

## Hirsutism: Diagnosis and Treatment

Gokalp Oner\*

Department of Obstetric and Gynecology, Van Baskale State Hospital, Van, Turkey

### Abstract

Hirsutism, which is a common clinical problem in women of reproductive age, is characterized by excessive growth of terminal hair in the androgen-sensitive skin regions. It is the result of either androgen excess or increased sensitivity of the hair follicles to normal levels of androgens. The therapeutic options of hirsutism can be divided into systemic, topical, and dermato-cosmetic therapies. Patients should be informed that the response to systemic agents is slow; occurring over 3-6 months after therapy has begun. In this review, the diagnosis and treatment of hirsutism were summarized with update literature.

### Definition

Hirsutism is defined medically as excessive terminal hair that appears in a male pattern in women [1]. The causes of hirsutism can be divided into non androgenic factors, hirsutism caused by androgen excess, and idiopathic hirsutism (IH). Non androgenic causes of hirsutism are relatively rare. Non androgenic anabolic drugs cause a generalised growth of many tissues, particularly hair, generally leading to vellus hypertrichosis and not hirsutism [2].

### Prevalence

The prevalence of hirsutism is approximately 10% in most populations, with the important exception of Far-East Asian women who present hirsutism less frequently [3]. Although usually caused by relatively benign functional conditions, with the polycystic ovary syndrome leading the list of the most frequent etiologies, hirsutism may be the presenting symptom of a life-threatening tumor requiring immediate intervention. Androgenic causes are responsible in up to 80% of patients, and include polycystic ovary syndrome (PCOS), which affects about 70-80% of hirsute women [4,5]; hyperandrogenic insulin-resistant acanthosis nigricans syndrome, affecting about 3% [6]; 21-OH-deficient non classic adrenal hyperplasia in 2-8% of patients; and, very rarely, ovarian or adrenal androgen-secreting neoplasms [7]. As it is known, PCOS is the most frequent cause of hirsutism and IH takes the 2nd place [2]. IH is responsible for approximately 10-20% of all hirsutism cases [8]. It is seen more frequently in certain ethnic communities, particularly in women of Mediterranean ancestry.

### Pathogenesis

The pathogenesis of IH is not fully understood. There is little information regarding the pathogenesis of IH in the literature. It has been postulated that 5 $\alpha$ -reductase enzyme activity in hair follicles of these patients has increased significantly [9]. Thus, in hair follicles, conversion of testosterone to its more powerful and active metabolite, dihydrotestosterone (DHT) increases. Excessive hair growth may be due to the exaggerated response of hair follicles to normal androgen levels [6]. Also, there might be an alteration in androgen receptor function [10]. Almost all of the testosterone circulating in blood depends on sex hormone binding globulin (SHBG) and albumin. In addition, in most IH patients, increased levels of 3 $\alpha$ -androstane diol glucuronid showing 5 $\alpha$ -reductase enzyme activity is determined [11]. This suggests that the description of IH is incorrect and in most patients, it is a result of peripheral androgen metabolism dysfunction. Recently, the paradoxically low gene expression levels of local 5 $\alpha$ -reductase and aromatase in women with IH were found [12]. Additionally, insulin resistance occurs in nonobese patients with IH and appears to be related to android obesity [13].

### Diagnosis

Recently, there is an European Consensus on the evaluation of women

presenting with excessive hair growth [6]. According to this Consensus, there are three sections: History, Clinical Examination, and Investigations (Figure 1). In the part of History; age, speed of onset, medications (e.g. danazol, valproic acid, anabolic or androgenic steroids), ethnicity (especially Asians), family history, menstrual cycle, and hyperandrogenism were noted. In the part of Clinical Examination; distribution of hair, dermatological examination (such as acne, excessive sebum secretion, or diffuse or localized loss of hair from the head or other regions), thickening and darkening of the skin (acanthosis nigricans which is related to high levels of insulin leading to severe insulin resistance), body mass index (BMI = weight/height<sup>2</sup>), Ferriman-Gallwey score (Figure 2), and psychosomatic aspects (changes in the quality of life) were evaluated. In the part of Investigation; thyroid function (especially, hypothyroidism), testosterone evaluation and free androgen index (FAI = total testosterone divided by SHBG  $\times$  100) [14], prolactin level (hyperprolactinaemia), ultrasound of the pelvis (the ovaries, the adrenal glands, or both is a useful screening procedure for PCOS or neoplasms), and psychosomatic/psychiatric diagnosis were investigated.

The diagnosis of PCOS is based on at least two of the three diagnostic criteria of the Rotterdam consensus [15] being present for each patient, namely clinical and biochemical evidence of hyperandrogenemia, oligomenorrhoea or amenorrhoea and polycystic ovaries on transvaginal ultrasound.

