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An Overview of Polycystic Ovarian Syndrome

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Abstract: ***Polycystic ovarian syndrome (PCOS) is a syndrome which affects women's hormone levels. It is also known as 'Stein-Leventhal syndrome'. [1] Nidhi, et al. prospectively studied 460 girls aged 15-18 years from a residential college in Andhra Pradesh, South India. The authors have reported a prevalence of PCOS in 9.13% of the Indian adolescents. [2] It is estimated that 105 million people suffer this syndrome among 15 to 49 year-old women worldwide. [3] Women with PCOS produce higher-than-normal amounts of male hormone. It is a health problem that affects 1 in 10 women of childbearing age. According to PCOS awareness association, polycystic ovarian syndrome occurs in around 10,000,000 people worldwide [4]. PCOS is a disorder of internal abnormal conditions of ovaries. 8-15% of women with procreative age square measure largely affected. PCOS is mainly caused by Genetic imbalances and classified lifestyle changes [5]. There is an emerging need for the diagnosis and early treatment of this disorder as it may lead to infertility and ovarian cancer to the women suffering from PCOS and who has remained undiagnosed. Mainly, it can be treated at the hormonal level by normalizing the elevated hormones which will reduce the signs and symptoms associated and thereby gradually decreasing the severity of the disorder.***

Keywords: Polycystic ovarian syndrome, Women, hormone, diagnosis, treatment

1. What is PCOS?

A variable disorder that is marked especially by oligommenorhea, hirsutism, obesity, infertility and ovarian cysts and is usually initiated by an elevated level of luteinizing hormone, androgen or estrogen which results in an abnormal cycle of gonadotropin release by the pituitary gland. Manifestations of PCOS are varied, but many signs of PCOS are intimately related to disease Pathophysiology:
Hyperandrogenism: [6]
Hirsutism
Acne
Alopecia: male-pattern hair loss

Hyperinsulinemia: [6]
Acanthosis nigricans
As defined by the Rotterdam Criteria in 2003, polycystic ovaries have as their concept, the presence of at least one ovary of 12 or more follicles with diameters of 2 - 9 mm and/or increase the ovarian size > 10 ml [7][8]

2. Causes of PCOS

2.1 Obesity is a common finding in women with PCOS and between 40–80% of women with this condition are reported to be overweight or obese. [9] Obesity is thought to exacerbate the symptoms of hyperandrogenism and hyperinsulinemia. Reproductive disturbances are more common in obese women regardless of the diagnosis of PCOS. Obese women are more likely to have menstrual irregularity and anovulatory infertility than normal-weight women. In reproductive-age women, the relative risk of anovulatory infertility increases at a BMI of 24 kg/m^2 and continues to rise with increasing BMI. [9]

2.2 Diabetes has been produced to describe the disease which is due to a dysfunction of the ovary, whereby the ovary does not process the FSH and LH from the brain appropriately so that ovulation does not occur resulting in the diversion to the testosterone pathway, leading to excess testosterone with various emphases on clinical or biochemical hyperandrogenism, polycystic ovaries, and oligoanovulation.

2.3 Insulin resistance is a common finding in PCOS that is independent of obesity. Insulin-mediated glucose disposal, reflecting mainly insulin action on skeletal muscle is decreased by 35–40% in women with PCOS compared to weight comparable reproductively normal women. Fasting insulin levels are increased in PCOS [9]

2.4 Another problems are:
a) Irregular menstrual cycle due to which the *endometrial lining thickens* leading to several problems: hemorrhagic bleeding and endometrial cancer.
b) Lack of Estrogen leading to dry vagina, flushing of skin and also increased risk of premature arteriosclerosis and dyslipidemia.

