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Efficacy of the Erbium: YAG 2940 NM Laser in the Treatment of Androgenetic Alopecia

Jéssica Scherer Dagostini[1], Victória Chechetto Segalla[2], Juliana Merheb Jordão[3] and Priscila Regina Orso Rebellato[4*]

[1,2]Medical doctor specializing in dermatology at Hospital Evangélico Mackenzie in Curitiba, Brazil
[2]Dermatologist of the Department of Laser Therapy at Hospital Evangélico Mackenzie in Curitiba, Brazil
[4]Dermatologist of the Department of Trichology at Hospital Evangélico Mackenzie in Curitiba, Brazil

[*]**Corresponding author:** Rebellato PRO, Dermatologist of the Department of Trichology at Hospital Evangélico Mackenzie in Curitiba, Brazil, Tel: +55 41 3240-5000; E-mail: prirebellato@yahoo.com.br

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Abstract

Androgenetic alopecia is an extremely common disease of the scalp. Although benign, it is progressive and can cause significant psychosocial damage. Among the various therapeutic modalities, the most widely recommended and considered the gold standard of treatment are antiandrogen therapies and 5% topical minoxidil. Recently, various laser modalities have been used for treatment, with promising results. The aim of this study was to assess whether the use of the Erbium:YAG 2940 nm laser shows comparable or superior results to topical 5% minoxidil in local treatment complementary to antiandrogens, as well as to evaluate its tolerability profile and side effects through an experimental clinical trial carried out through clinical and trichoscopic analysis before and after treatment, of patients previously diagnosed with AAG and already on antiandrogen therapy for at least 6 months, seen at the Trichology Service of the Dermatology outpatient clinic at Hospital Evangélico Mackenzie from May 2021 to December 2022. The study was carried out in a half scalp model where each patient received both treatments on each half of the scalp, comparing the results of each treatment. After statistical evaluation, we observed that the Erbium:YAG laser as a complementary local therapy to systemic anti-androgenic treatment showed good tolerance with minimal side effects and similar results to the use of topical 5% minoxidil (even if not statistically significant), and may represent an alternative complementary topical therapy to the use of minoxidil for intolerant or poorly adherent patients.

Keywords: ***Androgenetic alopecia; Hair loss; Alopecia; Therapeutics; Laser light therapy***

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1. Introduction

Androgenetic alopecia (AAG) is the most common cause of hair loss in men and women, affecting up to 70% of men and 40% of women at some point in their lives [1]. It can start as early as puberty in males and its frequency and severity increase with age in both sexes [2]. Although considered benign, it can have a significant psychosocial impact [3]. Various therapeutic modalities have been used to treat AAG, including systemic and local drug therapies, hair transplantation and lasers [1]. Among the drugs recommended, Minoxidil 5% solution is the most commonly used treatment, often in association with systemic antiandrogen therapies. Although this drug has been shown to be effective in hair growth, regular and continuous daily use is necessary to maintain the benefits, with poor adherence being one of the major challenges encountered [4,5]. As an alternative, low-dose oral minoxidil has been increasingly used, supported by numerous studies describing its efficacy and favorable safety profile, with better therapeutic adherence. Recently, the use of laser-based therapies for hair loss in different types of alopecia has become very popular; with evidence of stimulating hair growth and preventing recurrence of hair loss by mechanisms that are not yet fully understood [6].

2. Methodology

An experimental clinical trial was conducted between May/2021 and December/2022. The study was approved by the institutional research and ethics committee of the Mackenzie Presbyterian Institute. The inclusion criteria were men and woman with age over eighteen years, clinical diagnosis of mild to moderate AGA according to the Norwood-Hamilton (men) or Ludwig (women) classification [7,8], confirmed by biopsy, being in treatment with only anti-androgenic systemic drugs for at least 6 months (finasteride, dutasteride or spironolactone), with ability to follow the protocol and who agreed to sign the informed consent form. Subjects were instructed to maintain the same hair color and style for the study duration.