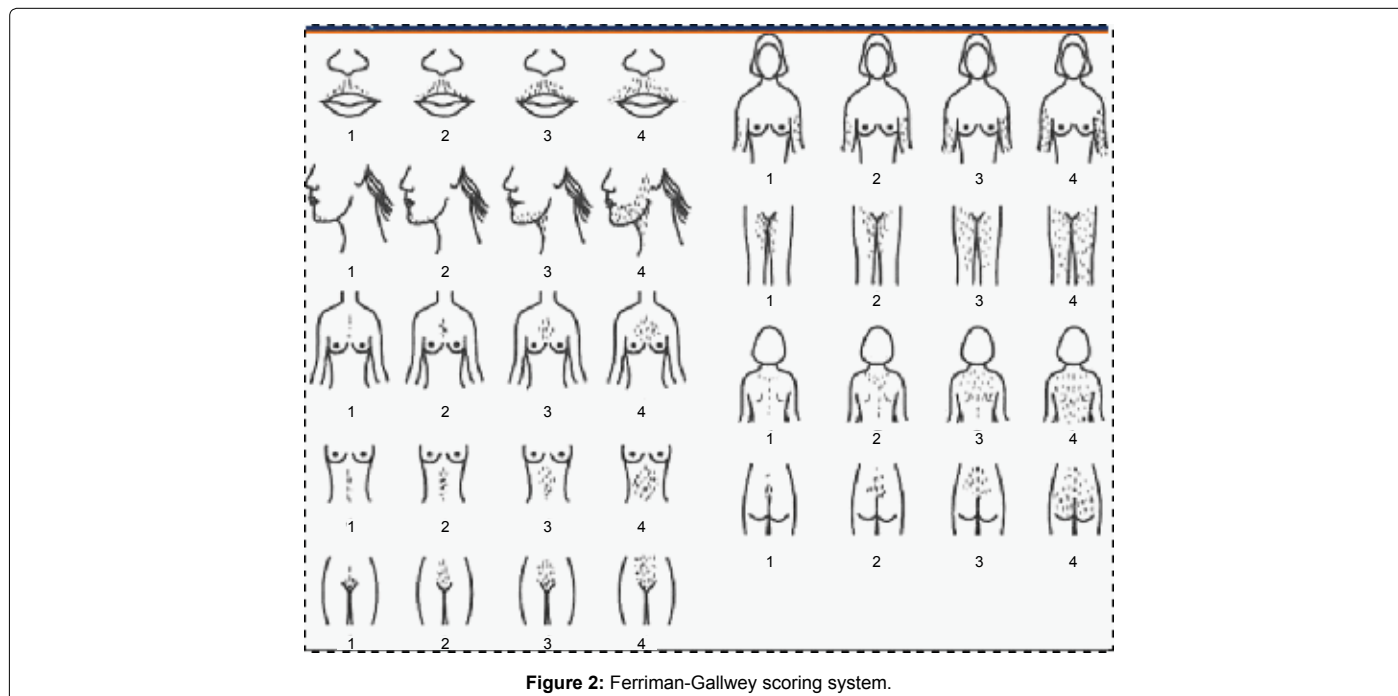
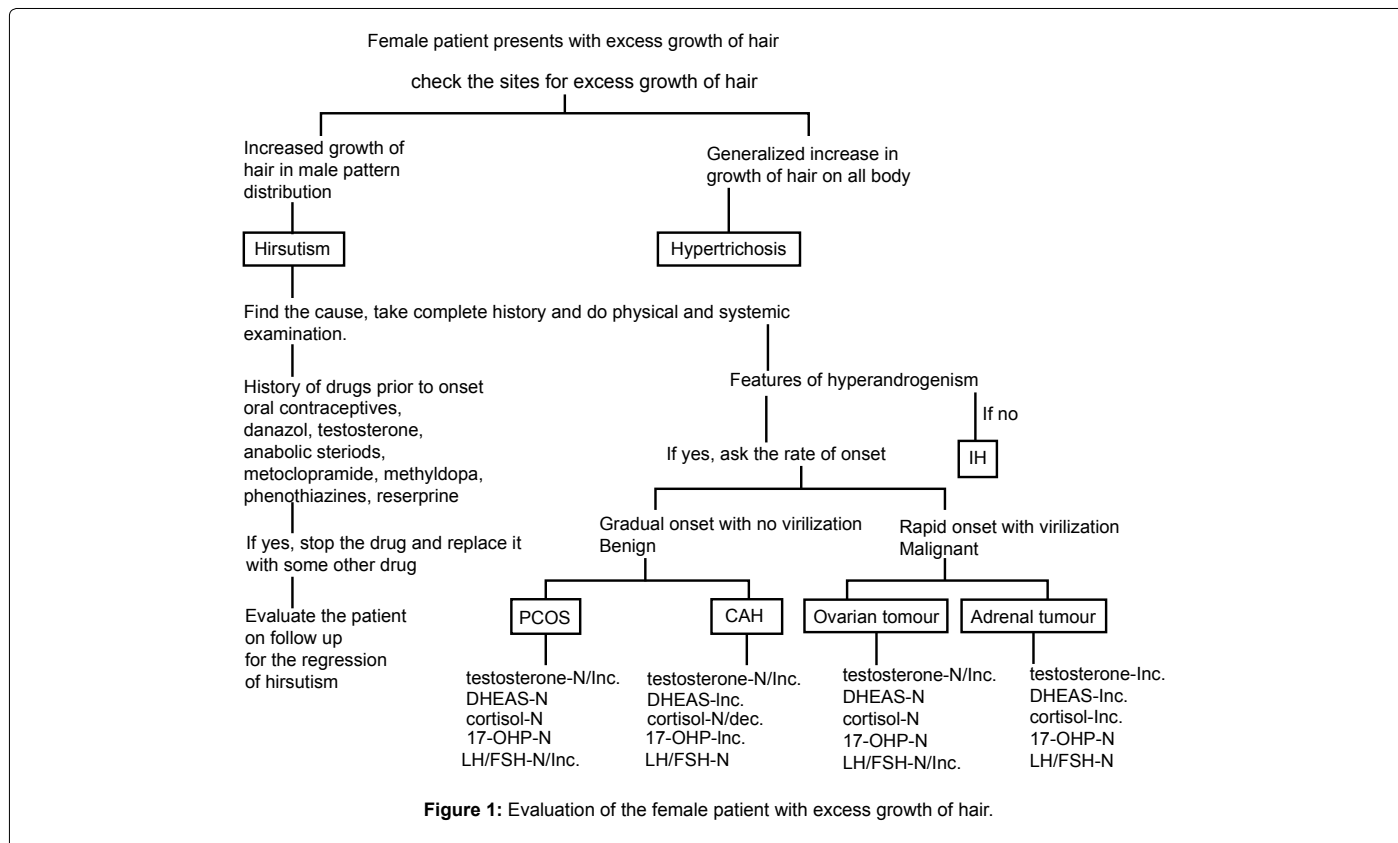
IH diagnosis in a woman is made based on hirsutism, normal ovulatory function and normal serum total and free testosterone levels [11]. Although approximately 40-70% of hirsute women have regular menstrual cycles, all of these cases are not IH [16]. History of regular menstruation does not eliminate ovulatory dysfunction or hyperandrogenemia. Therefore, in some of the PCOS cases menstruation is regular. In women with IH no virilization findings such as cliteromegaly, increased muscle mass, breast atrophy, male pattern hair loss and voice deepening are present. During the physical examination of patients, mild to moderate hirsutism is present. Ferriman-Gallwey score is between 8 and 15. In laboratory studies, all routine laboratory tests are normal. In women with IH, DHT hormone serum levels are generally normal, despite the expected

