Rotterdam criteria, the end

Maria-Elisabeth Smet, MD[1] and **Andrew McLennan**, BSc, MBBS (Hons), FRANZCOG, FRCOG, COGU[1,2]

[1]Sydney Ultrasound for Women, Level 1, 56 Neridah Street, Chatswood, New South Wales 2067, Australia
[2]Discipline of Obstetrics Gynaecology and Neonatology, Faculty of Medicine, University of Sydney, Sydney, New South Wales 2067, Australia

Rotterdam criteria

According to the Rotterdam consensus,[1] polycystic ovarian syndrome (PCOS) is defined by the presence of two of three of the following criteria: oligo-anovulation, hyperandrogenism and polycystic ovaries (≥ 12 follicles measuring 2-9 mm in diameter and/or an ovarian volume > 10 mL in at least one ovary). The sonographic criteria were based on a study published in 2003 by Jonard *et al.*,[2] where patients with PCOS were found to have significantly more follicles in the 2-5 mm range than a control group comprised of women with tubal or male factor infertility. The decision to set the cut-off at 12 follicles measuring between 2 and 9 mm resulted from a compromise between specificity (99%) and sensitivity (75%), noting that narrowing the range to between 2 and 5 mm did not improve the diagnostic power. A suggestion was made to repeat the assessment in a subsequent cycle if the ovary was enlarged and its antral follicle count obscured by a dominant follicle (>10 mm) or a corpus luteum.[3] There is no consensus on how to classify ovaries with a high follicle count when using oral contraception or other exogenous hormones or when there is evidence of a dominant follicle or corpus luteum in successive cycles.

Is the Rotterdam consensus still appropriate?

Over the 15 years since the Rotterdam consensus, increasing use of transvaginal assessment and technological improvements in ultrasound resolution have resulted in 20%–30% of regularly cycling, normo-ovulatory women satisfying the Rotterdam criteria for polycystic ovarian morphology[4] and even more in a younger demographic.[5] The sonographic assessment has, over time, become the dominant indicator of PCOS and is often either overinterpreted or misinterpreted as a *de facto* diagnostic test, often ignoring the presence of a dominant follicle or corpus luteum. These women may then be inappropriately considered 'polycystic' without having the requisite clinical or biochemical correlates.

Post-menarcheal teenagers almost always have at least one ovary with > 12 visible follicles and labelling them as 'polycystic' can lead to unnecessary investigations, inappropriate management and stigmatisation. The same is true for women with regular, ovulatory cycles attending ultrasound for reasons other than fertility assessment, who happen to have 15 visible antral follicles and a dominant follicle or corpus luteum. Being wrongfully labelled 'polycystic' may also adversely affect self-esteem and influence women's choices around their diet and use of contraception.

So, is there a better way?

Over the past few years, the sonographic criteria embedded in the Rotterdam Consensus have been rightly challenged. In 2011, Dewailly[6] studied 240 consecutive patients with mixed symptoms and recommended an ovary not be considered to have polycystic ovarian morphology until ≥ 19 follicles were noted, whilst Lujan *et al.*[7] in 2013 studying 98 women with NIH classified PCOS and 70 normo-ovulatory volunteers recommended a threshold at ≥ 26 follicles. The difference in recommended follicle numbers is explained by Dewailly excluding clinically normal patients with high follicle numbers from the control group. A meta-analysis performed by the Androgen Excess and Polycystic Ovary Syndrome Society in 2014[8] found that the median follicle number per ovary (FNPO) in women of reproductive age is between 13 and 16 and strongly advocated increasing the threshold for polycystic ovarian morphology to ≥ 25 follicles. Use of ≥ 25 follicles is also supported by the International Society of Ultrasound in Obstetrics and Gynaecology Consensus Group.[9,10]

Labelled or numbered?

Strictly, use of the term 'polycystic' in most contexts is incorrect. A cyst is defined as a pathological cavity having fluid or gaseous contents and 'polycystic' has the connotation of multiple pathological collections. A tertiary (antral) follicle that becomes visible is a physiological process and the number of them does not necessarily reflect a pathological process. In many cases, it may simply reflect a physiological increase in the number of visible immature follicles. We all have experience of the label 'polycystic' being a source of confusion, anxiety and occasionally resulting in unnecessary interventions. It is a term still poorly understood by many women – and their healthcare providers – with the quality of counselling and information provided to women varying greatly. Alternative terms are now

Correspondence to email amclennan@sufw.com.au
doi: 10.1002/ajum.12096

Table 1: Suggested classification to use in routine clinical practice in women with no exogenous hormone therapy. Table adapted from Martins et al[9] and Coelho Neto et al.[10]

Ovarian morphology	FNPO	Clinical interpretation
Low follicle count	1–3	Menopause potential increased within 7 years
Normal follicle count	4–24	Normal follicle count
High follicle count	≥ 25	Higher risk of hyperandrogenic anovulation

also in use, such as 'multifollicular' when ultrasound criteria are satisfied and 'hyperandrogenic anovulation' when associated syndromic biochemical or clinical features are additionally present. This has resulted in further confusion for women and their doctors, and we strongly recommend avoiding the use of labelling in this setting.