Patients were excluded if they had used topical or oral Minoxidil or if they had used any medication that could cause hypertrichosis in the 6 months prior to the study, patients who had used any other type of topical medication or anti-hair loss shampoos on the scalp, patients who had undergone hair transplantation or tattooing/micropigmentation in the alopecia area, patients who have had hair procedures such as LLLT, microneedling, MMP or laser in the previous 6 months, patients who had any known underlying medical conditions that could adversely affect hair growth, patients with an active infectious lesion on the scalp (including herpes, tinea capitis and folliculitis), as well as patients with photosensitivity, other causes of hair loss, scalp dermatosis or hypersensitivity to minoxidil.

There was no sample size calculation prior to the beginning of the study. All patients included received treatment in the "Split scalp" model during 20 weeks, where the left/right half of the scalp - divided by a central parting line following a sagittal parting plane - was selected for each intervention. In this way, half of the scalp received treatment only with Erbium:YAG 2940 nm laser sessions Etherea® Platform (Vydence Medical), type 100 microzones thermal (MZT), energy 10mJ, pulse duration 5 ms. The other half of the scalp received only daily topical treatment with minoxidil 5% solution during the same period. On each side of the scalp, 3 splits were made equidistant and parallel to this central split line (FIG. 1). The laser intervention side received 1 shot per cm^2 to each of the 3 distribution lines. Sessions were carried out every 15 days for 5

months, for a total of 10 sessions in 20 weeks. On the contralateral side, the patient was instructed to apply 1 jet to each line (totaling 3 jets, i.e. 0.5ml of the drug), 2x/day in males and 1x/day in females, according to current treatment guidelines [9,10].

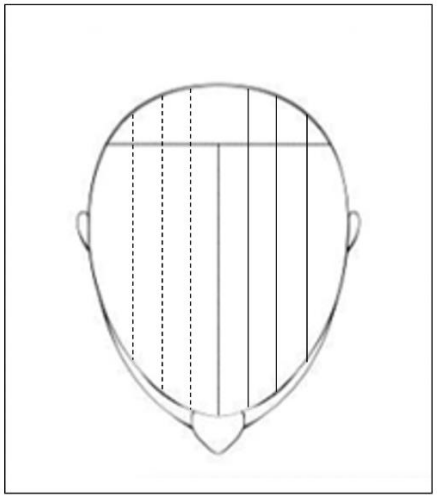


FIG. 1. **Equidistant and parallel splits to the central split line. Dashed lines represent the laser application side and continuous lines represent 0,5ml minoxidil application side.**

Medical consultations were carried out with clinical and trichoscopic evaluations on each side of the interventions, before and 30 days after the last laser application, in order to assess the progress of the proposed treatments. The clinical assessments were documented using photographs. Biopsies were performed before the treatment with the aim of confirming the diagnosis of AAG and discarting a cicatricial pathology. The clinical photos were standardized and taken of the regions typically affected by androgenetic alopecia, on both sides of the scalp. The evaluation of the pre- and post-intervention clinical photos was carried out by 11 blinded dermatologists, who were unaware of the side on which each intervention was carried out. The clinical responses on each half of the scalp were scored using a global evaluation scale, as specified in figure 2.

-1 point	Worsen (increase in rarefaction)
0 point	No change (lack of hair growth)
+ 1 point	Slight improvement (partial hair growth, slightly noticeable)
+ 2 points	Moderate improvement (partial hair growth, easily noticeable)
+ 3 points	Significant improvement (hair growth throughout the treated area)

Figure 2: Global evaluation scale

The trichoscopic evaluation of the areas of hair loss, on both sides of the scalp, pre and post-treatment, was carried out by 11 dermatologists using standardized trichoscopic photographs that were taken at 6 points (at 2 cm, 6 cm and 10 cm from the frontal implantation line, along a line distant 3 cm from the midline, to the right and left, each side corresponding to one of the treatments that carried out) as seen in figure 3. The photographs were taken with the aid of a 'Dino-Lite AD4113TL' digital dermoscope at 40x magnification, and the images were evaluated in search of dermoscopic findings related to the disease and

changes in these findings, in the same patient, after the different interventions, with the aim of comparing the results obtained. An improvement in the hair density, a reduction in the degree of variability in hair width and an increase in the number of hairs per follicular unit were evaluated.