**Corresponding author:** Gokalp Oner, Department of Obstetric and Gynecology, Van Baskale State Hospital, Van, Turkey, E-mail: [oner@yahoo.com](mailto:oner@yahoo.com)

**Received** February 13, 2012; **Accepted** February 15, 2012; **Published** February 18, 2012

**Citation:** Oner G (2012) Hirsutism: Diagnosis and Treatment. J Metabolic Synd 1:e101. doi:10.4172/2167-0943.1000e101

**Copyright:** © 2012 Oner G. This is an open-access article distributed under the terms of the Creative Commons Attribution License, which permits unrestricted use, distribution, and reproduction in any medium, provided the original author and source are credited.



increased DHT levels due to primary increase in peripheral 5 $\alpha$ -reductase activity. This situation is probably due to majority of DHT, produced in the skin, not being released into circulation and showing its effect locally before it is rapidly metabolized [11]. Serum DHT measurement is not a practical laboratory measurement in evaluating androgen metabolism or peripheral defects in peripheral androgen receptor/protein up-regulation.

On the other hand, serum total testosterone levels, by themselves, are not sufficient measurements to indicate hyperandrogenemia. While serum total testosterone levels are normal, a decrease in SHBG levels can lead to hyperandrogenemia through increased free testosterone, a bioactive version of testosterone.

