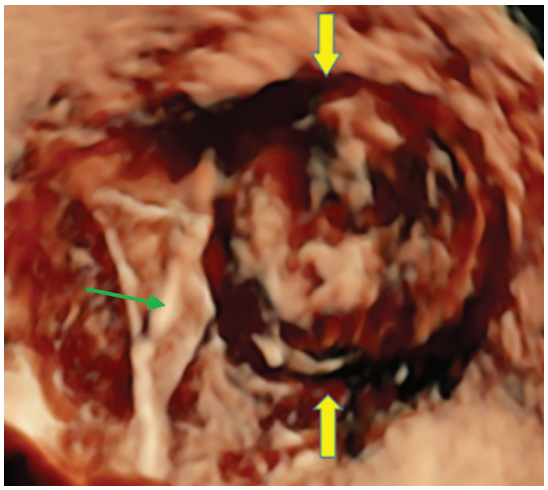


Fig. 2: 3D ultrasonography of uterine fibroid: distorted serosal margin (yellow arrow) due to large fibroid extending from mucosa to serosa; green arrow—intrauterine device

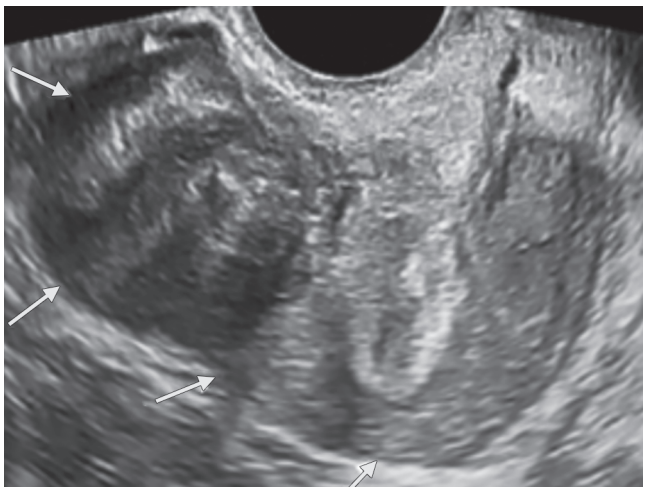


Fig. 3: Distorted serosal margin due to subserosal fibroid (white arrows)

asymptomatic and are detected on routine examination. The most common symptom caused by fibroids is uterine bleeding, which is usually in the form of either menorrhagia or hypermenorrhea. Larger fibroids are associated with pain and bloating in the abdomen. In myomas, infarction can be severe and may cause severe pain, like in the acute abdomen of any cause. Depending on their localization, urinary incontinence, constipation, and dyspareunia may occur. Interestingly is the fact that submucosal fibroids are the least frequent (only 5%) but are accompanied by the greatest consequences in terms of symptoms such as uterine bleeding, as well as it's negative impact on reproduction in women.

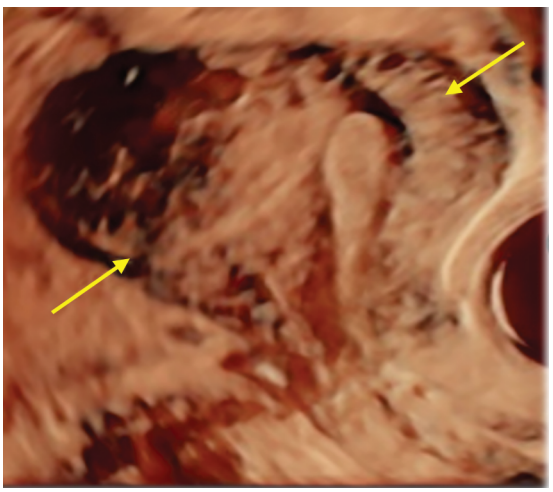


Fig. 4: 3D ultrasonography: asymmetry of uterine walls with a large fibroid on the posterior wall (yellow arrows)

Classifications of the Leiomyoma

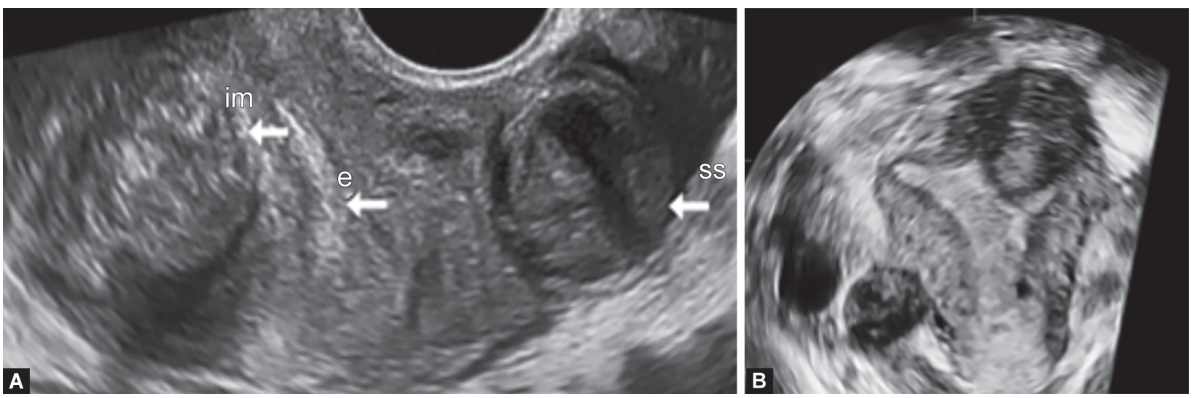
Therefore, there are several types of classifications that aim to localize the tumor itself preoperatively. The most commonly used one now is by FIGO PALM-COEIN classification 7.

FIGO: Leiomyoma Subclassification System

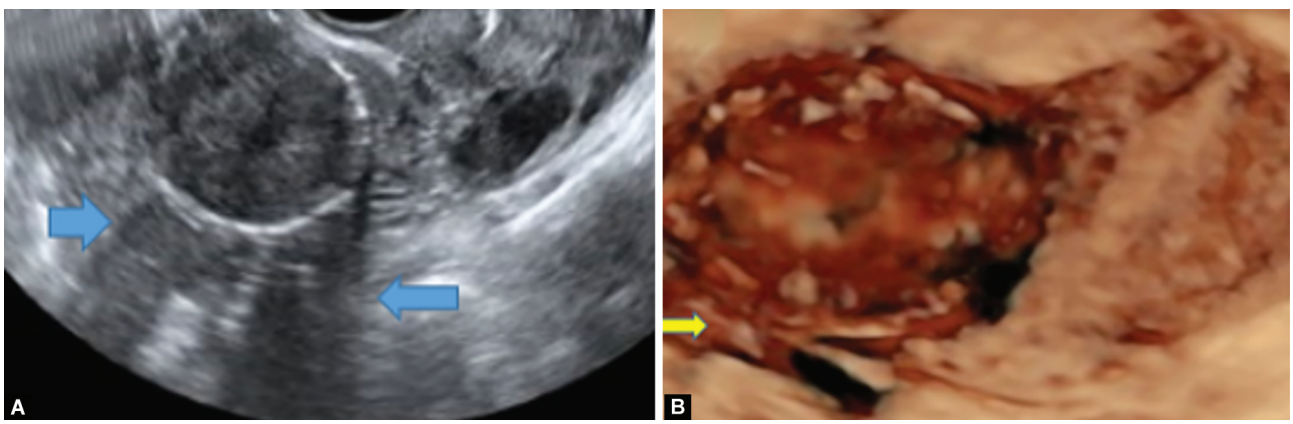
This classification of fibroids is based on the localization of the tumor in relation to the uterine cavity or endometrium on the one hand and the localization of the fibroid in relation to the serosa of the uterus (Figs 21 and 22).[8]

SM Myoma

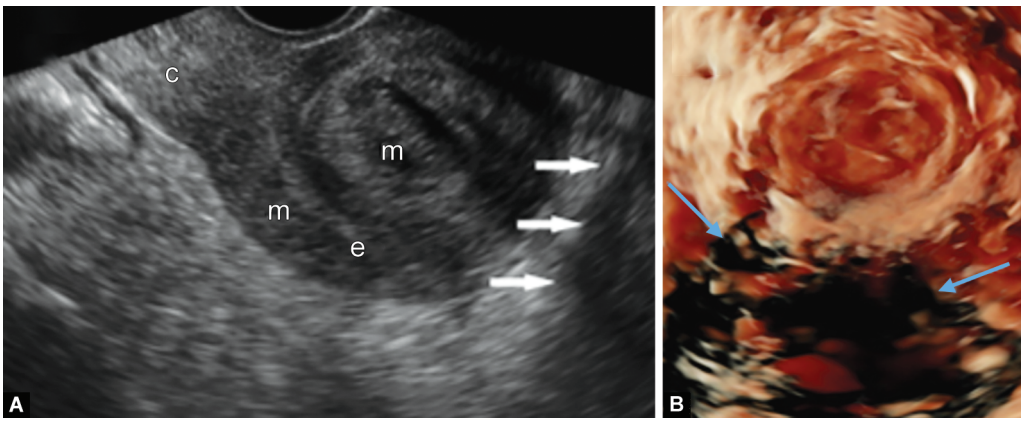
Submucous (SM) fibroids are subdivided into type 0 (completely intracavitary) (Fig. 23). Type 1 (being <50% of the mean diameter intramural) (Fig. 24), and type 2 (at least 50% intramural) (Fig. 25).[8] There are two options for diagnosis of submucosal leiomyomas: 2D and 3D ultrasound.