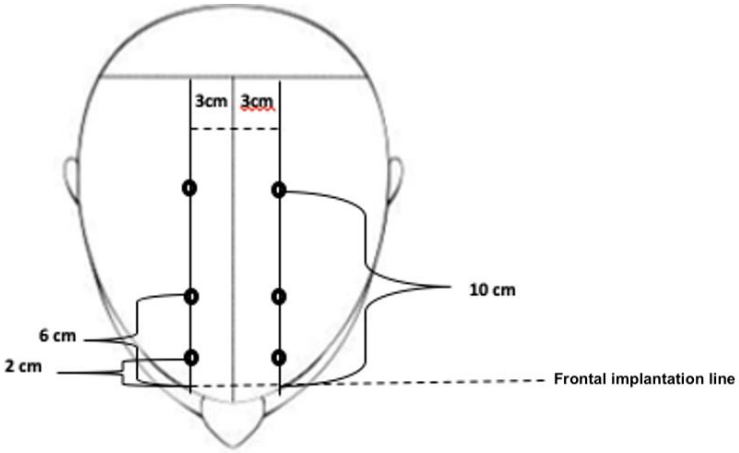


FIG. 3. **Points of trichoscopic photographs.**

At the end of the study, patients were also asked to report the presence or absence of pain, itching, redness, and scaling (mild, moderate, intense), the level of general tolerability (well tolerated, tolerated or intolerable), and the presence of any difficulties related to both treatments. In addition, the patients were asked to fill in a 0 to 3 point scale to indicate their satisfaction (0=dissatisfied, 1=not very satisfied, 2=moderately satisfied, 3=very satisfied) with the overall results obtained on each half of the scalp, and to evaluate the outcome of the treatments using the global evaluation scale mentioned above. All the patients also answered a questionnaire comparing the two treatments from their point of view in terms of convenience and personal preference.

3. Statistical Analysis

The data were organized in an Excel® spreadsheet and analyzed using IBM SPSS Statistics v.28.0. Results for quantitative variables were described by mean, median, minimum, and maximum. Categorical variables were described by absolute frequency and percentage. The Wilcoxon non-parametric test was used to compare the treatments (Laser and Minoxidil, scalp sides) in terms of the mean results of the 11 evaluators. The same comparison in terms of patient evaluations was made using the binomial test.

4. Results

The study included 8 patients aged between 42 and 66 years, 2 men and 6 women. In terms of the examiner's evaluations, there were no significant differences in the clinical and trichoscopic assessments of the two interventions. Consistent with this, the majority of examiners (57%) reported similar clinical results when assessing improvement in rarefaction and general hair density on both sides of the interventions (TABLE 1). Regarding the trichoscopic improvement of hair density, 53.4% of the evaluators considered the results to be similar and 19.3% considered minoxidil to be inferior (TABLE 2). As for the reduction

in hair shaft width variability, 58% considered the interventions to be a tie and 20.5% considered minoxidil to be inferior (TABLE 3). As for the increase in the number of hairs per follicular unit, 47% did not see any difference and 19.3% considered Minoxidil inferior (TABLE 4). FIG. 4, 5 and 6 illustrate the clinical and trichoscopic results of one of the study participants.