Very high testosterone levels more than 1.5-2 times the upper limit

Drug Dosage Treatment Schedule
<b>Androgen suppression</b>
Oral contraceptives 30-50 µg/day One tablet per day for 21 days followed by 7-day pill-free interval
Gn-RH agonist 7/5 mg monthly A combination with 25-50 µg transdermal estradiol or 35 µg (Leuprolide acetate) intramuscularly ethinyl estradiol
<b>Antiandrogens</b>
Spirolactone 50-200 mg/day Continuously
Cyproterone acetate (CA) Induction: 50-100 mg By mouth at bedtime. Maintenance: 5 mg Cycle days 5-14 (or 15) (combination with estrogens needed in women with uterus) also available as a combination oral contraceptive pill: 2 mg CA + 35 µg ethinyl estradiol
Finasteride 1-5 mg/day Continuously
Flutamide 62.5-500 mg/day Continuously
Bicalutamide 25 mg/day Continuously
Drospirenone (DRSP) 3 mg Available only as a combination oral contraceptive pill: 3 mg DRSP + 30 µg ethinyl estradiol or 3 mg DRSP + 20 µg ethinyl estradiol

**Table 1:** Medications used in treatment of hirsutism.

of normal or a history of rapid development of virilisation are more likely to be associated with tumour associated hyperandrogenism. This would then trigger measurement of dehydroepiandrosterone sulfate (DHEAS) and androstenedione to identify an adrenal or ovarian source of the hyperandrogenaemia, respectively [17]. In some patients with hirsutism, functional hyperandrogenism with hidden ovary or adrenal origin can be discovered by gonadotropin-releasing hormone (GnRH) stimulation test and corticotropin (ACTH) stimulation test [17].

Thyroid dysfunction and hyperprolactinemia should be excluded by serum TSH and PRL measurements. During the early follicular phase, 21-hydroxylase deficiency and non-classical adrenal hyperplasia should be excluded through the measurement of 17-OH-progesterone level and ACTH stimulation test. In these patients, exogen androgen use should also be investigated. In summary, IH is a diagnosis of exclusion. In these cases, ovulatory dysfunction, hyperandrogenemia and other undefined states of excess androgen should be eliminated [11].

Ultrasonographic examination of the ovaries, the adrenal glands, or both is a useful screening procedure if the symptoms suggest the presence of a neoplasm. Pelvic ultrasound may also be useful if PCOS is suspected to fulfil the Rotterdam criteria for its diagnosis.

## Treatment

Hirsutism clinically presents in women as excessive hair growth in androgen-dependent areas. It is a particularly important diagnosis to make, because it often significantly affects a woman's perception of her femininity and less commonly can be a sign of an underlying malignancy or a cutaneous manifestation of a condition with significant cardiovascular or other morbidity. A variety of treatments exist to help minimize the appearance of unwanted hair [18]. In this part, treatment modalities are summarized in (Table 1).

### Androgen suppression

Oral contraceptive (OC) agents are considered to be the first-line therapy for hirsutism in premenopausal women [19]. This treatment option has the advantage of regulating the menstrual cycle and providing contraception. Oral contraceptive pills commonly contain ethinyl estradiol (EE), in combination with a progestin. The most androgenic progestins are norgestrel and levonorgestrel, whereas the least androgenic progestins are norgestimate and desogestrel. Other progestins, such as cyproterone acetate and drospirenone, work as androgen receptor antagonists. The recommended OC includes a combination of EE with either 2 mg of cyproterone acetate or 3 mg drospirenone. In a recent prospective

randomized trial, low-dose ethinyl estradiol (0.02 mg) plus drospirenone 24/4 combined oral contraceptive and ethinyl estradiol (0.03 mg) plus drospirenone 21/7 combined oral contraceptive have comparable effects in the treatment of hirsutism and were well-tolerated [20]. The mechanisms by which OCs improve hirsutism include the suppression of luteinizing hormone secretion, resulting in the inhibition of ovarian androgen biosynthesis, stimulation of sex hormone binding globulin production (effectively decreasing serum free androgen concentrations), and a mild reduction in adrenal androgen synthesis. OCs should not be prescribed to women with a history of venous thrombosis.

### Antiandrogens

Antiandrogen drugs prevent cellular effects of androgens by blocking intracellular androgen receptors. In this group, spironolactone, cyproterone acetate, finasteride, flutamide, bicalutamide and drospirenone are most frequently used drugs [21]. Since all these drugs are teratogenic, contraception should absolutely be recommended to patients. Treatment period is long and at least a 6-9 months wait is necessary to evaluate the effectiveness of treatment.

**Spirolactone (SPA):** This drug is an aldosterone antagonist as well as an androgen receptor antagonist [21]. It is a dose-dependent and competitive androgen receptor inhibitor. It also inhibits 5α-reductase enzyme activity and adrenal androgen biosynthesis. Daily effective dose vary between 50-200 mg. A recent Cochrane review of trials comparing spironolactone 100 mg/d with placebo showed a significant subjective improvement in hair growth (odds ratio 7.18, 95% confidence interval [CI] 1.96 to 26.28). The Ferriman-Gallwey score, however, did not validate these findings (weighted mean difference 7.20, 95% CI -10.98 to -3.42) [22]. Spirolactone is generally well tolerated with few side-effects, such as menorrhagia, lethargy and stomach upset. A clinically significant hypotension and increased serum potassium levels are rare if spironolactone has been used at doses of 100 mg/day. In the first months of treatment, measurements of blood pressure and serum potassium levels every 4 weeks are recommended. Spirolactone should not be prescribed to patients with renal insufficiency or hyperkalemia. As spironolactone usually causes feminization of the male fetus as well as menstrual alterations, it is best to add oral contraceptive pills.