Clinical practice points

1 Before interpreting the sonographic results, the menstrual cycle day, length and pattern should be ascertained along with hormone (particularly oral contraceptive) use, where the follicle count is clinically unreliable.
2 Record the FNPO as well as the total antral follicle count (AFC), especially in case of fertility treatment where the follicle numbers have implications for ovarian stimulation protocols and outcomes[9] and describe the presence and dimensions of the dominant follicle or corpus luteum.
3 Whilst trying to avoid unhelpful labelling, it is still necessary to classify the FNPO into clinically useful groups for consistency of counselling and management. They may be classified into low, normal (4–24 FNPO) and high follicle counts (Table 1).[10]
   i Women with an increased follicle count (≥ 25 FNPO) may be at higher risk for hyperandrogenic anovulation, and correlation with clinical and biochemical factors would be appropriate in this group.
   ii Women with a low follicle count (< 4 FNPO, in the absence of contraception) are at an increased risk of menopause within 7 years.[11]
   iii In the context of fertility treatment, a total AFC of > 20 follicles carries with it an increased risk of ovarian hyperstimulation syndrome (OHSS).[12]

References

1 Rotterdam ESHRE/ASRM-Sponsored PCOS consensus workshop group. Revised 2003 consensus on diagnostic criteria and long-term health risks related to polycystic ovary syndrome (PCOS). *Hum Reprod* 2004; 19(1): 41–7.
2 Jonard S, Robert Y, Cortet-Rudelli C, Pigny P, Decanter C, Dewailly D. Ultrasound examination of polycystic ovaries: is it worth counting the follicles? *Hum Reprod* 2003; 18(3): 598–603.
3 Balen AH, Laven JS, Tan SL, Dewailly D. Ultrasound assessment of the polycystic ovary: international consensus definitions. *Hum Reprod Update* 2003; 9(6): 505–14.
4 Lie Fong S, Laven JSE, Duhamel A, Dewailly D. Polycystic ovarian morphology and the diagnosis of polycystic ovary syndrome: redefining threshold levels for follicle count and serum anti-Müllerian hormone using cluster analysis. *Hum Reprod* 2017; 32 (8): 1723–31.
5 Duijkers IJ, Klipping C. Polycystic ovaries, as defined by the 2003 Rotterdam criteria, are found to be very common in young healthy women. *Gynecol Endocrinol* 2010; 26(3): 152–60.
6 Dewailly D, Gronier H, Poncelet E, Robin G, Leroy M, Pigny P, *et al.* Diagnosis of polycystic ovary syndrome (PCOS): revisiting the threshold values of follicle count on ultrasound and of the serum AMH level for the definition of polycystic ovaries. *Hum Reprod* 2011; 26: 3123–9.
7 Lujan ME, Jarrett BY, Brooks ED, Reines JK, Peppin AK, Muhn N, *et al.* Updated ultrasound criteria for polycystic ovary syndrome: reliable thresholds for elevated follicle population and ovarian volume. *Hum Reprod* 2013; 28: 1361–8.
8 Dewailly D, Lujan ME, Carmina E, Cedars MI, Laven J, Norman RJ, *et al.* Definition and significance of polycystic ovarian morphology: a task force report from the Androgen Excess and Polycystic Ovary Syndrome Society. *Hum Reprod Update* 2014; 20(3): 334–52.
9 Martins WP, Kollmann M, Raine-Fenning N. Counting ovarian follicles: updated threshold for diagnosis of hyperandrogenic anovulation. *Ultrasound Obstet Gynecol* 2014; 44(2): 131–4.
10 Coelho Neto MA, Ludwin A, Borrell A, Benacerraf B, Dewailly D, Da Silva Costa F, *et al.* Counting ovarian follicles by ultrasound: a practical guide. *Ultrasound Obstet Gynecol* 2018; 51: 10–20.
11 Ferraretti AP, La Marca A, Fauser BC, Tarlatzis B, Nargund G, Gianaroli L, *et al.* ESHRE consensus on the definition of 'poor response' to ovarian stimulation for *in vitro* fertilization: the Bologna criteria. *Hum Reprod* 2011; 26: 1616–24.
12 Nastri CO, Ferriani RA, Rocha IA, Martins WP. Ovarian hyperstimulation syndrome: pathophysiology and prevention. *J Assist Reprod Genet* 2010; 27: 121–8.