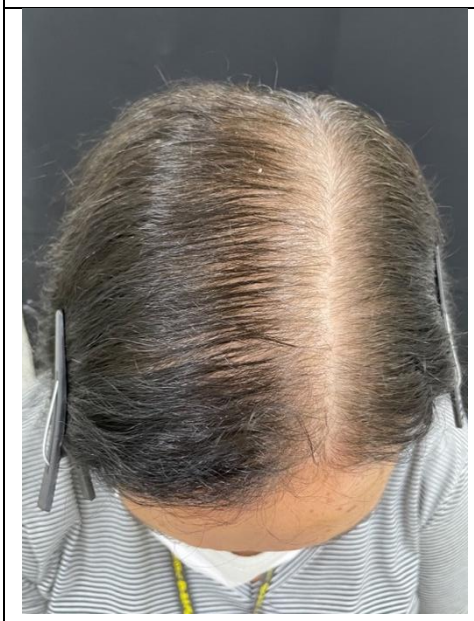
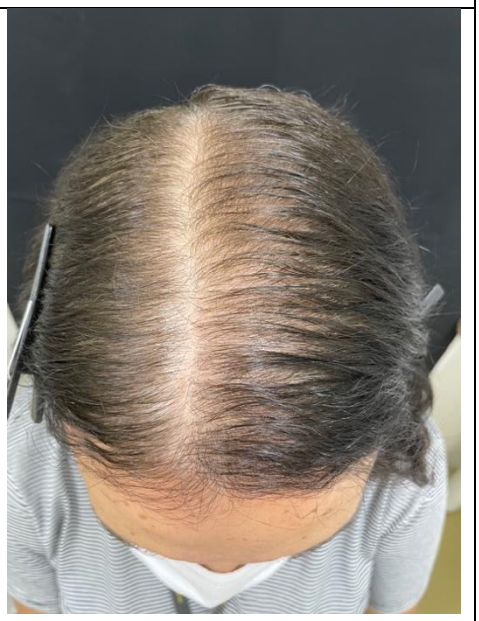
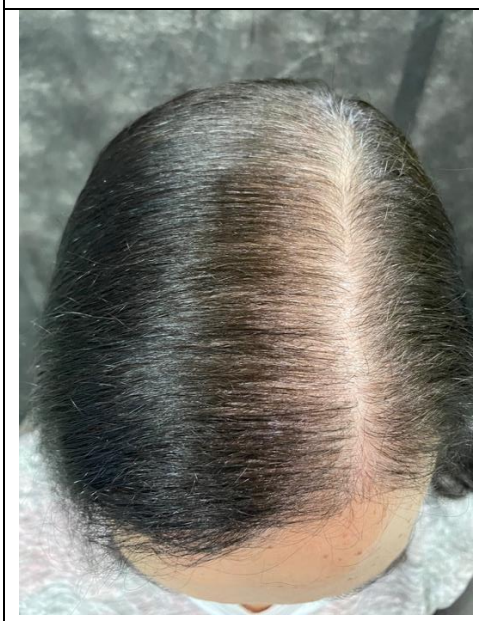
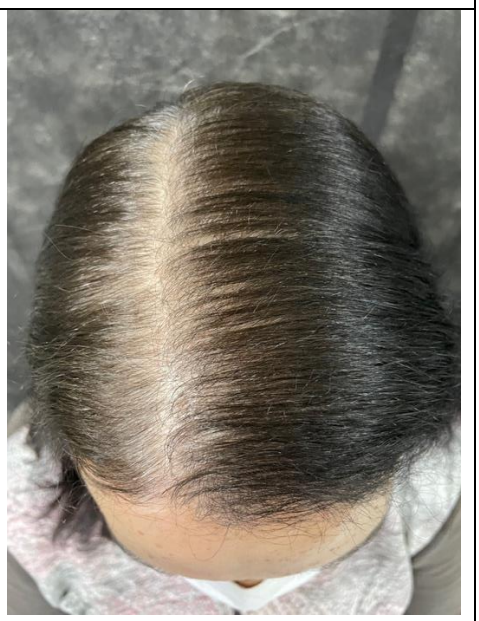
Top view left side – before treatment (Minoxidil side)	Top view right side – before treatment (Laser side)
	
Top view left side – after 20 weeks treatment (Minoxidil side)	Top view right side – after 10 sessions (Laser side)
	