**Cyproteron acetate (CA):** Cyproterone acetate (CA) is a powerful progestin with antiandrogenic activity that interferes with the binding of dihydrotestosterone to the androgen receptor and inhibits the secretion of gonadotropin, thereby reducing ovarian and adrenal androgen production. CA (2 mg) combined with EE has been shown to be more effective than placebo, but not better than other antiandrogens [23]. In the treatment of

hirsutism, CA, 100 mg/day + EE, 30-35 Kg/day combination is as effective as the SPA, 100 mg/day + OCC combination [24]. When small doses of CA, such as 2 mg/day, are combined with 35 Kg/day or 50 Kg/day of EE, it can be used as OCC. Loss of libido can be listed as one of the side effects of CA. Adrenal insufficiency is a rare complication. During the treatment, appropriate contraception should be used since the drug can cause feminization in the male fetus.

**Finasteride:** Finasteride is a potent inhibitor of the type 2 isoenzyme of 5 $\alpha$ -reductase, which blocks the conversion of testosterone to 5 $\alpha$ -dihydrotestosterone. Finasteride has been shown to lower hirsutism scores by 30%-60% in addition to reducing the average hair diameter [25]. In comparative studies, finasteride demonstrated efficacy similar to that of other antiandrogens with fewer adverse effects [26]. Other trials suggested that spironolactone and flutamide were more effective than finasteride [27,28]. In women with hirsutism, finasteride is used in doses of 2.5-7.5 mg/d. Doses of 2.5 mg and 5 mg seem to be equally effective [29]. Since the drug may lead to ambiguous genital in the male fetus, an effective contraception during its use is necessary in all women of reproductive age.

**Flutamide and bicalutamide:** Flutamide is a pure nonsteroidal antiandrogen that acts as an androgen receptor blocker. Studies have shown that flutamide 250-500 mg/d is more effective than finasteride and triptorelin, a long acting gonadotropin-releasing hormone antagonist [30,31]. A systematic review and meta-analysis of randomized controlled trials assessing the efficacy of different antiandrogens for the treatment of hirsutism reported that when compared with metformin, flutamide reduced the hirsutism score by 5 (95% CI 3.0-7.0;  $I^2 = 0\%$ ). Spironolactone reduced the score by 1.3 (95% CI 0.03-2.6) [32]. Due to its propensity for severe hepatotoxicity, which is occasionally fatal, flutamide should not be used as first-line therapy for hirsutism. Bicalutamide is a new, powerful and nonsteroidal pure antiandrogen drug. Its half-life is 7-10 days. It was developed in prostate cancer treatment at a 50 mg/day dose [6]. Low dose bicalutamide (25 mg/day) was shown to be effective in the treatment of hirsutism related to IH and PCOS [33]. It does not have any significant side effects and lead to irregular periods. However, hepatotoxic effects may develop at a dose of 50 mg/day.

**Drospirenone:** Drospirenone, a progestin found in OCC, is also an antiandrogen. However, it has a weak effect [6]. In regards to potency, 3 mg of drospirenone in OCC, is equivalent to 25 mg of SPA or 1 mg of CA. In a study with 52 young women (34 IH and 18 PCOS), patients were treated with a OCC including 3 mg drospirenone and 30 mcg EE and as a result, clinical and biochemical findings of hirsutism were corrected through antiandrogenic and antiminerlocorticoid effects [34]. In this study, serum total and free testosterone levels decreased while SHBG increased.

### Other treatment modalities

**Insulin-Sensitizing drugs:** Metformin lowers hepatic glucose production and decreases insulin levels. Thiazolidinediones (rosiglitazone and pioglitazone) sensitize end organs to insulin through their action on the peroxisome-proliferator-activated receptor- $\alpha$ . Meta-analyses of randomized controlled trials of insulin sensitizers for the treatment of hirsutism concluded that insulin sensitizers provide limited or no improvement for women with hirsutism [35].

**Gonadotropin-Releasing Hormone (GnRH) agonists:** GnRH agonists suppress luteinizing hormone, and to a lesser degree follicle stimulating hormone secretion, leading to a decline in ovarian androgen production. GnRH agonist therapy seems to have no therapeutic advantage over OC and antiandrogens [36,37]. As GnRH agonist therapy is expensive, requires injections, and estrogen needs to be added to the therapy, its use should be reserved for severe forms of hyperandrogenemia, such as

patients with ovarian hyperthecosis who have a suboptimal response to OCs and antiandrogens.