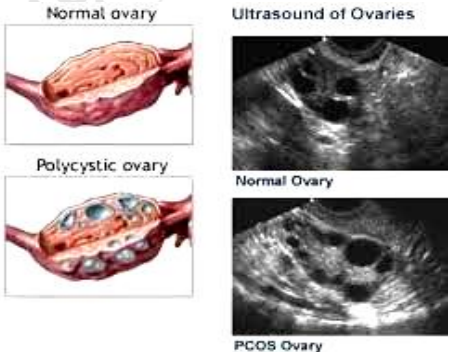

Figure 1: Normal vs. Polycystic ovary [10]

Figure 2: Comparative ratio of ages affected [11]

3. Difference between PCO and PCOS

Factors	*PCO*	*PCOS*
Definition	Ultrasound scan image of the ovaries that appear to be polycystic (ovaries containing high density of partially mature follicles). [6]	It is a metabolic condition that may or may not come with having polycystic ovaries. In fact, to be diagnosed with PCOS a woman needs to have at least 2 of the following: 1) Polycystic ovaries appear on ultrasound. 2) Irregular periods. 3) Increased male hormone in the blood test or associated symptoms such as excess hair growth or acne. [6]
Prevalence	It is more prevalent to pre-reproductive age group having polycystic ovaries on ultrasound and no other symptoms.	It affects 12-18% of women of reproductive age. [11]
Type of disease	It is a variant of normal ovaries.	It is a metabolic disorder associated with an unbalanced hormone levels released by the woman's ovaries.
Risk associated	Women do not have the major risk profile. [6]	Women are at risk of developing diabetes, pregnancy complications (i.e. gestational diabetes), cardiovascular diseases, obesity and endometrial cancer.
Onset of disease	May be present early in life, but there are no symptoms.	Often start showing symptoms (acne, excess hair growth etc.) in teen years, due to the associated metabolic disturbances. [6]
Hormonal level	Women may still retain hormonal balance and continue to ovulate regularly.	There is hormonal imbalance which interferes with ovulation. It is majorly linked to high insulin release that stimulates the production of androgens from the ovary disturbing ovulation.
Conception	Conception may not be difficult.	May have problems getting pregnant. In addition, women have a higher miscarriage rates. [6]

4. Pathogenesis and risk factors

Risk factors	*Pathogenesis*
Genetics	20-40% of female first-degree relatives of women with PCOS also have the syndrome, suggesting that the disease is partially heritable and clusters in families. Some genes have been identified as contributing to risk of the disease, including 7β-hydroxysteroid-dehydrogenase type 6 (HSD17B6). [6]
Intrauterine exposures	Exposure to testosterone in uterine [6] is correlated with development of a PCOS-like syndrome including hyperinsulinemia, hyperandrogenism, oligoanovulation, and polycystic ovaries. Exposure to androgens may impair estrogen and progesterone inhibition of GnRH, contributing to increased pulse frequency. [6]
Environment/lifestyle	Sedentary lifestyle results in increased metabolic dysfunction and weight gain which leads to oligoanovulation and hyperandrogenism.
Obesity	Adipose tissue possesses aromatase, an enzyme that converts androstenedione to estrone and testosterone to estradiol. The excess of adipose tissue in obese patients causes them to have both excess androgens (which are responsible for hirsutism and virilization) and estrogens (which inhibit FSH via negative feedback). [12] Obese women with PCOS are at increased risk of anovulation and consequent subfertility.

Figure 3: Outline of Pathogenesis

5. Pathophysiology of PCOS

5.1 Hyperandrogenism:

Hyperandrogenism is the most characteristic feature of PCOS. In PCOS, the ovaries produce up to 60% of androgens, while the adrenals contribute the remaining 40%. [13]. Hyperandrogenism is exacerbated by hyperinsulinemia and antral follicle arrest and may itself increase the risk of follicle arrest. [6]

5.2 Neuroendocrine abnormalities

Neuroendocrine abnormalities including increased gonadotropin-releasing hormone [GnRH] pulse frequency and hence luteinizing hormone [LH] pulsatility and relative follicle stimulating hormone [FSH] deficiency are a nearly universal finding in PCOS and contribute to its pathogenesis[14]. A high LH: FSH ratio leading to an ovarian excess of androgens relative to estrogens is seen. Women with PCOS demonstrate persistently rapid GnRH pulse frequency, which in contrast to normal ovulatory cycles, has lost its typical pattern of slowing during the luteal phase of their often anovulatory cycles. Normal luteal slowing of GnRH and LH pulse frequency occurs via feedback inhibition by increased progesterone levels during the luteal phase. [15]