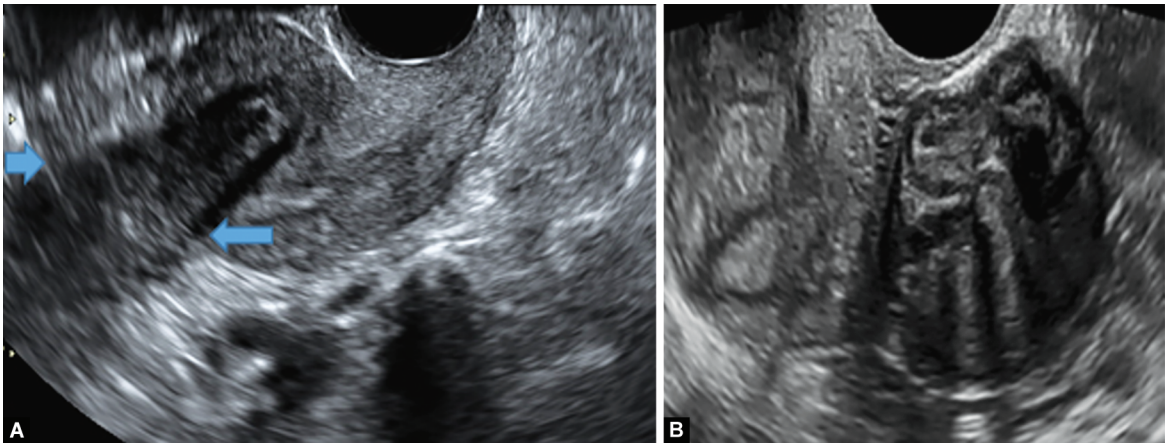
Figs 5A and B: (A, B) Multiple fibroids on B mode ultrasound with lobulated uterine margins



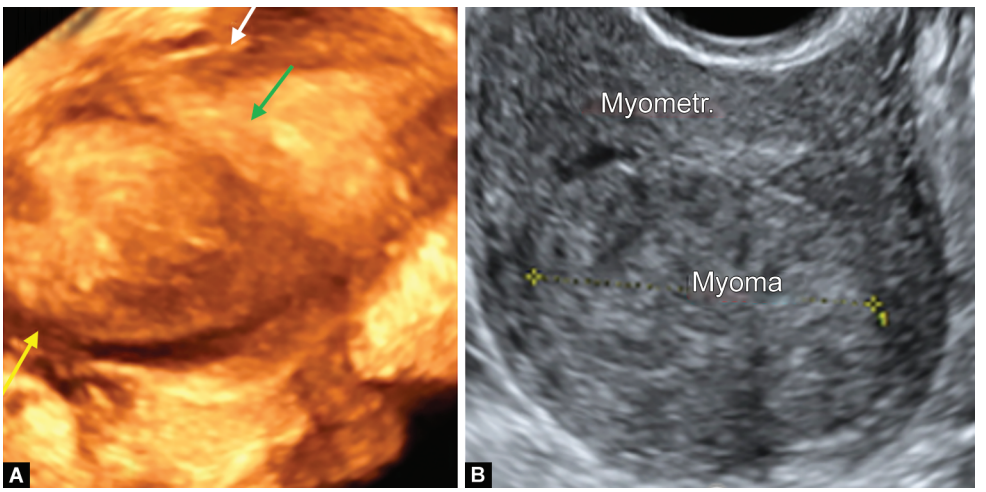
Figs 6A and B: (A) 3D ultrasound image showing oval fibroid with calcification, large subserosal fibroid with fan and edge shadows in the rounded fibroid (arrow) 2D; and (B) 3D ultrasound



Figs 7A and B: (A) 2D ultrasound of leiomyoma "shadowing sign;" (B) Intramural fibroid with edge shadows



Figs 8A and B: 2D ultrasound of leiomyoma "shadowing sign": (A) Internal shadows—intramural calcification leiomyoma; (B) Fan-shaped shadowing with edge shadows-subserosal leiomyoma



Figs 9A and B: Echogenicity of the leiomyoma: (A) Uniform roundish lesion and is echogenic as myometrium on 2D and 3D ultrasound—3D—leiomyoma (yellow arrow), endometrium (green arrow), myometrium (white arrow); (B) 2D ultrasound

The 2D ultrasound detects an initial pathological change, and an image of leiomyoma protrusion into the uterine cavity is easily obtained, but it can be underestimated or overestimated if the image is not in the right projection. 3D gives a much better image and can correct this lack of 2D ultrasonography,[9] noting that analysis in recent studies has shown that 3D ultrasonography does not give an ideal clear picture of protrusion into the intracavitary space (protrusion of <50% was generally overestimated, and fibroid protrusion of greater than 50% was generally underestimated compared to hysteroscopy.[10] On the other hand, a study comparing the preoperative hysteroscopic

lasmar score with the 3D ultrasonographic lasmar score can be obtained from 3D ultrasound. A 3D ultrasound is best done in the luteal phase.[11]

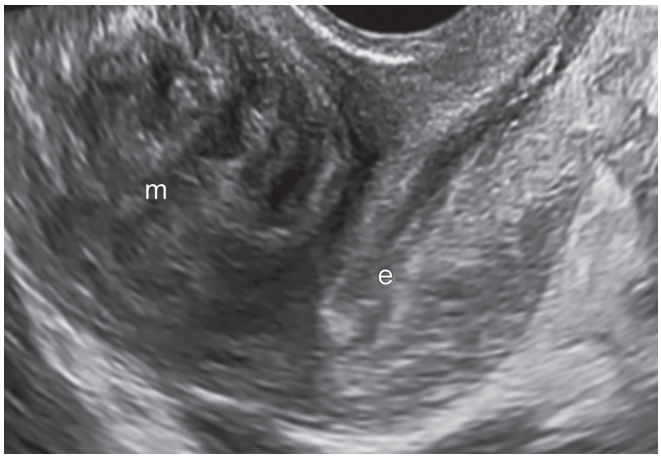


Fig. 10: Echogenicity of the leiomyoma: uniform roundish lesion and mixed echogenicity on 2D ultrasound

SIS and SM Leiomyoma

One method that can give a clearer picture, especially in small intramural myomas, is SIS. The technique of this method is based on injecting contrast into the uterine cavity during the examination with vaginal ultrasonography. This shows the whole interior better and the one determined by subtle pathology. It is better to perform it in the first phase of the cycle, that is, immediately after the end of the menstrual bleeding.

Both 2D and 3D transvaginal sonography can be combined with SIS to improve the contrast between the myometrium, fibroid, and uterine cavity. Regarding the 3D SIS studies, they prove that 3D SIS is associated with more successful resection of submucosal leiomyomas because preoperative ultrasound findings are very precise in terms of location, the ratio of the endometrium to the myometrium of the leiomyoma itself (Figs 26 to 28).[12,13]

Intramural Leiomyoma

Federation of Gynecology and Obstetrics type 3 leiomyomas are totally intramural but also contact the endometrium.

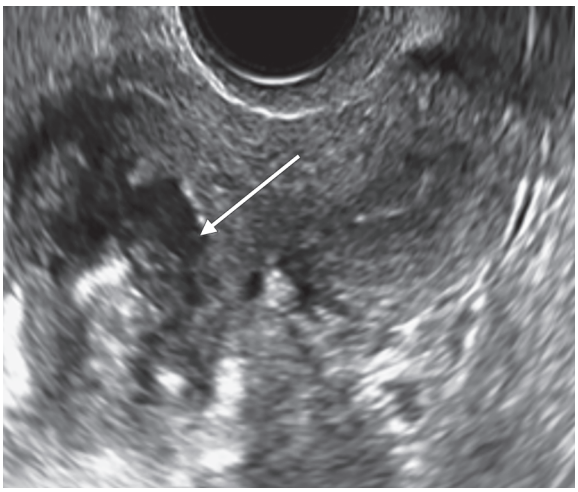


Fig. 11: Echogenicity of the leiomyoma: nonuniform; hypoechogenic mixed echogenicity as a result of degeneration of the tumor, a hypoechogenic area with hyperechogenic shadows

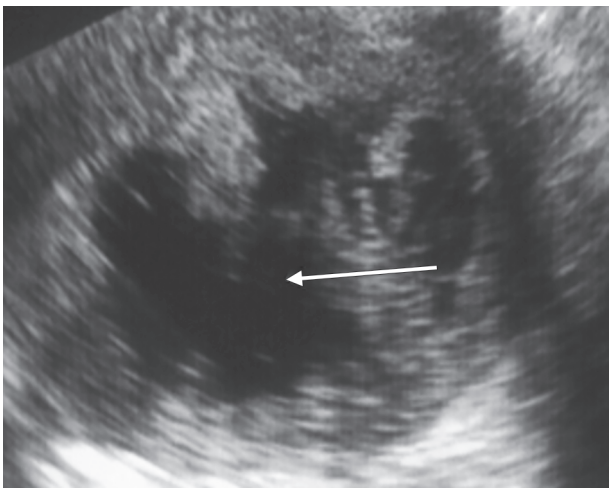
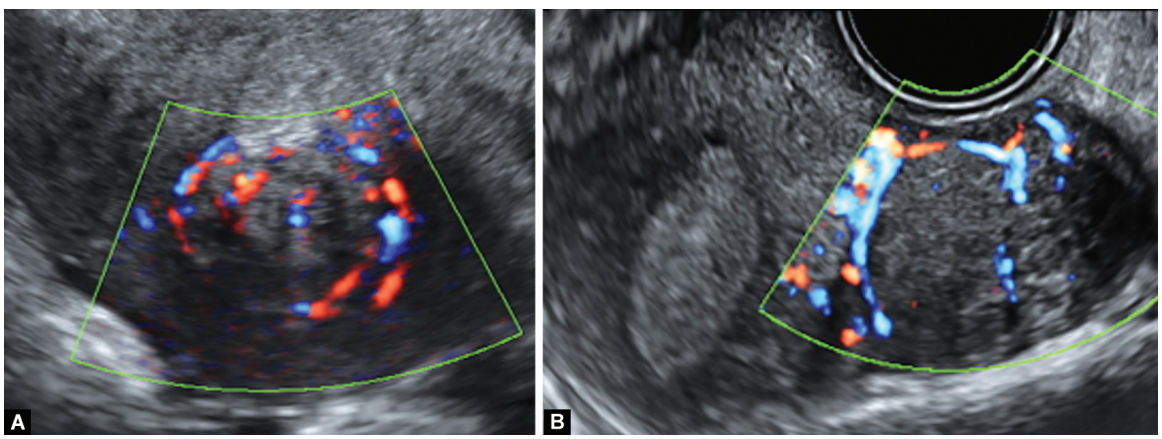