FIG. 4. **Clinical results.**

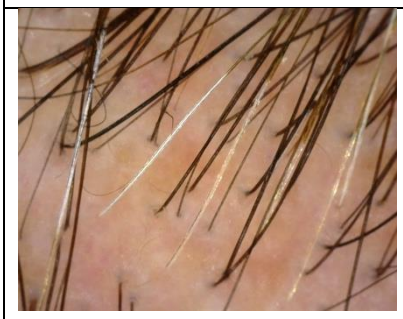
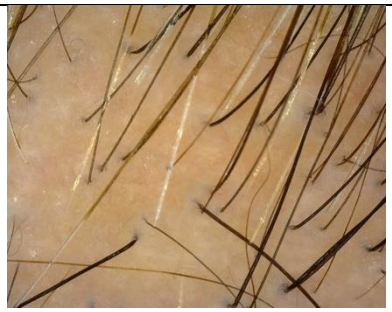
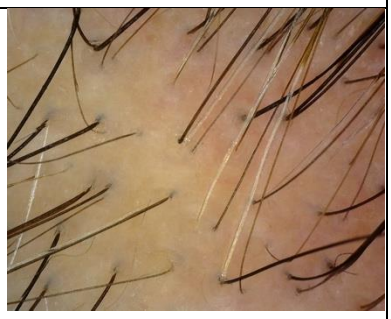
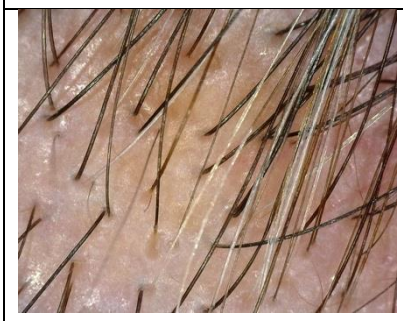
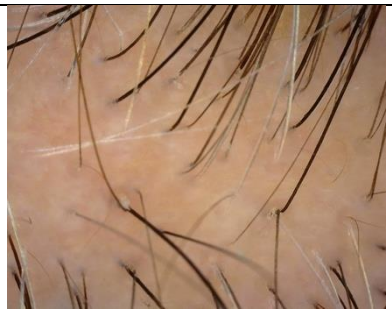
Before treatment 2 cm	Before treatment 6 cm	Before treatment 10 cm
		
After treatment 2 cm	After treatment 6 cm	After treatment 10 cm
		

FIG. 5 - **Trichoscopic results of right side (Laser side).**

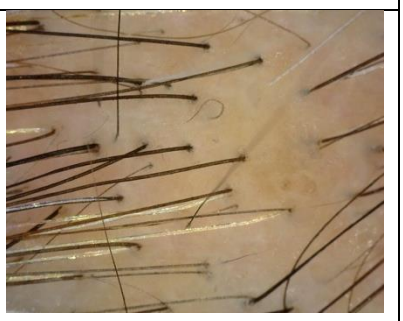
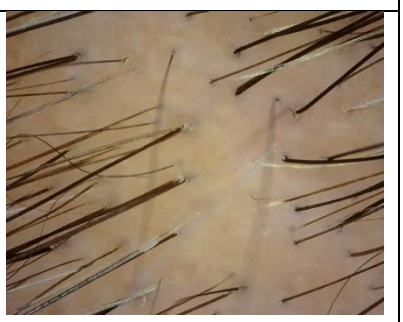
Before treatment 2 cm	Before treatment 6 cm	Before treatment 10 cm
		
After treatment 2 cm	After treatment 6 cm	After treatment 10 cm
		

FIG. 6. **Trichoscopic results of left side (Minoxidil side).**

In the patient's assessment, the laser was well tolerated (87.5% had no pain or discomfort and only 1 patient had mild discomfort). As for pruritus, 37.5% experienced it with laser treatment, but it was very mild. Although a lower percentage (25%) had pruritus with the use of Minoxidil, the intensity reported was higher, of mild intensity.