5.3 Insulin resistance and Type 2 Diabetes Mellitus:

Obesity and hormonal abnormalities are thought to make additive contributions to insulin resistance: Patients with PCOS exhibit a greater degree of insulin resistance than patients with the same BMI and visceral adiposity who do not have PCOS. [6]Hyperglycemia can occur with hyperinsulinemia or after beta cell exhaustion with insulinopenia. Thus, a serum insulin level at diagnosis is not helpful in the classification of the type of diabetes .Absent islet cell antibodies may be helpful in confirming a clinical diagnosis of type 2 diabetes. [16] The resulting

hyperinsulinemia leads to insulin spillover into other tissues, most commonly the skin. Insulin causes excess keratinocyte growth, producing velvety skin patches known as acanthosis nigricans. [17]

5.4 Polycystic ovaries

The "cysts" in polycystic ovaries are not true cysts, but rather antral follicles which have arrested in development. [6] Hyperinsulinemia*:* exacerbates ovarian hyperandrogenism by:

a) Increasing 17a-hydroxylase activity in theca cells and promoting androstenedione and testosterone production.
b) Promoting LH- and IGF1-stimulated androgen production
c) Elevating free testosterone by decreasing the production of sex hormone binding globulin (SHBG) [6]

5.5 Long term morbidity:

5.5.1 Subfertility: This is largely a consequence of oligoanovulation, but may also result from abnormalities in oocyte development due to hormonal or other abnormalities. [6]

5.5.2 Miscarriage*:* Obese patients with PCOS have high risk of miscarriage. [6]

5.5.3 Malignancies*:* A combination of hyperinsulinemia, hyperandrogenism, and oligoanovulation increases the risk of endometrial cancer and other endometrial disorders. [6]

5.5.4 Psychiatric disorders*:* Women with PCOS have an increased risk of anxiety, depression and bipolar disorder.

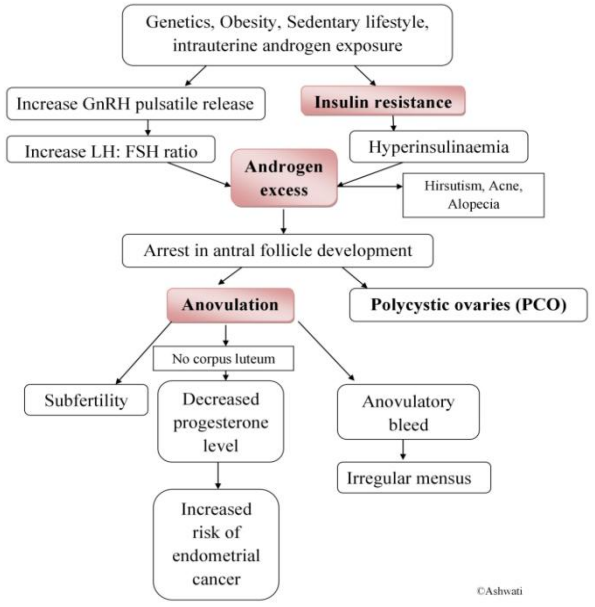

Figure 4: Schematic representation of Pathophysiology of PCOS

6. Complications of PCOS:

6.1. Infertility: This happens when ovaries aren't releasing an egg every month. [6]

6.2. Repeated miscarriages

6.3. Gestational diabetes: Diabetes in women with PCOS during pregnancy. [18]

6.4. Hypertension during pregnancy or delivery

6.5. Nonalcoholic Steatohepatitis: a severe liver inflammation caused by fat accumulation in liver. [19]

6.6. Abnormal uterine bleeding [19] [20]

6.7. Depression and anxiety [20]

6.8. Endometrial hyperplasia (Precancerous uterine linings): This can happen when a woman doesn't have regular menstrual cycles, which normally build up and "clear off" the uterine lining every month. [6]