Fig. 12: Echogenicity of the leiomyoma: nonuniform; a hypoechogenic area with hyperechogenic shadows in the side central hypoechogenic area as a result of central tumor degeneration



Figs 13A and B: (A) 2D/3D color Dopler, vascularity leiomyomas; (B) The circumferential flow of fibroid on HD Doppler flow

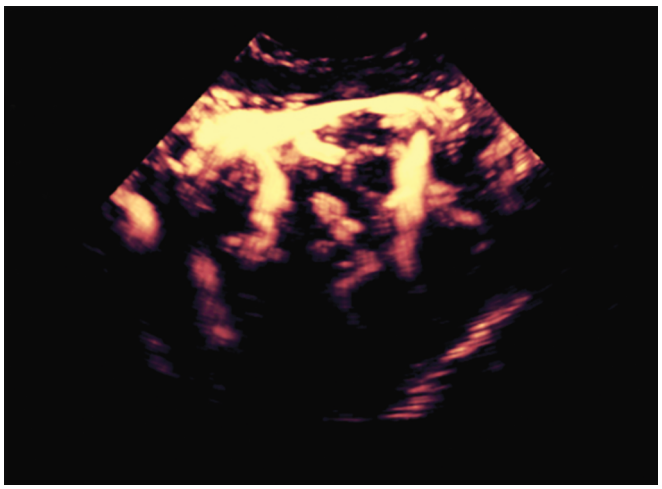


Fig. 14: 2D/3D color Dopler, vascularity leiomyomas: rich vascularized pseudo capsule of leiomyoma

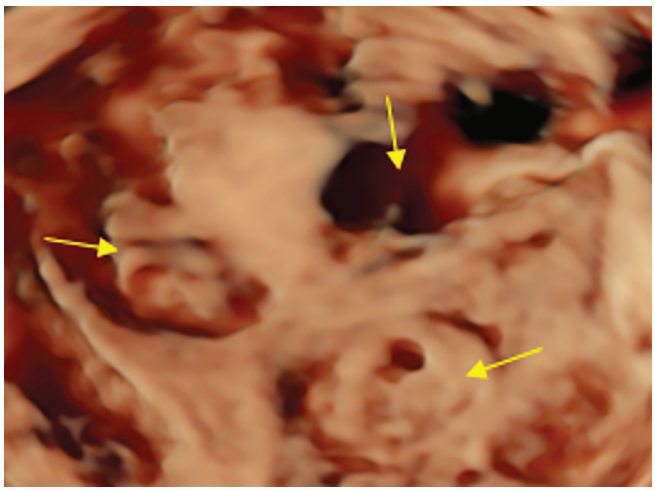


Fig. 16: 3D ultrasonography of JZ: distorted JZ by several leiomyomas

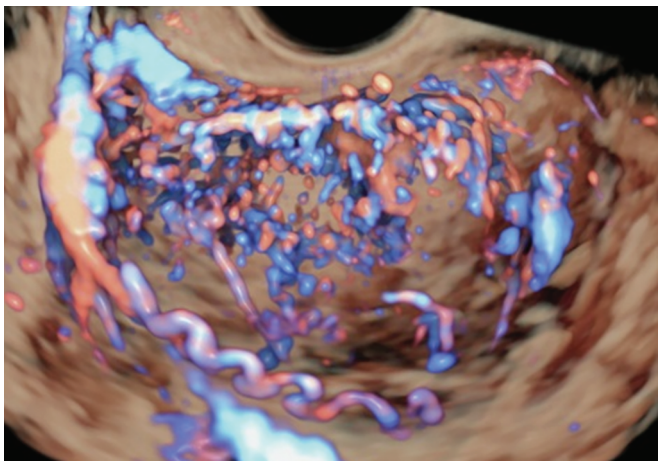


Fig. 15: High definition imagine (HDI) 3D—mapping the leiomyoma and uterine vessels

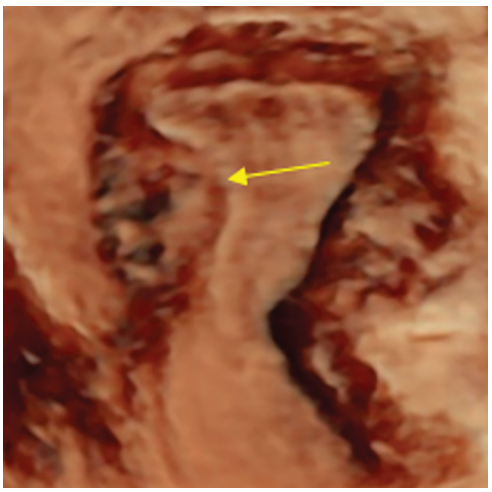
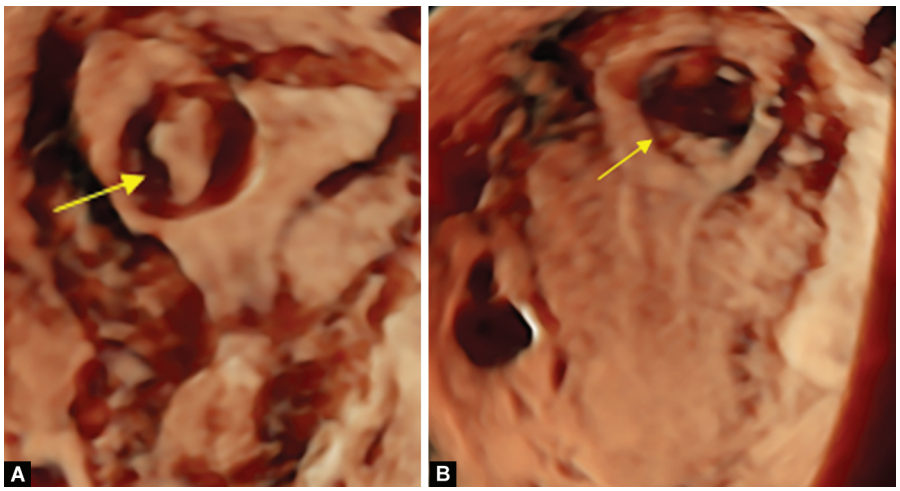


Fig. 17: 3D ultrasonography of JZ: overstretched JZ by intramural leiomyoma (yellow arrow)



Figs 18A and B: (A, B) Eight SM fibroid on 3D ultrasound

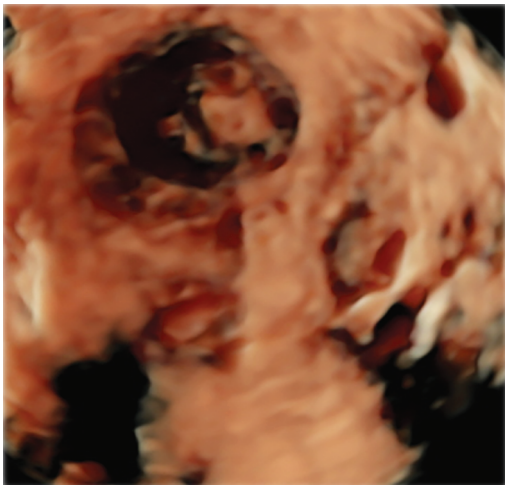


Fig. 19: Submucosal fibroid extending into an intramural layer

SM- submucous	0	Penduculated intarcavitary
	1	<50% intramural
	2	>50% intramural
	3	Contact endometrium, 100% intramural
o-other	4	Intramural
	5	Subseros >50% intramural
	6	Subseros <50% intramural
	7	Subseros penduculated
	8	Other; cervical, parasitic
Hybrid	2-5	Contact both endometrium and serosa

Fig. 21: FIGO—classification of uterine fibroids[8]

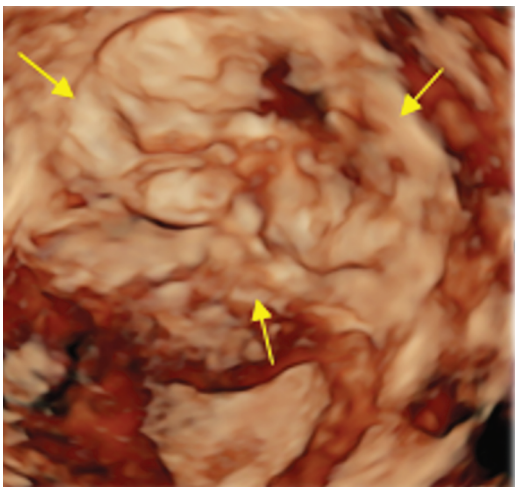


Fig. 20: Subserosal fibroid on uterine fundus with heterogeneous echogenicity.

