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Short Communication

Radiological Predictors of Metabolic Risk in Women with Polycystic Ovarian Disease

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ABSTRACT

Background: Polycystic Ovarian Disease (PCOS) is a common endocrine disorder associated with significant metabolic complications, including insulin resistance, obesity, dyslipidemia, and increased cardiovascular risk. While biochemical markers are traditionally used to assess metabolic dysfunction, radiological imaging, particularly ultrasound, has emerged as a valuable tool for identifying high-risk phenotypes through evaluation of ovarian morphology and fat distribution.
Objective: To review current evidence on radiological predictors of metabolic risk in women with PCOS and to summarize imaging parameters associated with insulin resistance and cardiometabolic abnormalities.
Methods: A narrative review of literature published between 2000 and 2024 was conducted using PubMed, Scopus, and Google Scholar. Studies evaluating ultrasound and magnetic resonance imaging parameters in adult women diagnosed with PCOS were included. Key radiological markers such as follicle number per ovary, ovarian volume, stromal echogenicity, ovarian vascularity, and visceral adiposity were analyzed in relation to metabolic outcomes.
Results: Increased follicle number per ovary and enlarged ovarian volume were consistently associated with insulin resistance and hyperandrogenism. Prominent ovarian stromal hypertrophy and increased stromal vascularity demonstrated strong correlations with adverse lipid profiles and elevated fasting insulin levels. Magnetic resonance imaging revealed disproportionate visceral fat accumulation in women with PCOS, even in those with normal body mass index, highlighting a hidden metabolic risk. Advanced ultrasound techniques improved assessment accuracy but remain limited in routine clinical practice.
Conclusion: Radiological markers provide important insight into metabolic risk in PCOS and serve as useful adjuncts to clinical and biochemical evaluation. Ultrasound-derived ovarian morphology and MRI-assessed visceral adiposity help identify high-risk phenotypes, supporting early intervention and personalized management. However, imaging findings should be interpreted within a comprehensive diagnostic framework. Standardized protocols and integrated diagnostic models are needed to enhance clinical utility.

Keywords: Polycystic Ovarian Disease; Ultrasound Imaging; Metabolic Risk; Ovarian Morphology

INTRODUCTION

Polycystic Ovarian Disease, commonly known as Polycystic Ovary Syndrome (PCOS), is a complex endocrine disorder affecting approximately 8–13% of women of reproductive age worldwide. [1,2] While traditionally recognized for its reproductive manifestations such as irregular menstruation, infertility, and hyperandrogenism, PCOS is increasingly understood as a metabolic disorder with long-term health implications. Women with PCOS are at significantly higher risk of insulin resistance, obesity, dyslipidemia, type 2 diabetes mellitus, and cardiovascular disease. [3-5] Early identification of metabolic risk is essential to prevent long-term complications. Although biochemical markers such as fasting glucose, insulin levels, and lipid profiles are commonly used, imaging has emerged as a valuable adjunct in risk stratification. Radiological techniques, particularly pelvic ultrasound, provide insight into ovarian morphology, stromal characteristics, and fat distribution, which are increasingly recognized as potential predictors of metabolic dysfunction. [6,7] Ultrasound-based parameters such as follicle number per ovary (FNPO), ovarian volume, and stromal echogenicity reflect underlying hormonal and metabolic disturbances. In addition, advanced imaging techniques including Doppler ultrasound and magnetic resonance imaging (MRI) allow assessment of ovarian vascularity and visceral adiposity, both of which correlate with metabolic risk. [8–10] This review explores the role of radiological markers in predicting metabolic risk among women with PCOS and highlights their clinical relevance in early diagnosis and personalized management.

OBJECTIVE

The objective of this review is to evaluate radiological parameters associated with metabolic risk in women with PCOS and to summarize evidence linking ovarian morphology and imaging findings with insulin resistance and cardiometabolic abnormalities.