6.9. Endometrial (Uterine) malignancy. [21]

6.10. Sleep apnea [20]

6.11. Metabolic syndrome: a cluster of conditions including high blood pressure, high blood sugar, and abnormal cholesterol or triglyceride levels that significantly increase your risk of cardiovascular disease. [19]

7. Diagnosis of PCOS

7.1. Physical Exam

Doctor may check blood pressure, BMI (body mass index), and waist size. Doctor may also look for extra hair growth, acne, and discolored skin. [22]

7.1.1 Pelvic exam: [22] Checking vagina, cervix, uterus, fallopian tubes, ovaries and rectum, checking for abnormalities.

7.1.2 Pelvic ultrasound (sonogram): [22] This produces an image of ovaries. For the ultrasound, doctor will check for cysts in ovaries and how thick the lining is in uterus. That lining may be thicker than normal if there is irregular menstruation. Ovaries may be 1½ to 3 times larger than normal for a person suffering with PCOS. The ultrasound can show ovary changes in about 90% of women who have PCOS.

7.2. Blood tests

7.2.1. Follicle-stimulating hormone (FSH) affects the ability to get pregnant. The level might be lower than normal, or even normal, for a person suffering with PCOS. [22]

7.2.2 Luteinizing hormone (LH) encourages ovulation. It could be higher than normal. [22]

7.2.3. Testosterone is a sex hormone that would be higher in women with PCOS. [22]

7.2.4. Estrogens [22] are group of hormones that allow women to get their menstrual cycle. The level may be normal or high in women with PCOS. The level of sex hormone binding globulin

(SHBG) may be lower than normal. A sex hormone called and rostenedione may be at a higher-than-normal level.

7.2.5. Human chorionic gonadotropin (hCG): This is a hormone test that is used for pregnancy confirmation test. [22]

7.2.6. Anti-Mullerian hormone (AMH): This test can check how well the ovaries are working and to help estimate the menopause period. The levels would be higher in women with PCOS. [22]

7.3. Other tests

7.3.1 Lipid profiles [22] check the cholesterol and triglycerides levels. PCOS patients are more prone to suffer with cardiac diseases.

7.3.2. Glucose tolerance test [22] is the diagnostic test for type-2 diabetes Mellitus. Women with PCOS were more insulin resistant than women without the disorder, at equivalent degrees of obesity. Insulin resistance has been identified as a major risk factor for the development of type 2 DM, and likely contributes to the high prevalence of glucose intolerance in women with PCOS. [23]

7.3.3. Insulin test: [22] Insulin is responsible for maintaining blood glucose levels. This test will help to find how well the body responds to insulin. If the body doesn't respond to the insulin it's making, a person may suffer from insulin resistance. It's common among women with PCOS and can lead to diabetes. Most common is in case of pregnant women with PCOS where they develop gestational diabetes.