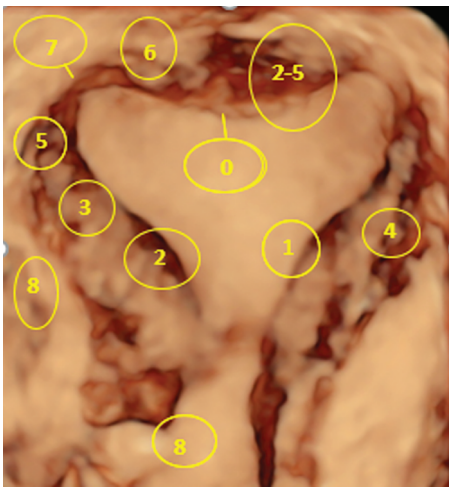
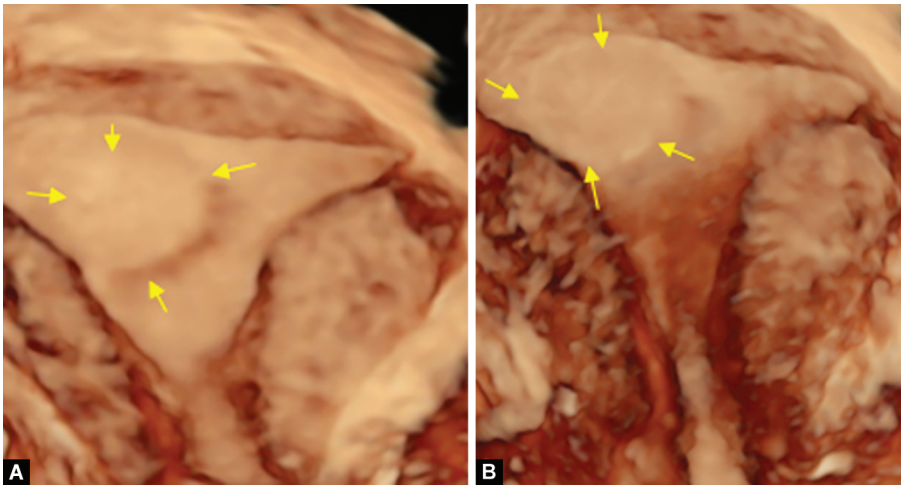


Fig. 22: FIGO—classification of uterine fibroids



Figs 23A and B: 3D ultrasonography: (A) SM leiomyoma within endometrial cavity, no myometrial extension—SM (FIGO and ESGE—type 0); (B) Yellow arrows

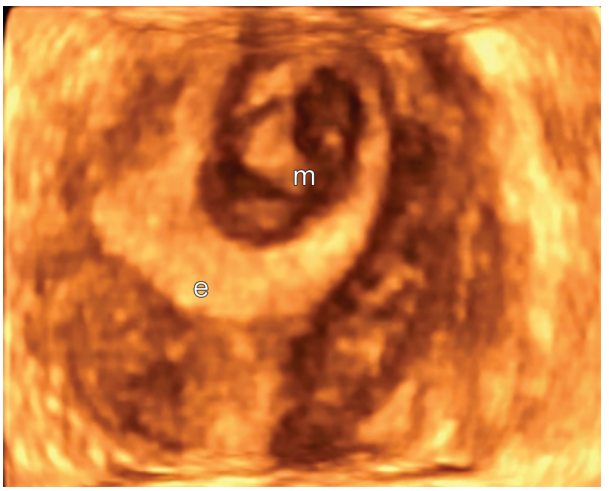


Fig. 24: The 3D ultrasound of distortion of the uterine cavity by submucosal myomas: FIGO/ESGE classification: type 1: <50% intramural/<50% myometrial extension (m—submucosal myoma, e—endometrium)

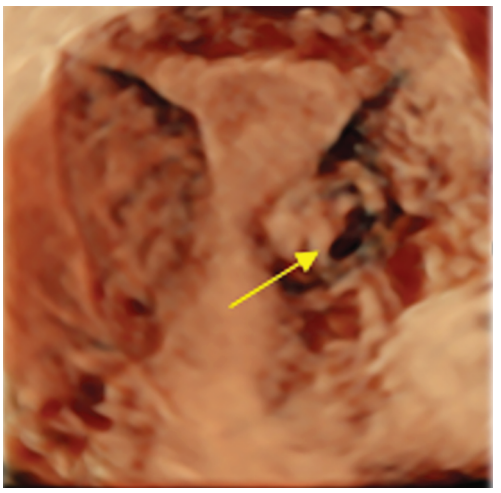
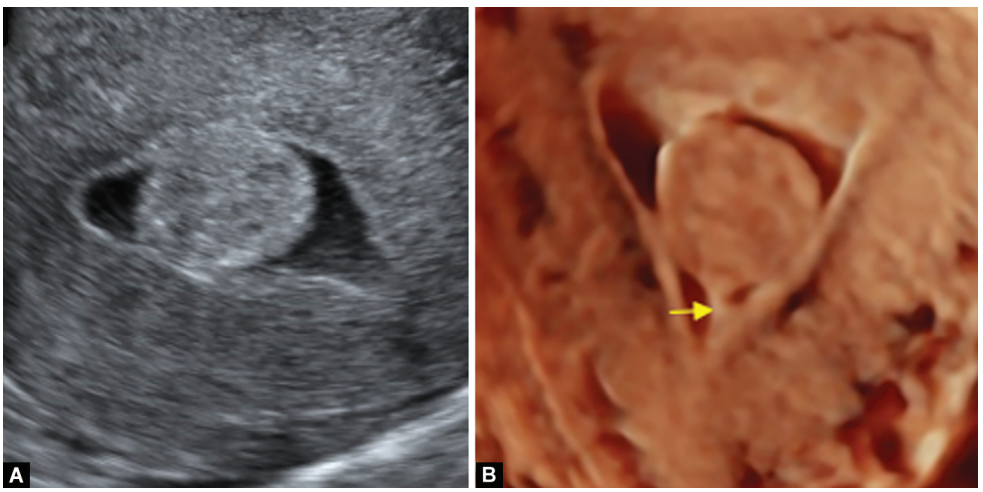


Fig. 25: The 3D ultrasound of distortion of the uterine cavity by SM myomas: FIGO/ESGE classification: type 2: >50% intramural/>50% myometrial extension

Type 3 is formally distinguished from type 2 with hysteroscopy using the lowest possible intrauterine pressure necessary to allow visualization (Fig. 29). Type 4 lesions are intramural leiomyomas that are entirely within the myometrium, with no extension to the endometrial surface or to the serosa (Fig. 30).[8] Intramural myomas are the most prevalent of all the leiomyomas (58–79%) occurrence, with a median growth rate of 35.2% by volume per year, and have a higher yearly volumetric increase of intramural myomas compared to either subserosal or SM myomas. There is no significant evidence of a negative impact of fibroids on female reproduction, but there are studies that indicate that reproduction is compromised when there exist intramural leiomyomas (especially >4 cm in diameter), primarily due to the presence of uterine contractions in fibroids,[14] the size of the fibroid[15] and the distance from the edge of the fibroid to the endometrium[16] have a negative impact on embryo implantation and live birth rate. In type 4 fibroids, it is essential to mention the minimum inner and outer free margin to decide the route of surgery.

Subserous Leiomyoma

Subserous (types 5, 6, and 7) leiomyomas represent the mirror image of the SM leiomyomas—with type 5 being at least 50% intramural (Fig. 31), type 6 being <50% intramural (Figs 32 and 33), and type 7 being attached to the serosa by a stalk that is also ≤10% or the mean of three diameters of the leiomyoma (Fig. 34). In type 8, is reserved for leiomyomas that do not relate to the myometrium at all and would include cervical lesions (demonstrated), those that exist in the round or broad ligaments without direct attachment to the uterus, and other so-called "parasitic" lesions (Fig. 35).[8] The existing data on the effects of subserosal fibroids on fertility support the conclusion that subserosal leiomyomas do not have any adverse effects on the fertility potential of women and no adverse effect on assisted reproductive technology outcome.[17] This conclusion is further supported by the fact that no beneficial effect on fertility is noted when myomectomy is performed for subserosal leiomyomas.[18]



Figs 26A and B: Saline hysterosonography SIS; (A, B) 2D and 3D: single penducle (yellow arrow) SM leiomyoma

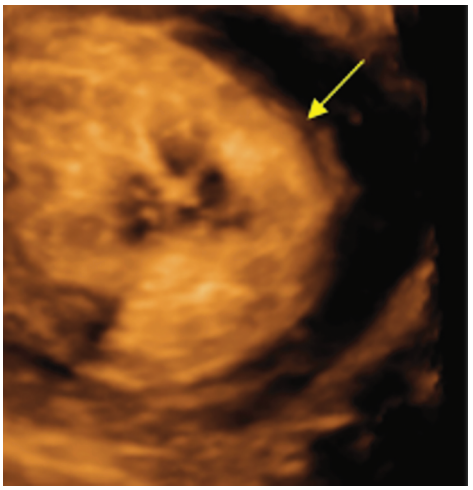


Fig. 27: Saline hysterosonography SIS 3D: huge SM myoma previously recognized as Cugell myoma, hysteroscopy (HSC) treatment successfully applied (yellow arrow)