There were no reports of scalp scaling associated with laser treatment. On the other hand, 3 patients (37.5%) had with minoxidil, of varying intensity (very mild 12.5%, mild 12.5% and moderate 12.5%). Erythema was more common with laser treatment (25%) than with minoxidil (12.5%).

As for the perception of improvement, on the side treated with laser 50% reported a moderate and 50% a significant improvement. On the side treated with minoxidil, 12.5% of patients reported slight improvement, 37.5% moderate improvement and 50% significant improvement.

The majority of patients (87.5%) reported being very satisfied with laser treatment and 75% very satisfied with Minoxidil.

With regard to therapeutic adherence, 100% of the patients had no difficulties with the laser, while 62.5% had some difficulty in adhering to the minoxidil treatment (37.5% sometimes forgot to apply it and 25%, as well as sometimes forgetting, didn't like the cosmetics). When asked to choose which treatment to follow, there was no absolute superiority between the treatments, since the number of patients who opted for laser instead of Minoxidil (3) was the same as those who said they were indifferent (3) (TABLE 5).

TABLE 1. **Clinical improvement of rarefaction and general hair density.**

Patient	**Similar**	**Minoxidil > Laser**	**Minoxidil < Laser**	**Total (number of specialists)**
	n (%)	n (%)	n (%)	
1	5 (45,5%)	1 (9,1%)	5 (45,5%)	11
2	5 (45,5%)	5 (45,5%)	1 (9,1%)	11
3	7 (63,6%)	2 (18,2%)	2 (18,2%)	11
4	8 (72,7%)	1 (9,1%)	2 (18,2%)	11
5	8 (80%)	2 (20%)	0 (0%)	11
6	5 (45,5%)	4 (36,4%)	2 (18,2%)	11
7	6 (54,5%)	3 (27,3%)	2 (18,2%)	11
8	6 (54,5%)	1 (9,1%)	4 (36,4%)	11
Average%	**57,7**	**21,8**	**20,5**	**100**

TABLE 2. **Trichoscopic improvement in hair density.**

Patient	**similar**	**minox>laser**	**minox<laser**	**Total (number of specialists)**
	n (%)	**n (%)**	**n (%)**	
1	4 (36,4%)	5 (45,5%)	2 (18,2%)	11
2	7 (63,6%)	3 (27,3%)	1 (9,1%)	11
3	6 (54,5%)	0 (0%)	5 (45,5%)	11
4	7 (63,6%)	4 (36,4%)	0 (0%)	11
5	6 (54,5%)	1 (9,1%)	4 (36,4%)	11
6	8 (72,7%)	2 (18,2%)	1 (9,1%)	11
7	3 (27,3%)	6 (54,5%)	2 (18,2%)	11
8	6 (54,5%)	3 (27,3%)	2 (18,2%)	11
% average	**53,4**	**27,3**	**19,3**	**100**

TABLE 3. **Trichoscopic reduction in hair width variability.**

Pacient	**similar**	**minox>laser**	**minox<laser**	**Total (nº of specialists)**
	n (%)	n (%)	n (%)	
1	3 (27,3%)	3 (27,3%)	5 (45,5%)	11
2	8 (72,7%)	1 (9,1%)	2 (18,2%)	11
3	7 (63,6%)	1 (9,1%)	3 (27,3%)	11
4	7 (63,6%)	3 (27,3%)	1 (9,1%)	11
5	6 (54,5%)	1 (9,1%)	4 (36,4%)	11
6	8 (72,7%)	2 (18,2%)	1 (9,1%)	11
7	4 (36,4%)	5 (45,5%)	2 (18,2%)	11
8	8 (72,7%)	3 (27,3%)	0 (0%)	11
% average	**58**	**21,6**	**20,4**	**100**