**Glucocorticoids:** Glucocorticoids can be prescribed to women who have hirsutism that is due to nonclassic congenital adrenal hyperplasia, have a suboptimal response to OCs and/or antiandrogens, exhibit poor tolerance to OCs, are seeking ovulation induction.

**N-Acetyl-cysteine (NAC):** NAC is commonly used as a safe mucolytic drug that has an antioxidant and insulin regulatory effect in women with PCOS [38]. Metformin and NAC appear to have comparable effects on hyperandrogenism, hyperinsulinaemia and menstrual irregularity in women with PCOS [39]. In this study, NAC also significantly decreased the hirsutism score.

**Topical treatment:** Eflornithine hydrochloride cream 13.9 % (Vaniqa<sup>®</sup>, Skin Medica) has been approved by the US FDA for the reduction of unwanted facial hair in women. Noticeable results take about 6-8 weeks. Adverse effects include itching and skin dryness.

### Cosmetic and physical measures in control and treatment of hirsutism

In treatment of hirsutism, mechanical control, removing, or destroying of unwanted hair is generally considered as a complementary treatment to drug therapy.

**Shaving:** Hair removal (plucking, depilation) and bleaching: Plucking or shaving of hair on the face and other parts of the body is a commonly used, but temporary method used by many women. Shaving is a commonly employed method of minimizing hair on the legs and axillae.

**Electrolysis:** Electrolysis (electroepilation) is a method resulting in a long-term hair damage. It is safe and effective but expensive. In this technique, a thin needle is inserted into the hair follicle, through which an electrical current is applied. There are two main types of electrolysis. Hair follicles are damaged through a chemical environment in electrolysis and through a thermal environment in thermolysis. In some cases, use of a combination of these treatments is suggested to be more effective, however, that are no clinical studies supporting this idea.

Effectiveness of repeating treatments (permanent hair loss) vary between 15-50% [40]. After the electrolysis procedure, especially if conducted by nonprofessionals, scar tissue, erythema and post-inflammatory pigment changes may occur as complications. The procedure is painful and time consuming, because the hair is treated individually. Physicians that are primarily following hirsutism patients should direct them to experienced electrolysis specialists.

**Laser epilation (selective photothermolysis):** Laser hair removal is one of the most effective options for reducing visible hair, however, it may not be wholly effective in all patients and combination therapy may need to be considered. Pharmacological therapy is often used in combination with mechanical hair removal due to the time needed for the drug treatment to demonstrate visible results. Clinical data investigating the use of laser treatment in combination with other treatments has focused on laser with topical eflornithine. The expert working group reviews existing data and provides guidance on the use of eflornithine in combination with laser for resistant hirsutism [41]. Permanent methods of hair reduction include photoepilation (using laser and intense pulse light [IPL]) and electrolysis. Photoepilation seems to be superior to the conventional methods, such as shaving, waxing and electrolysis. A Cochrane review of photoepilation of unwanted hair growth showed that alexandrite and diode lasers are more effective, whereas little evidence was obtained for the effect from IPL, Nd:YAG, or ruby lasers [42]. However, some longer wavelength lasers (neodymium:YAG), or IPL, appear to provide benefits in patients



who have darker skin types and therefore have less risk of burning and dyspigmentation. Paradoxical hypertrichosis is a possible, but rare, adverse effect of photoepilation, particularly in dark-skinned individuals. The basic principle of this treatment is to create direct damage to dark hair follicles [43]. Laser systems that are commonly used for the treatment of hirsutism include the ruby laser (694 nm), the diode laser (800 nm), the alexandrite laser (755 nm) and the Nd:YAG laser (1084 nm). The diode laser and alexandrite laser are considered effective in treatment of hirsutism in dark-skinned patients. The response of hairs to these laser systems is variable and not complete. In a recent study, there is no significant difference between sequential treatment with diode and alexandrite lasers versus alexandrite laser alone in the treatment of hirsutism [44]. It is still unclear whether laser treatment provides clinically significant permanent hair follicle damage. Removing hair by these means is expensive and requires multiple treatment sessions. Most patients require at least 5 to 7 sessions at least 1 month apart to permanently reduce hair growth on any single area. Hair growth is delayed when shock waves induced by thermal energy damage the germinal cells of the hair follicle [45]. Compared to electrolysis, laser treatment was shown to be a more expensive yet much less painful method that is 60 times faster. However, further new and advanced studies are necessary. Side effects of laser epilation treatment can be listed as; pigmentation changes in the treated skin, scars and burns in the treatment area. These side effects are minimized using today's laser technologies.