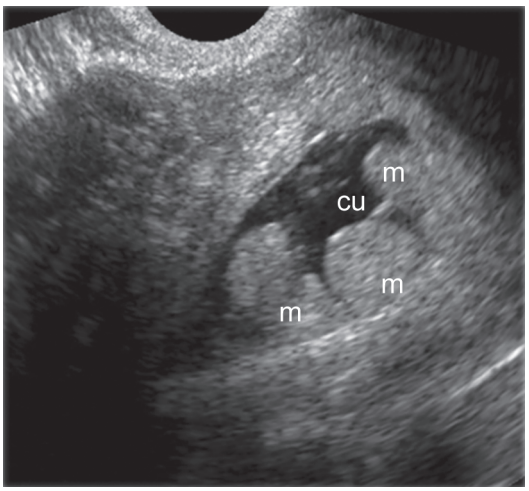
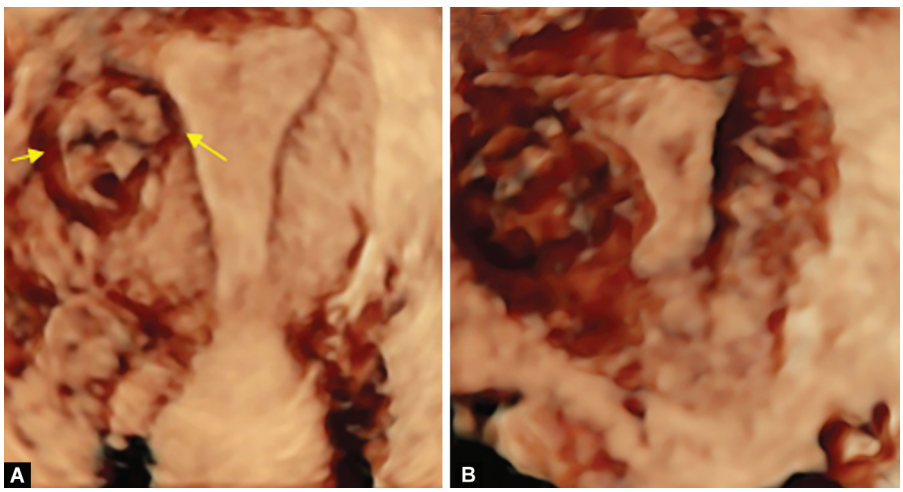
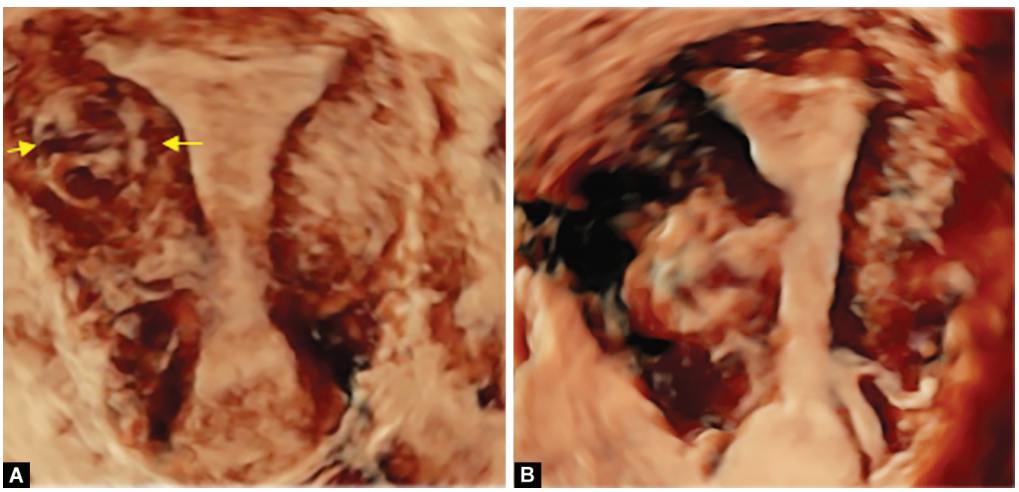


Fig. 28: Saline hysterosonography SIS 2D: several SM myoma (m—myoma; cu—uterine cavity)



Figs 29A and B: (A) FIGO classification of intramural myomas; (B) Intramural myomas with no distortion of uterine cavity even though the tumor is near to endomrtertial myometrial junction zone (EMJZ) (FIGO type 3)



Figs 30A and B: FIGO classification of intramural myomas: (C) FIGO type 4; (D) 100% intramural myoma with no distortion of the uterine cavity

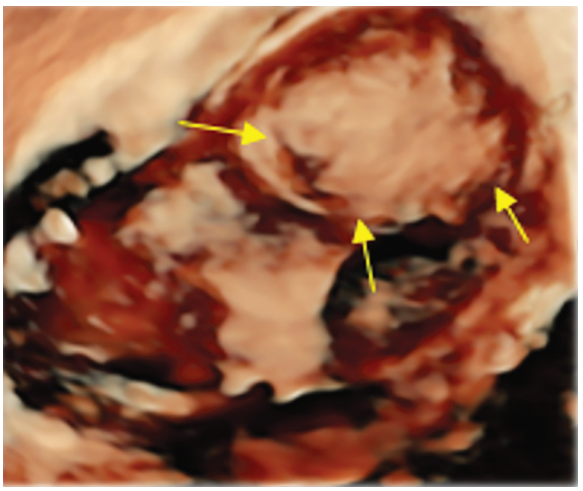


Fig. 31: Subserosal leiomyoma: FIGO type 5: subserous leiomyomas with 50% or more contact with the myometrium

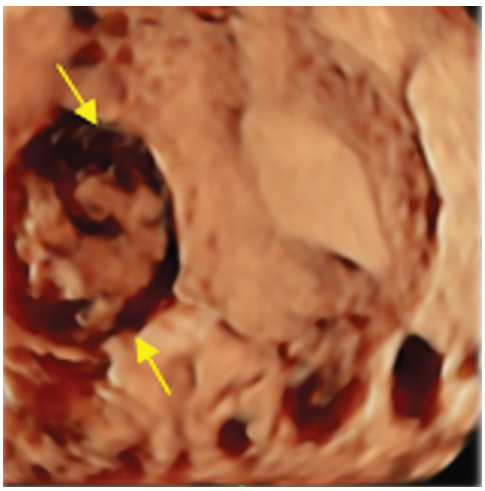
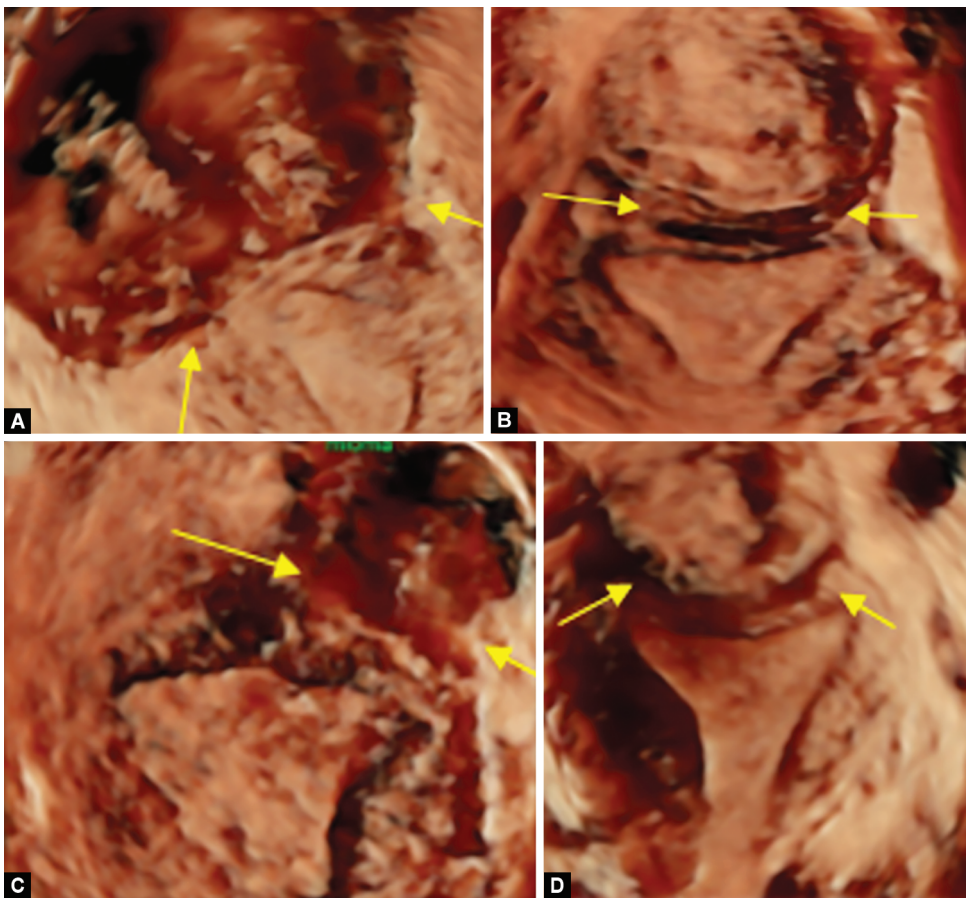


Fig. 32: Subserosal leiomyoma: FIGO type 6: subserous leiomyomas with <50% contact with the myometrium



Figs 33A to D: (A, B, C, D) Subserosal leiomyoma: FIGO type 6: subserous leiomyomas with a very low percentage of contact with the myometrium

Hybrid Leiomyomas

Classification of lesions that are transmural is categorized by their relationship to both the endometrial and the serosal surfaces. The endometrial relationship is noted first, with the serosal relationship second (Figs 36 and 37).[8]

Unlike previous classifications such as ESGE (European Association for Gynecological Endoscopy), the type 3 where the intramural myoma touches the area of the endometrium, cavitation distortion, also in the group of subserosal fibroids introduces new subgroups.[8] This is important because this

system provides a basic framework for deciding on surgical treatment of fibroids, that is, which lesions should be operated on and, of course, important information on the possible use of resection endoscopy in subserosal fibroids, which according to this system in this type of fibroids does not work in patients with infertility.