TABLE 4. **Trichoscopic increase in the number of hairs per follicular unit.**

Pacient	**Similar**	**minox>laser**	**minox<laser**	**Total (nº of specialists)**
	n (%)	**n (%)**	**n (%)**	
1	4 (36,4%)	4 (36,4%)	3 (27,3%)	11
2	3 (27,3%)	5 (45,5%)	3 (27,3%)	11
3	7 (63,6%)	1 (9,1%)	3 (27,3%)	11
4	4 (36,4%)	7 (63,6%)	0 (0%)	11
5	5 (45,5%)	0 (0%)	6 (54,5%)	11
6	6 (54,5%)	4 (36,4%)	1 (9,1%)	11
7	6 (54,5%)	4 (36,4%)	1 (9,1%)	11

8	7 (63,6%)	4 (36,4%)	0 (0%)	11
% average	**47,7**	**33,0**	**19,3**	**100**

TABLE 5. **Patient's answers when comparing the two treatments.**

Question	**Answer**	**n**	**%**
Superior Results	Laser	3	37,5%
	Minoxidil	3	37,5%
	Similar	2	25,0%
More side effects	Laser	0	0%
	Minoxidil	3	37,5%
	Neither of them	5	62,5%
More convenient	Laser	4	50,0%
	Minoxidil	4	50,0%
	Similar	0	0%
Which would you choose?	Laser	3	37,5%
	Minoxidil	2	25,0%
	Whatever	3	37,5%

5. Discussion

Androgenetic Alopecia (AAG), also known as baldness, is considered the most common type of progressive hair loss in men and women [11,12]. It affects up to 70% of men and 40% of women at some point in their lives [1]. In men it can start as early as puberty [2], while in women the peak incidence occurs after the age of 50 [13]. The incidence and prevalence of AAG also vary depending on age and race [14,15,16]. Chinese, Japanese and African-Americans are less affected than Caucasians [17], and in general, both its frequency and severity tend to increase with age in both sexes [2]. The pathophysiology of AAG is still not fully understood. There is evidence that genetic, hormonal, and environmental factors and the interaction between them are the pillars at the origin of the disease [18].

In 1951, Hamilton observed that eunuch and castrated men before puberty did not develop AAG, and that AAG could be triggered in these men by the injection of testosterone. However, this only occurred if they had a family history of baldness. These observations established an important role for androgens as a prerequisite for the development of baldness and suggested genetic influence as a determinant [14,19,20]. More recently, it has been observed that men with a genetic deficiency of the enzyme 5 alpha reductase type 2, which converts testosterone into dihydrotestosterone (DHT), do not develop baldness, suggesting that DHT is the main androgen involved in the development of AAG in men [21]. In addition, the use of drugs that block this hormonal conversion, such as Finasteride, has been shown to be effective in treating men [22,23]. In women, the role of androgens is uncertain [12,24] and hormone blockade with finasteride and dutasteride shows less consistent results [25-

29]. Only a third of women with AAG have abnormal levels of androgens, and it has been postulated that an increased peripheral sensitivity to androgens could explain AAG in these cases [23,30]. However, this type of alopecia has also been described in patients without androgen receptors, suggesting that an androgen-independent mechanism could be involved [32].

Genetics is considered an important predisposing factor [24]. Analyses of monozygotic twins show concordance rates of between 80 and 90% [33]. Similarly, family analyses show a significantly increased risk of AAG in men with a positive family history, both in those with a bald father and in those with a family history from their mother or maternal grandfather [33]. Current scientific data supports the theory that AAG has a polygenic trait [24].

The diagnosis of AAG is usually clinical. This alopecia manifests clinically differently in both sexes. In men, alopecia begins in the temporal region with the formation of a symmetrical bitemporal recess, evolving with involvement of the vertex. It often begins after puberty with variable progression, usually more exuberant the earlier the onset [23]. In women, female androgenetic alopecia usually presents between the third and fourth decade of life, with progressive worsening after the menopause and has three main patterns of presentation [34]. The most common pattern manifests as diffuse thinning of the frontal hair, a "Christmas tree" pattern (Olsen pattern) [34,35].