METHODS AND MATERIALS

A narrative review methodology was adopted. A literature search was conducted using PubMed, Scopus, and Google Scholar for studies published between 2000 and 2024. Keywords included PCOS, ultrasound, ovarian morphology, metabolic risk, insulin resistance, stromal echogenicity, and visceral fat. Original research articles, systematic reviews, and international guidelines were included. Twenty-five peer-reviewed articles were selected based on relevance to radiological predictors of metabolic risk. Studies involving adult women diagnosed with PCOS using Rotterdam or Androgen Excess Society criteria were prioritized. Data were qualitatively synthesized focusing on ultrasound findings, MRI parameters, and their associations with metabolic markers.

RESULTS AND DISCUSSION

Ovarian Morphology and Metabolic Dysfunction: Polycystic ovarian morphology (PCOM) is characterized by increased follicle number and ovarian enlargement. Several studies demonstrate that women with higher FNPO tend to exhibit greater insulin resistance and elevated androgen levels. [11,12] FNPO reflects follicular arrest driven by hyperinsulinemia and excess luteinizing hormone stimulation, creating a feedback loop that worsens metabolic dysfunction. [13] Ovarian volume has also been linked to metabolic abnormalities. Enlarged ovaries are associated with higher body mass index (BMI), fasting insulin levels, and homeostatic model assessment for insulin resistance (HOMA-IR) (14). However, ovarian volume alone lacks specificity and is influenced by age and body composition.

Stromal Changes as Predictors of Insulin Resistance: Increased ovarian stromal echogenicity and stromal area represent androgen-producing tissue. Studies report strong correlations between stromal hypertrophy and biochemical hyperandrogenism, as well as insulin resistance. [15,16] Women with prominent stromal changes demonstrate higher triglyceride levels and lower HDL cholesterol, indicating elevated cardiometabolic risk.[17] Doppler ultrasound further reveals increased stromal vascularity in PCOS, reflecting enhanced ovarian blood flow and metabolic activity. Elevated vascular indices correlate positively with serum insulin and inflammatory markers. [18]

Visceral Adiposity and MRI Findings: MRI studies provide valuable information on fat distribution. Women with PCOS tend to accumulate visceral fat disproportionately compared to subcutaneous fat, even when BMI is similar to controls. [19] Visceral adiposity is a known driver of insulin resistance and cardiovascular risk. MRI-derived visceral fat volume has shown strong associations with glucose intolerance and dyslipidemia in PCOS populations. [20]

Role of Advanced Ultrasound Techniques: Three-dimensional ultrasound improves accuracy of follicle counts and stromal volume estimation. Studies report better correlation between 3D-derived ovarian parameters and metabolic indices compared to conventional 2D imaging. [21] However, limited availability restricts routine clinical use. [22]

Clinical Implications: Radiological predictors provide a non-invasive means of identifying high-risk PCOS phenotypes. Women with increased FNPO, enlarged ovaries, prominent stromal hypertrophy, and elevated ovarian blood flow are more likely to exhibit metabolic syndrome features. [22]. These findings support early lifestyle intervention and targeted metabolic screening. Importantly, imaging should complement—not replace, clinical and biochemical evaluation. Adolescents and young women may demonstrate PCOM without metabolic abnormalities, highlighting the need for cautious interpretation. [23]

CONCLUSION

Radiological assessment plays an increasingly important role in identifying metabolic risk among women with PCOS. Ultrasound parameters such as follicle number, ovarian volume, stromal echogenicity, and vascularity provide valuable insight into underlying insulin resistance and cardiometabolic dysfunction. Advanced imaging modalities further enhance risk stratification through assessment of visceral adiposity. However, radiological findings must be interpreted within a comprehensive clinical framework. Integration of imaging with hormonal and metabolic evaluation offers the most reliable approach to early diagnosis and personalized management. Future research should focus on standardizing imaging criteria and developing predictive models combining radiological and biochemical markers.

DECLARATION

Ethics Approval and Consent to Participate: Not applicable. This manuscript is a narrative review based exclusively on previously published studies and does not involve direct participation of human subjects or animals.

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