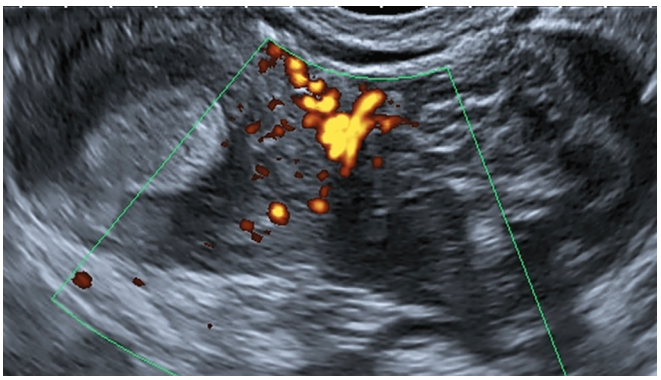


Fig. 34: Subserosal leiomyoma: FIGO type 7: serous pedunculated vascularization of the pedicle

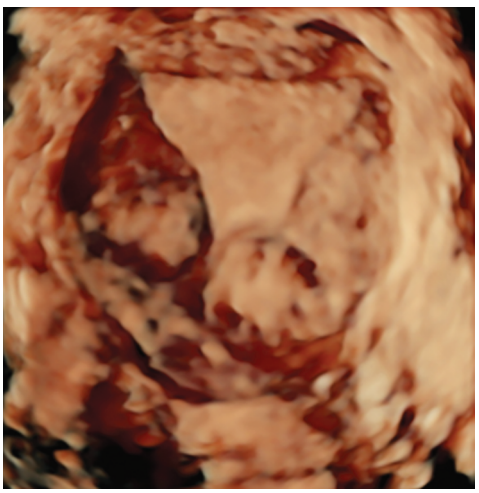


Fig. 35: 3D ultrasound: FIGO type 8: cervical leiomyoma

In addition to these two important data provided by ultrasound, of course, other variables such as the size and number of fibroids and, of course, the topography of the tumor seen not only in terms of uterine parts such as the cervix, lower or upper segment but also the anteroposterior and lateral orientation of the tumor itself and proximity to blood vessels, provides valuable preoperative data.[19] Vaginal ultrasonography can also detect myomas of 5 mm in diameter, but it is limited in terms of detection of the number and size of the tumor mass. Namely, it is considered that the volume of the uterus or the tumor itself over 375 mL or several four or larger myomas requires a combined approach of transvaginal and transabdominal ultrasonography in the detection of the leiomyomas (Figs 38 and 39).[20]

Other methods for the diagnosis and assessment of fibroids are hysteroscopy and magnetic resonance imaging, but ultrasound remains the first and most cost-effective method in screening the population for the detection of this pathology. In general, the results of the comparative study show the excellent performance of vaginal ultrasound

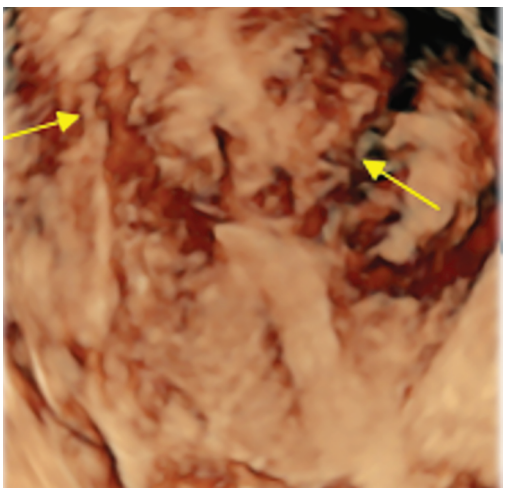
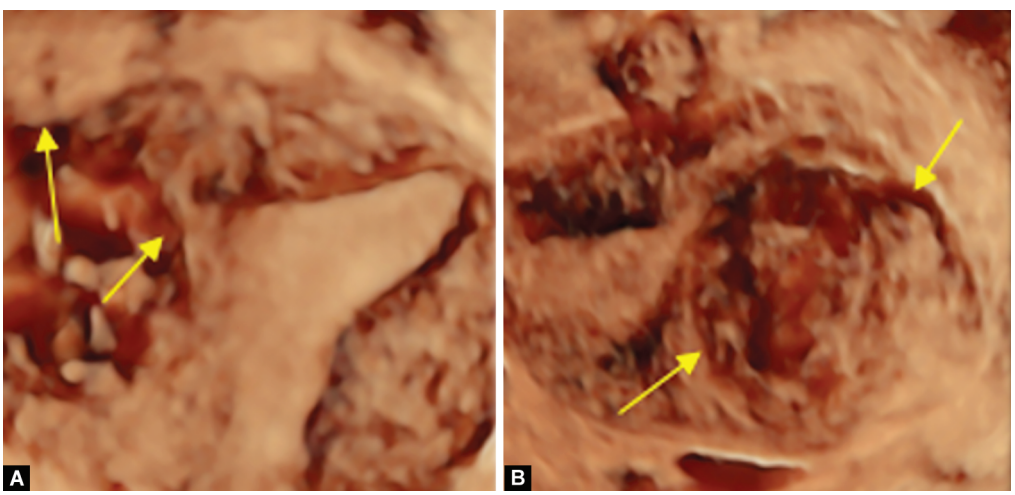
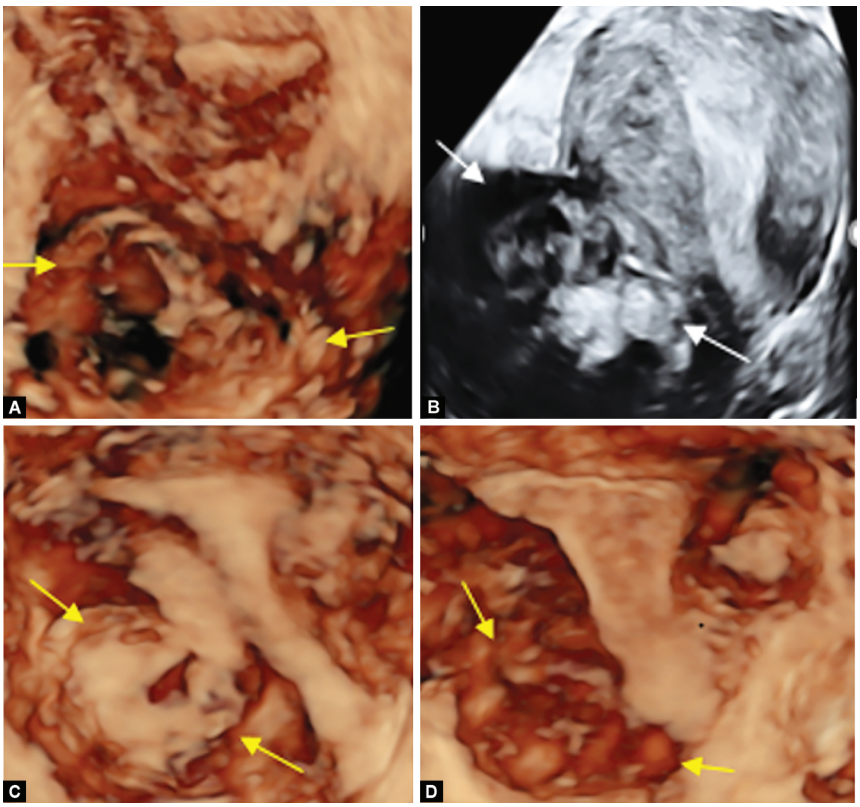


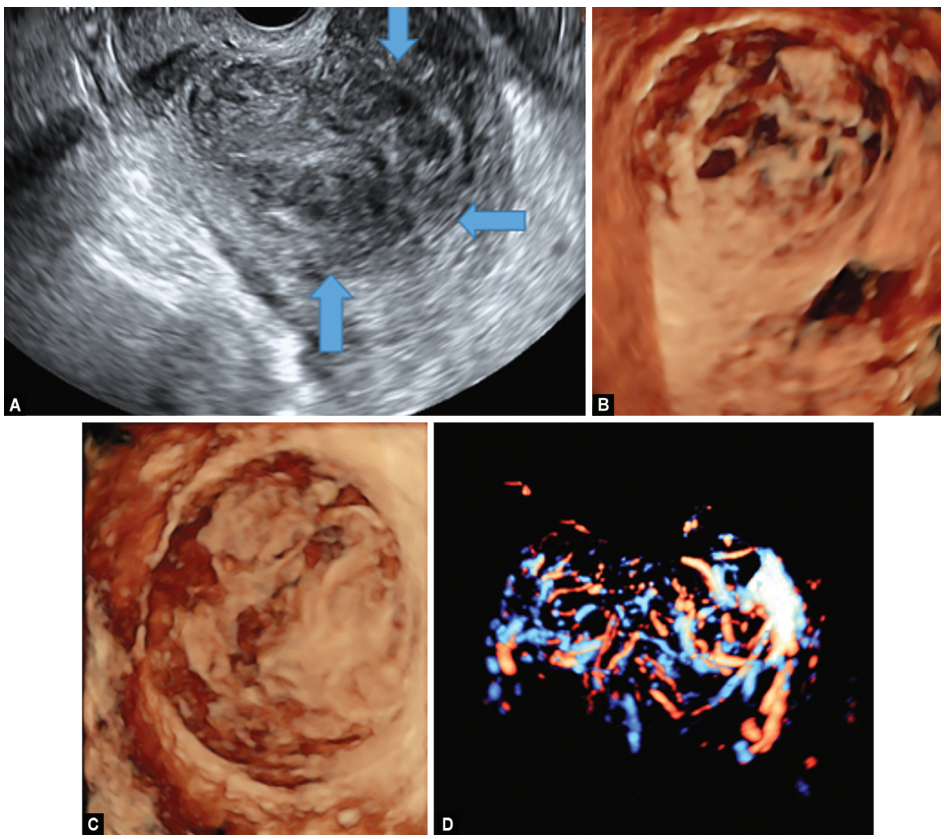
Fig. 37: 3D ultrasonography of hugh myoma on fundal region distorting endometrium and serosa (hybrid myoma by FIGO)