8. Treatment for PCOS

8.1 Allopathic treatment

Drug used	*Treatment*	*Mechanism of action*	*Adverse effects*
Estrogen and progestin oral contraceptive (OCP) therapy [24][25]	Acne, Hirsutism, Irregular menstrual cycles [25]	Estrogen and Progestin causes inhibition of feedback of FSH & LH secretion from the pituitary gland to inhibit ovulation.	1.Weight gain 2.Amenorrhoea 3.Cadiovascular diseases 4.Carcinogenicity: Breast cancer, cervical cancer
Anti-androgens (e.g. Spironolactone, Flutamide) [26]	Acne and Hirsutism.	Spironolactone Aldosterone antagonist. Competes with dihydrotestosterone for binding with androgen receptor which inturn inhibits ovarian and adrenal steroidogenesis Flutamide Nonsteroidal anti-androgen. Inhibits androgen uptake or inhibits nuclear binding of androgen in target tissues or both. Inhibits testosterone biosynthesis.	Contraindicated in pregnancy because they are teratogenic
Metformin [24][25]	glucose intolerance, hyperinsulinemia, anovulation [25]	i. Suppress hepatic gluconeogenesis and glucose output from liver. ii. Insulin mediated glucose disposal in fats which enhances GLUT 1 transportation from intracellular site to plasma membrane. iii. Interfere with mitochondrial respiratory chain and promote peripheral glucose utilization by enhancing anaerobic glycolysis. iv. Inhibit intestinal absorption of glucose, other hexoses, amino acids, vitamin B12.	1.Lactic acidosis (rare) 2.Vitamin B12 deficiency
Clomiphene citrate [24][27] (First line treatment) [28]	For inducing ovulation.	Anti estrogen. Induce Gn secretion by blocking estrogenic feedback inhibition. Binds to both ERα and ERβ receptors. Blocks estrogenic feedback inhibition of pituitary and induces Gn secretion. Increase amount of secretion of FSH/LH at each secretory pulse.	1.Multigestational pregnancy 2.Longer-term treatment is associated with increased risk of ovarian cancer due to ovarian hyperstimulation[27]
Gonadotropin therapy[27]	Recombinant FSH and hCG can be used to induce ovulation in cases where treatment with clomiphene citrate and metformin has been unsuccessful.	In selective females with infertility, hCG has action similar to LH that is it triggers ovulation and development of the corpus luteum. It also increases oestradiol production.	Ovarian hyperstimulations: Polycystic ovary, ovarian bleeding. Precocious puberty in children, Hormone dependent malignancies (breast)[27]

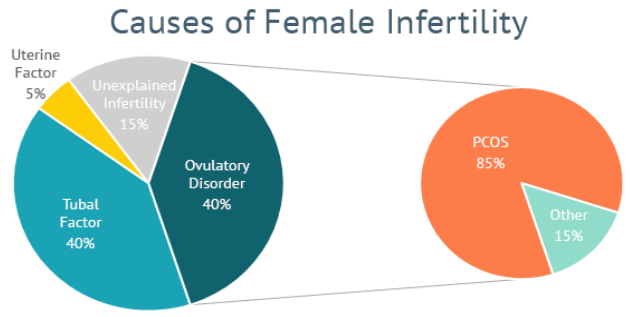

Figure 5: Causes of Female infertility [28]

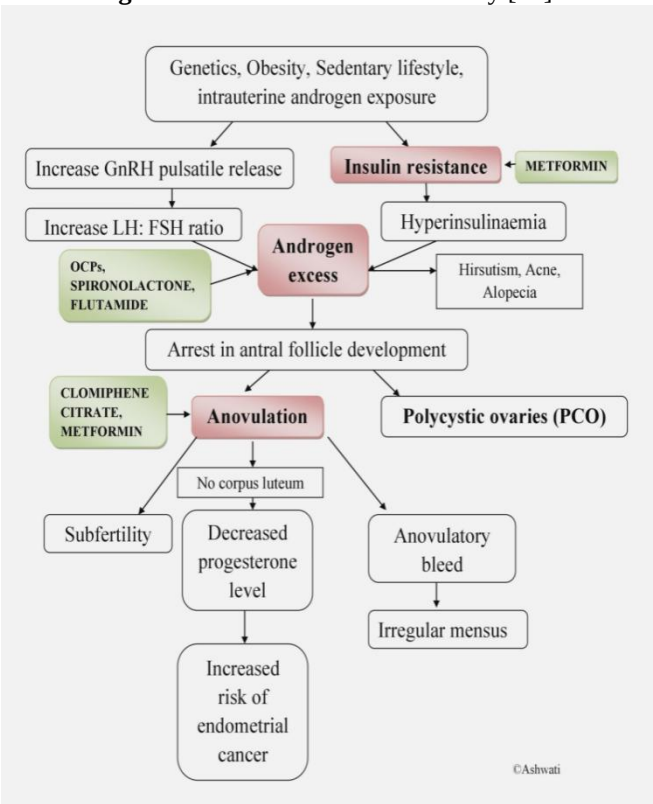

Figure 6: Schematic representation of pathophysiology and targeted treatment for PCOS