## References

- Rosenfield RL (2005) Clinical practice. Hirsutism. *N Engl J Med* 353: 2578-2588.
- Trueb RM (2002) Causes and management of hypertrichosis. *Am J Clin Dermatol* 3: 617-627.
- Escobar-Morreale HF, Carmina E, Dewailly D, Gambineri A, Kelestimur F, et al. (2011) Epidemiology, diagnosis and management of hirsutism: a consensus statement by the Androgen Excess and Polycystic Ovary Syndrome Society. *Hum Reprod Update*.
- O'Driscoll JB, Mamtora H, Higginson J, Pollock A, Kane J, et al. (1994) A prospective study of the prevalence of clear-cut endocrine disorders and polycystic ovaries in 350 patients presenting with hirsutism or androgenic alopecia. *Clin Endocrinol (Oxf)* 41: 231-236.
- Morán C, Tapia MC, Hernández E, Vázquez G, García-Hernández E, et al. (1994) Etiological review of hirsutism in 250 patients. *Arch Med Res* 25:311-314.
- Blume-Peytavi U, Atkin S, Shapiro J, Lavery S, Grimalt R, et al. (2009) European Consensus on the evaluation of women presenting with excessive hair growth. *Eur J Dermatol* 19: 597-602.
- Waggoner W, Boots LR, Azziz R (1999) Total testosterone and DHEAS levels as predictors of androgen-secreting neoplasms: a populational study. *Gynecol Endocrinol* 13: 394-400.
- Elghblawi E (2008) Idiopathic hirsutism: excessive bodily and facial hair in women. *Br J Nurs* 17: 192-197.
- Mofid A, Seyyed Alinaghi SA, Zandieh S, Yazdani T (2008) Hirsutism. *Int J Clin Pract* 62:433-443.
- Sawaya ME, Shalita AR (1998) Androgen receptor polymorphisms (CAG repeat lengths) in androgenetic alopecia, hirsutism, and acne. *J Cutan Med Surg* 3: 9-15.
- Azziz R, Carmina E, Sawaya ME (2000) Idiopathic hirsutism. *Endocr Rev* 21: 347-362.
- Caglayan AO, Dundar M, Tanriverdi F, Baysal NA, Unluhizarci K, et al. (2011) Idiopathic hirsutism: local and peripheral expression of aromatase (CYP19A) and 5 $\alpha$ -reductase genes (SRD5A1 and SRD5A2). *Fertil Steril* 96: 479-482.
- Abdel Fattah NS, Darwish YW (2009) Is there a role for insulin resistance in nonobese patients with idiopathic hirsutism? *Br J Dermatol* 160: 1011-1015.
- Escobar-Morreale HF, Asunción M, Calvo RM, Sancho J, San Millán JL (2001) Receiver operating characteristic analysis of the performance of basal serum hormone profiles for the diagnosis of polycystic ovary syndrome in epidemiological studies. *Eur J Endocrinol* 145: 619-624.
- Rotterdam ESHRE/ASRM-Sponsored PCOS Consensus Workshop Group (2004) Revised 2003 consensus on diagnostic criteria and long-term health risks related to polycystic ovary syndrome. *Fertil Steril* 81: 19-25.
- Somani N, Harrison S, Bergfeld WF (2008) The clinical evaluation of hirsutism. *Dermatol Ther* 21: 376-391.
- Sathyapalan T, Atkin SL (2009) Investigating hirsutism. *BMJ* 338: b912.
- Brodell LA, Mercurio MG (2010) Hirsutism: Diagnosis and management. *Gend Med* 7: 79-87.
- Martin KA, Chang RJ, Ehrmann DA, Ibanez L, Lobo RA et al. (2008) Evaluation and treatment of hirsutism in premenopausal women: an endocrine society clinical practice guideline. *J Clin Endocrinol Metab* 93: 1105-1120.
- Oner G, Muderris II (2011) A prospective randomized trial comparing low-dose ethinyl estradiol and drospirenone 24/4 combined oral contraceptive vs. ethinyl estradiol and drospirenone 21/7 combined oral contraceptive in the treatment of hirsutism. *Contraception* 84: 508-511.
- Bulun SE, Adashi EY (2008) The physiology and pathology of the female reproductive axis. In: Kronenberg HM, Melmed S, Polonsky KS, Larsen PR (ed) *Williams Textbook of Endocrinology*, 11th edition. Philadelphia, Saunders & Elsevier, pp 541-614.
- Brown J, Farquhar C, Lee O, Toomath R, Jepson RG (2009) Spironolactone versus placebo or in combination with steroids for hirsutism and/or acne. *Cochrane Database Syst Rev* (2): CD000194.
- Van der Spuy ZM, le Roux PA (2003) Cyproterone acetate for hirsutism. *Cochrane Database Syst Rev* (4): CD001125.
- O'Brien RC, Cooper ME, Murray RM, Seeman E, Thomas Ak, et al. (1991) Comparison of sequential cyproterone acetate/estrogen versus spironolactone/oral contraceptive in the treatment of hirsutism. *J Clin Endocrinol Metab* 72: 1008-1013.
- Townsend KA, Marlowe KF (2004) Relative safety and efficacy of finasteride for treatment of hirsutism. *Ann Pharmacother* 38: 1070-1073.
- Wong IL, Morris RS, Chang L, Spahn MA, Stanczyk FZ, et al. (1995) A prospective randomized trial comparing finasteride to spironolactone in the treatment of hirsute women. *J Clin Endocrinol Metab* 80: 233-238.
- Erenus M, Yucelten D, Durmusoglu F, Gurbuz O (1997) Comparison of finasteride versus spironolactone in the treatment of idiopathic hirsutism. *Fertil Steril* 68: 1000-1003.
- Unluhizarci K, Ozel D, Tanriverdi F, Karaca Z, Kelestimur F (2009) A comparison between finasteride, flutamide, and finasteride plus flutamide combination in the treatment of hirsutism. *J Endocrinol Invest* 32: 37-40.
- Bayram F, Muderris II, Güven M, Kelestimur F (2002) Comparison of high-dose finasteride (5 mg/day) versus low-dose finasteride (2.5 mg/day) in the treatment of hirsutism. *Eur J Endocrinol* 147: 467-471.
- Falsetti L, Gambera A, Legrenzi L, Iacobello C, Bugari G (1999) Comparison of finasteride versus flutamide in the treatment of hirsutism. *Eur J Endocrinol* 141: 361-367.
- Pazos F, Escobar-Morreale HF, Balsa J, Sancho JM, Varela C (1999) Prospective randomized study comparing the long-acting gonadotropin-releasing hormone agonist triptorelin, flutamide, and cyproterone acetate, used in combination with an oral contraceptive, in the treatment of hirsutism. *Fertil Steril* 71: 122-128.
- Swiglo BA, Cosma M, Flynn DN, Kurtz DM, Labella ML, et al. (2008) Clinical review: Antiandrogens for the treatment of hirsutism: a systematic review and meta-analyses of randomized controlled trials. *J Clin Endocrinol Metab* 93: 1153-1160.
- Muderris II, Bayram F, Ozcelik B, Güven M (2002) New alternative treatment in hirsutism: bicalutamide 25 mg/day. *Gynecol Endocrinol* 16: 63-66.
- Gregoriou O, Papadias K, Konidaris S, Bakalianou K, Salakos N, et al. (2008) Treatment of hirsutism with combined pill containing drospirenone. *Gynecol Endocrinol* 24: 220-223.
- Cosma M, Swiglo BA, Flynn DN, Kurtz DM, Labella ML, et al. (2008) Clinical review: Insulin sensitizers for the treatment of hirsutism: a systematic review and meta-analyses of randomized controlled trials. *J Clin Endocrinol Metab* 93: 1135-1142.
- Heiner JS, Greendale GA, Kawakami AK, Lapolt PS, Fisher M, et al. (1995) Comparison of a gonadotropin-releasing hormone agonist and a low dose oral contraceptive given alone or together in the treatment of hirsutism. *J Clin Endocrinol Metab* 80: 3412-3418.