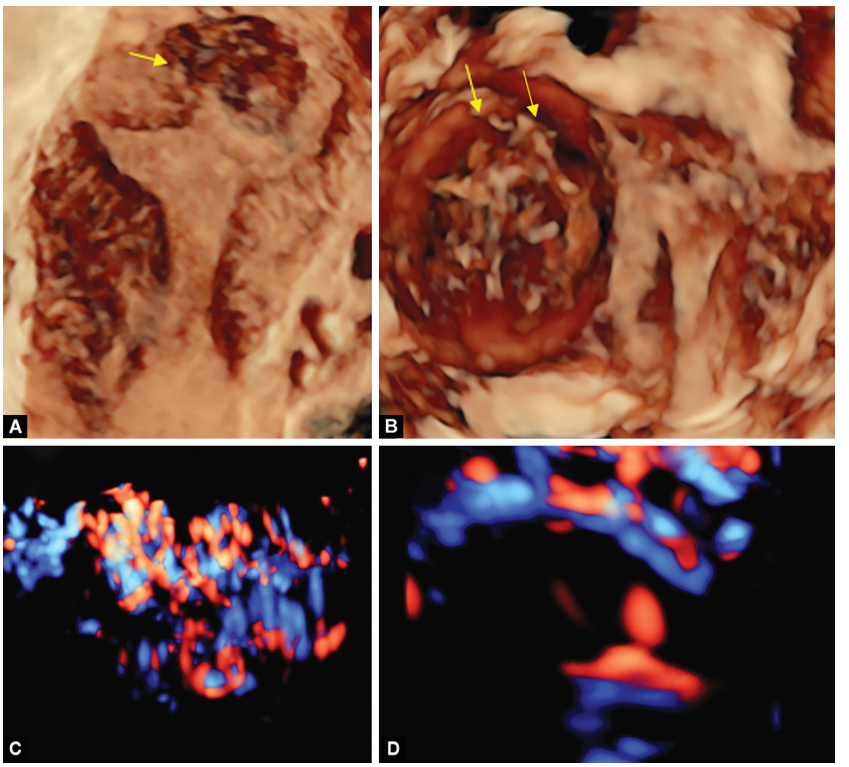
Figs 36A and B: (A) 3D ultrasonography of FIGO hybrid leiomyoma; (B) Transmural leiomyoma are categorized by their relationship to both the endometrial and the serosal surfaces



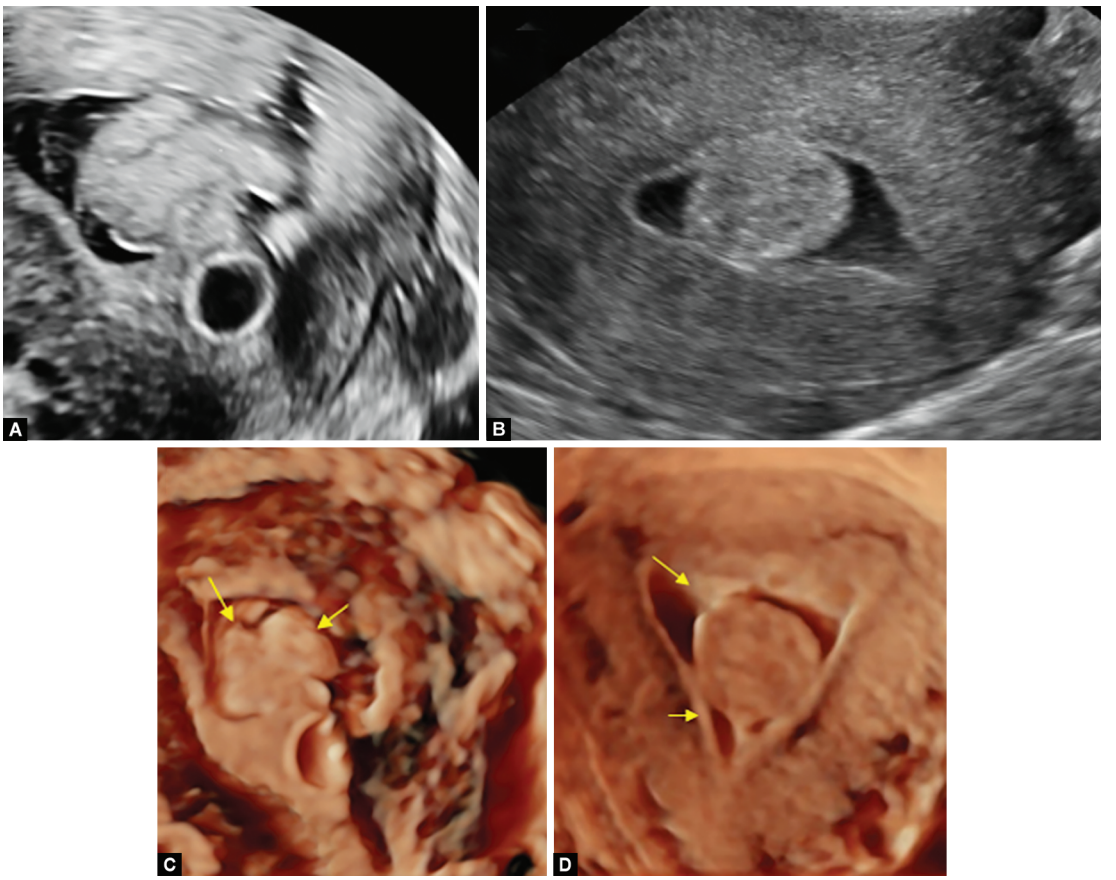
Figs 38A to D: 3D Ultrasonography: (A) Different dimensions and location of leiomyoma. Isthmic cervical location FIGO; type 6; (B) Hugh myoma–same location; (C) Hugh intramural myoma FIGO type 5; (D) Specific location of isthmic cervical myoma



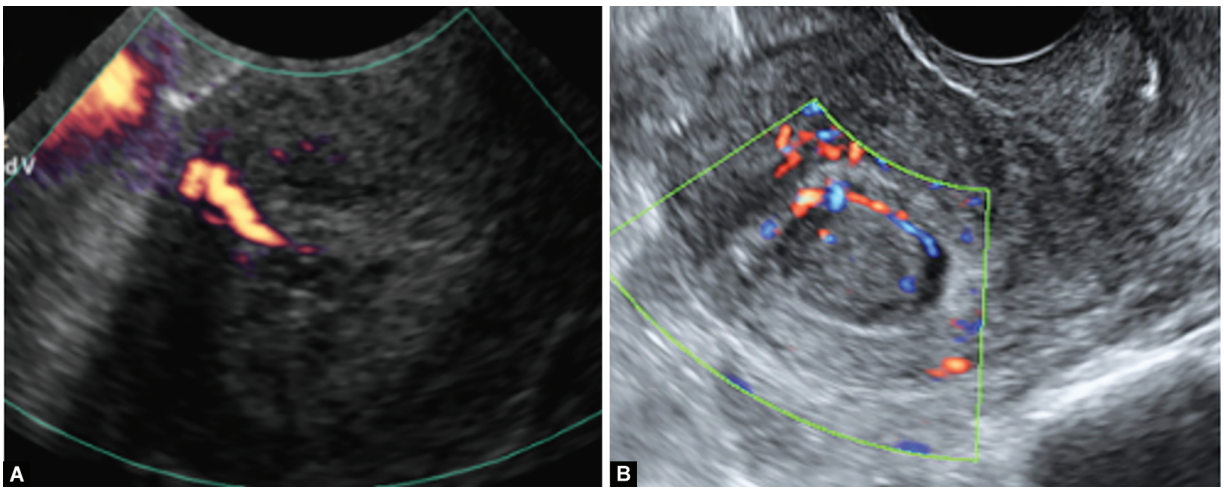
Figs 39A to D: (A) 2D/3D ultrasonography; (B) Hugh submucosal leiomyoma; (C) Nonhomogeneous echogenic; (D) 3D mapping of color vessels



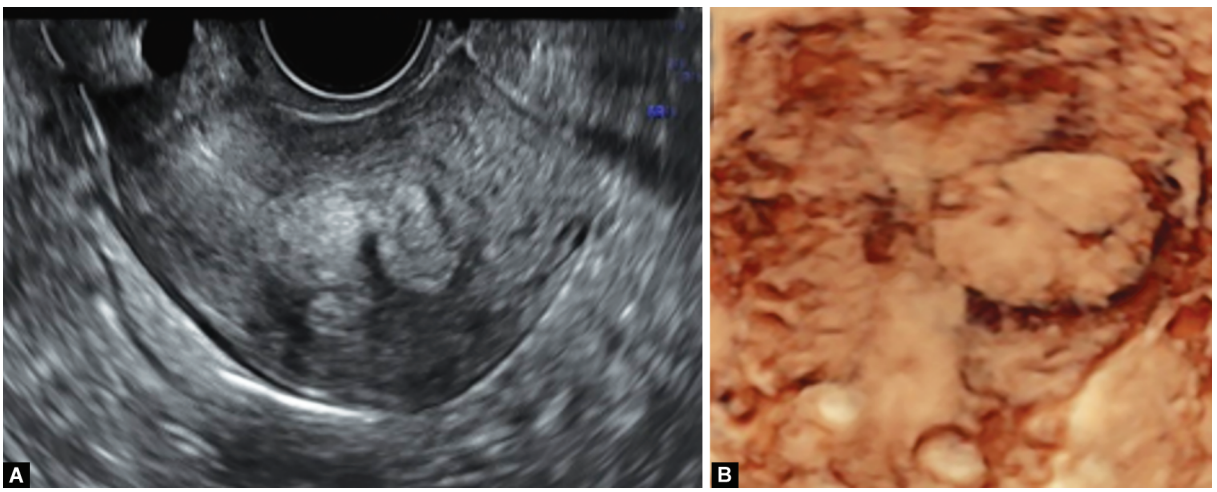
Figs 40A to D: 3D ultrasound: (A) The structure of adenomyosis is almost identical to fibroids, even though there is no clear demarcation; (B) Clear demarcation et leiomyoma uteri; (C) Different color Doppler network between adenomyosis (intralesional); (D) Myoma uteri (circumferential)



Figs 41A to D: SIS different shape of endometrial polyp in (A and C) distinctive of leiomyomas od (B and D) 2D and 3D ultrasonography



Figs 42A and B: (A) "Single vessel" sign on color Dopler et endometrial polyp; (B) Peripheral circumferential pseudocapsule vascularization et leiomyomas



Figs 43A and B: (A and B) 2D/3D ultrasound: uterine angioma, very rare conditions, note the specific pattern different from the myometrium