8.2 Laboratory/ surgical method

1) Ovarian drilling

This technique is second-line treatment [29] in infertile women with PCOS. Laparoscopic surgical procedure may be used to treat clomiphene citrate-resistant anovulation. [6]. Ovarian drilling involves the creation of ~10 perforations in the ovary using either cautery or laser. The ablation of some of the ovarian theca is thought to help induce ovulation by decreasing androgen production. [6] The mechanism of action of ovarian drilling in the treatment of infertility in women with PCOS is suggested to be based on the decreased secretion of androgens and consequent reduction of peripheral aromatization of these compounds into estrone. Furthermore, the follicular microenvironment becomes more estrogenic, which facilitates follicular growth [30]. If the patient does not present with ovulatory cycles at three months after ovarian drilling, then the procedure should be combined with Clomiphene citrate treatment. The use of gonadotropins should be considered after 6 months of anovulatory cycles following the ovarian drilling procedure. Ovarian drilling should not be indicated as a treatment for menstrual irregularity, metabolic complications or hyperandrogenism in PCOS. [29] Ovarian drilling has some advantages compared with gonadotropin treatment because it is associated with a lower multiple gestation rate. [29] Due to the high cost of the procedure, the need for hospitalization, general anesthesia and higher complications risks, ovarian drilling present's low cost effectiveness compared with gonadotropin plus timed intercourse. Moreover, the lack of standardization of the surgical technique and the absence of studies that have evaluated the repercussions of long-term of ovarian drilling demonstrate that this procedure should not be routinely performed but should only be considered as second line of therapy in women with PCOS who will be undergoing laparoscopy for another reason (adnexal mass or pelvic pain, for example). Additionally, ovarian drilling could be an alternative before the assisted reproduction treatment (ART) in individuals without financial conditions for the realization of ART and those who are resistant to Clomiphene citrate. [27]

2) Invitro fertilization (IVF)

It is used for the treatment of infertility in women who have not responded to other therapies to induce ovulation. [6] Third-line treatment [28] in infertile women with PCOS. In vitro fertilization (IVF) is a highly effective form of treatment for women with PCOS. [28] IVF involves the retrieval of oocytes from the ovaries and in vitro combination with sperm to produce embryos. Viable embryos are then transferred into the uterus. [6] The risk of OHSS (Ovarian hyperstimulation syndrome (**OHSS**) is a medical condition that can occur in some women who take fertility medication to stimulate egg growth, and in other women in very rare cases.) is the main complication of the highly complexity treatment in women with PCOS. Thus, to minimize this side effect, ovarian stimulation should be initiated with low doses of gonadotropins (100 to 150 IU of FSHr) and the pituitary should be suppressed with a gonadotropin-releasing hormone (GnRH) antagonist because this method is associated with a reduced risk of OHSS compared with an agonist. [27] Most women who suffer from this condition will have successful pregnancies. The issue of cysts growing on the ovary does not prevent fertilization and pregnancy – it only prevents the release of the egg. Once the embryo has been created, many women who opt for IVF go on to have a healthy baby. [31] Women with PCOS have similar success and live birth rates compared to women without PCOS. [6]

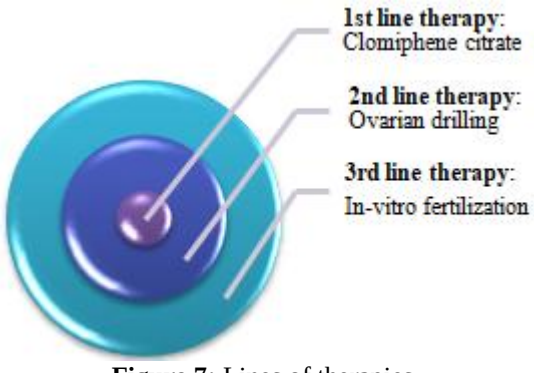

Figure 7: Lines of therapies

8.3 Herbal medicines in treatment of PCOS

8.1. Aloe

Figure 8.1: *Aloe Barbadensis*

Aloe gel obtained from *Aloe Barbadensis* can alter ovarian-placental steroid status by modulating luteinizing hormone receptor, androgen receptor, aromatase and steroidogenic acute regulatory. Reproductive performance was improved after Aloe gel treatment. The study showed Aloe gel is a good pre-conceptive agent for PCOS phenotype. [32]