37. Carmina E, Lobo RA (1997) Gonadotrophin-releasing hormone agonist therapy for hirsutism is as effective as high dose cyproterone acetate but results in a longer remission. *Hum Reprod* 12: 663-666.
38. Fulghesu AM, Ciampelli M, Muzj G, Belosi C, Selvaggi L, et al. (2002) N-acetylcysteine treatment improves insulin sensitivity in women with polycystic ovary syndrome. *Fertil Steril* 77: 1128-1135.
39. Oner G, Muderris II (2011) Clinical, endocrine and metabolic effects of metformin vs N-acetyl-cysteine in women with polycystic ovary syndrome. *Eur J Obstet Gynecol Reprod Biol* 159: 127-131.
40. Wagner RF Jr (1990) Physical methods for the management of hirsutism. *Cutis* 45: 319-321, 325-326.
41. Lapidoth M, Dierickx C, Lanigan S, Paasch U, Campo-Voegeli A, et al. (2010) Best practice options for hair removal in patients with unwanted facial hair using combination therapy with laser: guidelines drawn up by an expert working group. *Dermatology* 221: 34-42.
42. Haedersdal M, Gøtzsche PC (2006) Laser and photoepilation for unwanted hair growth. *Cochrane Database Syst Rev* 4: CD004684.
43. Dierickx CC, Grossman MC, Farinelli WA, Anderson RR (1998) Permanent hair removal by normal-mode ruby laser. *Arch Dermatol* 134: 837-842.
44. Nilforoushadeh MA, Naieni FF, Siadat AH, Rad L (2011) Comparison between sequential treatment with diode and alexandrite lasers versus alexandrite laser alone in the treatment of hirsutism. *J Drugs Dermatol* 10: 1255-1259.
45. Brodell LA, Mercurio MG (2010) Hirsutism: Diagnosis and management. *Gend Med* 7: 79-87.