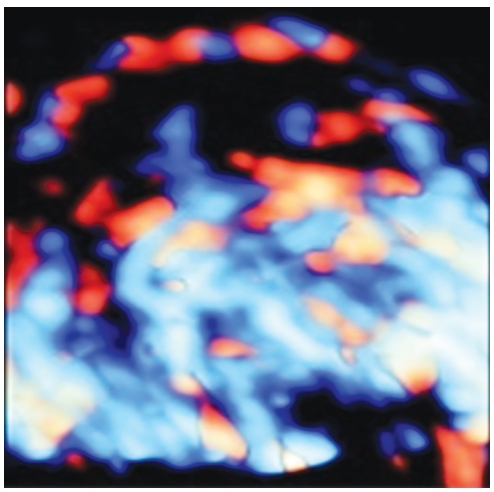


Fig. 44: 3D color mapping of the same tumor: rich vascularization of the tumor

in detecting fibroids compared to other methods, where a vaginal ultrasound showed a sensitivity of 83% and specificity of 90%.[16,20] In addition to the above, the ultrasound should answer important solutions. One is to make a differential diagnosis, that is, to differentiate fibroids from other pathologies of the uterus, which are most often adenomyosis and endometrial polyps, and the second is to recognize the possible malignant potential of these tumors. It is important to recognize adenomyosis because the therapeutic proximal differs from that of myoma.[7] There are cases where the structure of adenomyosis is similar, almost identical to fibroids, but vascularization is different; fibroids have strong circumferential vascularization of the pseudocapsule, while in adenomyosis it is more homogeneous and it is translesional (Fig. 40).[7] Endometrial polyps are more difficult to differentiate from submucosal fibroids. However, in polyps, there is a hyperechogenicity similar to that of the unicorn in the secretory phase and often a vascular loop

(Figs 41 and 42).[7,21] A rare pathological condition is uterine angioma. Hemangioma should be detected before deciding on hysteroscopic resection due to expected increased bleeding during surgery (Figs 43 and 44).[22]

Conclusion

From what has been stated so far, it can be seen that ultrasound is essential in the detection of fibroids, their number, dimensions, and topography in terms of the body of the uterus, but also important information about the relationship between the tumor and the cavity of the uterus. The negative impact of submucosal fibroids on a woman's fertile potential, on the one hand, and the increased risk of premature birth and miscarriage, on the other, have been reported.[23] These data are important for the choice of the final treatment of the tumor itself, the possibility of application of endoscopic treatment, and possible intraoperative complications. Of course, certain other variables, such as dysfunction of the surrounding organs and anemia, affect the choice of treatment.[24] Regarding the other types of fibroids and the impact on the fertile potential in women as well as pregnancy, number, size, and pressure, collision with the uterine cavity of the fibroids is decisive for the possible surgical treatment, especially in intramural myomas. Studies show that intramural myomas larger than 4 cm affect a woman's fertility potential.[25] Certain other meta-analyses show insignificant improvement in fertility potential in a woman with intramural myomas, while subserosal ones do not have any particular effect on her fertility potential.[26] A 3D ultrasonography improves the image of leiomyoma, volume, and localization (Fig. 44). With 3D SIS ultrasonography, it is possible to make a solid presurgical score et SM leiomyoma in terms of treatment choice and certainly a prognosis in terms of preserving the reproductive potential of the uterus.

References

1. Petanovski Z, Kurjak A. 3D-4D Ultrasound in Gynecology. Jaypee Brothers, New Delhi, 2022, pp 21-37.
2. Tinelli A, Malvasi A, Rahimi S, et al. Myoma pseudocapsule: a distinct endocrino-anatomical entity in gynecological surgery. Gynecol Endocrinol 2009;25(10):661–667. DOI: 10.1080/09513590903015502
3. Ishikawa H, Reierstad S, Demura M, et al. High aromatase expression in uterine leiomyoma tissues of African-American women. J Clin Endocrinol Metab 2009;94(5):1752–1756. DOI: 10.1210/jc.2008-2327
4. Rein MS, Barbieri RL, Friedman AJ. Progesterone: a critical role in the pathogenesis of uterine myomas. Am J Obstet Gynecol 1995;172(1 Pt 1):14–18. DOI: 10.1016/0002-9378(95)90077-2
5. Practice Committee of American Society for Reproductive Medicine in collaboration with Society of Reproductive Surgeons Myomas and reproductive function. Fertil Steril 2008;90(5 Suppl):S125–S130. DOI: 10.1016/j.fertnstert.2008.09.012
6. Baird DD, Dunson DB, Hill MC, et al. High cumulative incidence of uterine Leiomyma in black and white women: ultrasound evidence. Am J Obstet Gynecol 2003;188(1):100–107. DOI: 10.1007/s00270-011-0228-5
7. Van den Bosch T, Dueholm M, Leone FP, et al. Terms, definitions and measurements to describe sonographic features of the myometrium and uterine masses: a consensus opinion from the Morphological Uterus Sonographic Assessment (MUSA) group. Ultrasound Obstet Gynecol 2015;46(3):284–298. DOI: 10.1002/uog.14806
8. Munro MG, Critchley HO, Broder MS, et al. FIGO classification system (PALM-COEIN) for causes of abnormal uterine bleeding in nongravid women of reproductive age. Int J Gynaecol Obstet 2011;113(1):3–13. DOI: 10.1016/j.ijgo.2010.11.011
9. Leone FP, Bignardi T, Marciante C, et al. Sonohysterography in the preoperative grading of submucous myomas: considerations on three-dimensional methodology. Ultrasound Obstet Gynecol 2007;29(6):717–718. DOI: 10.1002/uog.4043
10. Keizer AL, Nieuwenhuis LL, Twisk JWR, et al. Role of 3-dimensional sonography in the assessment of submucous fibroids: a pilot study. J Ultrasound Med 2018;37(1):191–199. DOI: 10.1002/jum.14331
11. Camanni M, Bonino L, Tessarolo M, et al. Is it possible to obtain a presurgical Lasmar score for hysteroscopic myomectomy by ultrasound alone? Ultrasound Obstet Gynecol 2012;40(1):106–111. DOI: 10.1002/uog.11165
12. Bingol B, Gunenc Z, Gedikbasi A, et al. Comparison of diagnostic accuracy of saline infusion sonohysterography, transvaginal sonography and hysteroscopy. J Obstet Gynaecol 2011;31(1):54–58. DOI: 10.3109/01443615.2010.532246
13. Mavrelos D, Naftalin J, Hoo W, et al. Preoperative assessment of submucous fibroids by three-dimensional saline contrast sonohysterography. Ultrasound Obstet Gynecol 2011;38(3):350–354. DOI: 10.1002/uog.9049
14. Yoshino O, Hayashi T, Osuga Y, et al. Decreased pregnancy rate is linked to abnormal uterine peristalsis caused by intramural fibroids. Hum Reprod 2010;25(10):2475–2479. DOI: 10.1093/humrep/deq222
15. Yan L, Ding L, Li C, et al. Effect of fibroids not distorting the endometrial cavity on the outcome of in vitro fertilization treatment: a retrospective cohort study. Fertil Steril 2014;101(3):716–721. DOI: 10.1016/j.fertnstert.2013.11.023
16. Lu N, Wang Y, Su YC, et al. Effects of the distance between small intramural uterine fibroids and the endometrium on the pregnancy outcomes of in vitro fertilization-embryo transfer. Gynecol Obstet Invest 2015;79(1):62–68. DOI: 10.1159/000363236
17. Somigliana E, Vercellini P, Daguati R, et al. Fibroids and female reproduction: a critical analysis of the evidence. Hum Reprod Update 2007;13(5):465–476. DOI: 10.1093/humupd/dmm013
18. Casini ML, Rossi F, Agostini R, et al. Effects of the position of fibroids on fertility. Gynecol Endocrinol 2006;22(2):106–109. DOI: 10.1080/09513590600604673
19. Lasmar RB, Barrozo PR, Dias R, et al. Submucous myomas: a new presurgical classification to evaluate the viability of hysteroscopic surgical treatment–preliminary report. J Minim Invasive Gynecol 2005;12(4):308–311. DOI: 10.1016/j.jmig.2005.05.014
20. Dueholm M, Lundorf E, Hansen ES, et al. Accuracy of magnetic resonance imaging and transvaginal ultrasonography in the diagnosis, mapping, and measurement of uterine myomas. Am J Obstet Gynecol 2002;186(3):409–415. DOI: 10.1067/mob.2002.121725

21. Timmerman D, Verguts J, Konstantinovic ML, et al. The pedicle artery sign based on sonography with color Doppler imaging can replace second-stage tests in women with abnormal vaginal bleeding. Ultrasound Obstet Gynecol 2003;22(2):166–171. DOI: 10.1002/uog.203
22. Vijayakumar A, Srinivas A, Chandrashekar BM, et al. Uterine vascular lesions. Rev Obstet Gynecol 2013;6(2):69–79. DOI: 10.3909/riog0207
23. Pritts EA, Parker WH, Olive DL. Fibroids and infertility: an updated systematic review of the evidence. Fertil Steril. 2009;91(4):1215–1223. DOI: 10.1016/j.fertnstert.2008.01.051
24. Oliveira FG, Abdelmassih VG, Diamond MP, et al. Impact of subserosal and intramural uterine fibroids that do not distort the endometrial cavity on the outcome of in vitro fertilization-intracytoplasmic sperm injection. Fertil Steril 2004;81(3):582–587. DOI: 10.1016/j.fertnstert.2003.08.034
25. Metwally M, Farquhar CM, Li TC. Is another meta-analysis on the effects of intramural fibroids on reproductive outcomes needed? Reprod Biomed Online 2011;23(1):2–14. DOI: 10.1016/j.rbmo.2010.08.006
26. Kroon B, Johnson N, Chapman M, et al. Fibroids in infertility–consensus statement from ACCEPT (Australasian CREI Consensus Expert Panel on Trial evidence). Aust N Z J Obstet Gynaecol 2011;51(4):289–295. DOI: 10.1111/j.1479-828X.2011.01300.x