8.2. Atractylodes

Figure 8.2: *Atractylodes macrocephala*

Atractylodesmacrocephalakoids (AMK) is a tonic herb usually clinically used in Chinese medicinal formula of treating PCOS. AMK improved estrous cycle reduced plasma levels of testosterone and androstenedione of the PCOS in rats. AMK relieves PCOS and regulates FSH receptor and aquaporin-9 expression. [33]

8.3. Guggul

Figure 8.3: *Commiphora wightii*

Commiphora wightii has a role in alleviating DHEA-induced PCOS by decreasing morphological abnormalities of ovarian follicles and also restoring hormonal levels to normal in adult rats. [34]

8.4. Hazel nut

Figure 8.4: *Corylus avellana*

The Hazelnut oil was found to contain tocopherol, sitosterols, squalene, campesterol and stigmasterol in the phytochemical analysis. It was found to be effective in PCOS because of its ability to regulate gonadotropins, steroids, serum lipid parameters and also its antioxidant properties. [35]

8.5. Turmeric

Figure 8.5: *Curcuma longa*

Curcumin reduced fasting blood glucose levels and glycosylated hemoglobin levels in the serum. It also normalized serum lipid profiles and serum sex steroid profiles. Curcumin showed beneficial effects in PCOS. [36]

8.6. Fennel

Figure 8.6: *Foeniculum vulgare*

Serum levels of urea had decreased in PCOS rats treated with *Foeniculum vulgare* at a dose of 150mg per body weight. Histopathological changes of kidney samples were comparable in PCOS rats with respect to groups treated with the extract. *Foeniculum vulgare* aqueous extract showed benefit effect at dose of 150mg per kg body weight on renal function of PCOS rats. [37]

8.7. Flax seed

Figure 8.7: *Linum usitatissium*

Flaxseed had reduced the ovarian volume and number of follicles. After flaxseed therapy peripheral follicles were not seen and the menstrual cycle had improved. [38]

8.8. Fenugreek

Figure 8.8: *Trigonella foenum-graecum*

Fenugreek seed extract caused a reduction in ovarian volume and number of ovarian cysts. It also increased luteinizing hormone and follicle-stimulating hormone levels. Fenugreek seed extract was found to be effective in alleviating the symptoms of PCOS in women. [39]

8.9. Green tea

Figure 8.9: *Camellia Sinensis*

Green tea extract is effective in improving the endocrine condition in the treatment of disturbances of ovulation in PCOS rats. [40]

8.10. Pomegranate

Figure 8.10: Punica granatum

Polyphenols are the major phytoconstituents present in the fruits. Pomegranate extracts lead to reduced effect of testosterone hormone. Consumption of pomegranate extract reduces the complications associated with polycystic ovary syndrome. [41]

8.11. Soy isoflavone

Figure 8.11: *Glycine max*

Soybean (*Glycine max*) contains isoflavones which are responsible for pharmacological actions. Isoflavones are classified as phytoestrogens have been postulated to be natural alternatives to hormonal therapy for menopausal women. isoflavone treatment exhibited significant recovery in the biochemical and clinical parameters. Histopathology evidence shows that soy isoflavones may be beneficial in PCOS. [42]

8.4 Yoga and Naturopathy

8.4.1 Naturopathy:
Naturopathy is defined as a drugless, noninvasive, rational, and evidence-based system of medicine imparting treatments with natural elements based on the theories of vitality, toxemia and the self-healing capacity of the body, and the principles of healthy living. Comprehensive systematic reviews have not only identified emerging evidence of the cost-effectiveness of various alternative therapies but also have a better quality of care without compromising patient outcomes. [43]

Therapies	*Duration (min)*	*Frequency*
Cold abdominal mud pack	10	6 days/week
Hydrotherapy		
Cold water enema	-	Once in 4 weeks
Cold hip bath	15	6 days/week
Hot foot immersion bath	10	Twice in a week
Massage		
Partial massage abdomen	10	3 days/week
Partial massage to back	10	3 days/week
Fasting therapy		
Juices of fruits and vegetables and fluid fasting*	-	Initial 3 days/month
Diet therapy		
Raw vegetables, fruits, sprouts, vegetable soup for breakfast and short vegetarian meal for lunch*	-	Next 18 days/month
Boiled vegetables, steamed food*	-	Final 7 days/month

*Fruits - pomegranate, papaya, apple, mosambi, orange, watermelon, grapes, muskmelon, pineapple, dry dates, dry and fresh figs, and dry grapes - any one of these fruits can be used for the preparation of juice. [43]

Vegetables-carrot, beetroot, cucumber, bitter gourd, ash gourd, and tomato - any one of these vegetables can be used for the preparation of juice. [43]
Raw sprouts - green gram, brown Bengal gram, and groundnut - any one of these can be used [43]

8.4.2 Yoga
Studies have shown that yoga therapy orchestrates fine tuning and modulates neuroendocrine axis which results in beneficial changes. It mainly improves reproductive functions by reducing stress and balancing the neurohormonal profile. [44] Yoga as a form of holistic mind–body medicine is effective in reducing anxiety symptoms in PCOS patients. [43] There is improvement in insulin secretion and sensitivity and this ultimately decreases blood glucose level in diabetics. [43] Various forms of yoga practice can be done to improve the condition. Following are the various practices: Asanas, Pranayama, Kapalbhati, Mudra (Yoni mudra). [43]

9. Conclusion

PCOS is the most common disorder in premenopausal women which is characterized by irregular menstrual cycles, hirsutism and is often associated with type-2 Diabetes Mellitus. It is a leading cause of infertility in women. Another highlighting cause for PCOS is obesity. Women with PCOS have a higher rate of Gestational Diabetes, Miscarriage, Preterm deliveries, Stillbirths and are most likely to develop endometrial cancer. Lifestyle modification along with pharmacological therapies that improve hyperandrogenism and improve insulin sensitivity, assisting

regular menstrual cycle and increase fertility can be the approach for treating PCOS.

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Author Profile

Miss Ashwati Nair, Final Year B. Pharmacy student, Saraswathi Vidya Bhavan's College of Pharmacy, Dombivli, Maharashtra. A distinction holder throughout the academics. Attended one day workshop on 'Hands-on training in use of nanonisation equipments'. 4 research projects and 1 review article was presented at various state level competitions.

Research projects:

1. Polyherbal floating beads for peptic ulcer (2019) - won consolation prize at 'Young Pharmacists Innovative Project Award'.
2. Presented Rejuvenating Camellia tablets (2019)
3. Presented Polyherbal capsules for PCOS (2018)
4. Pediatric sore throat herbal candy (2017) - won third prize at 'Young Pharmacists Innovative Project Award'.

Review article:

Presented Osmotic controlled drug delivery system for Schizophrenia (2018)

Skilled at poster presentations, leadership quality, power point presentations, MS word, reading research articles and communication skills.

Been teacher assistance for subjects Pharmaceutics and Pharmacognosy & Phytochemistry and guided how to study.

Dr. Swati Balakrishnan, A recent MBBS graduate with an avid interest in research. Research titled "Frequency, duration, characterization and association of preterm and full term neonatal smiling with sleep" was chosen by the Indian Council of Medical Research and granted a stipend of Rs.10000 under the STS Scholarship, among applicants from all over the country. Excelled in academics and sports. Was the College Magazine Editor in the year 2018. Attended various workshops and conferences during undergraduate course.