In the trichoscopic evaluation, there is a reduction in hair density, and the main sign of AAG is the presence of hair width variability >20%, which corresponds to miniaturization of the hairs [36]. There is also a reduction in the number of hairs per pilosebaceous unit. In healthy individuals, it is common for two to five hairs to emerge from the same follicular orifice, which is not seen in AAG, where the pilosebaceous units house one to two hairs, with an increase in the frontal to occipital ratio of single hairs [24,37-40]. In our study, both trichoscopically suggestive signs of AAG were present and were assessed by the 11 examiners pre- and post-treatment. In both interventions, there was comparative improvement before and after treatment, with results considered similar with regard to improving the degree of hair density, reducing the variability of hair shaft diameter, and increasing the number of hairs per follicular unit by the majority of examiners, 53.4%, 58% and 47% respectively (TABLES 2, 3 and 4).

Although AGA is considered benign, several studies have reported a reduction in quality of life. In fact, alopecia can cause significant damage and psychosocial impact, leading to anxiety and depression [3,41]. In this sense, various treatment modalities, such as drug therapies, surgical hair transplantation and laser treatment have been used to treat AAG, with the aim of increasing scalp coverage and slowing down the progression of hair loss [1,24].

Among the drug treatments available, antiandrogen therapies (such as oral finasteride) and topical minoxidil are the most extensively studied agents with the greatest evidence of results and are considered first-line treatments approved by the main regulatory agencies. Both drugs require chronic use for satisfactory results [20,24,42].

Minoxidil is a vasodilating agent that acts on endothelial smooth muscle cells by blocking potassium channels [31,34]. Originally used as an oral hypotensive, it had a peculiar side effect of hair growth, which paved the way for its use for this purpose [34]. The actual mechanism of action of minoxidil on hair growth is unclear [24]. There are hypotheses that it acts by

increasing perfusion in the hair follicles, with proliferative, antiandrogenic and anti-inflammatory effects [31,43]. The end result is the cessation of follicle miniaturization, with an increase in the duration of the anagen phase, a decrease in the transition time back to anagen and induction of conversion of miniaturized hair follicles into terminal follicles, contributing to an increase in hair density [31,44]

Minoxidil is currently the most commonly used topical treatment for AAG. As a first-line therapy, it is widely associated as a complementary local treatment to systemic antiandrogens, in concentrations of 5% for men and 2 to 5% for women [24,45]. There are numerous randomized clinical trials that support the use of topical minoxidil solutions for both sexes [46,47]. It usually takes a course of 3 to 6 months of daily treatment to reduce hair loss and 6 to 12 months for substantial results, with improved scalp coverage, to be observed [4,48].

Although it is an effective treatment option, many patients have low adherence to topical minoxidil due to a lack of perceived efficacy (substantial results take time to appear), the need to apply the drug daily (1-2 times a day), altered hair cosmetics with undesirable hair texture and scalp irritation [5,49]. Patients should also be informed about a period of transient increase in telogen hair loss in the first few months after starting the application, which occurs due to the synchronization of the hair cycle by stimulating telogen follicles to re-enter anagen [44,49]. Increased initial hair loss is also one of the reasons why many patients discontinue use prematurely, especially when not advised [49]. In general, the adverse effects of topical minoxidil are largely cutaneous, with the most common complaints being itching and scaling of the scalp and hypertrichosis, especially facial. In our study, 25% of patients experienced mild pruritus with minoxidil treatment and 37.5% reported scaling from very mild to moderate intensity. In addition, 12.5% reported erythema. When questioned, 62.5% of all patients had experienced some difficulty with minoxidil treatment (mainly forgetting to apply it in 37.5% and problems with hair cosmetics in 25% of patients). Although in our study no patient developed dermatitis, contact dermatitis can also develop over time in the form of allergic or irritant contact dermatitis, commonly related to the propylene glycol solution vehicle [48,50-52]. Hypertrichosis is a disturbing side effect in women, and can be the result of personal sensitivity or, more often, incorrect application by spreading the product outside the recommended location, requiring care at the time of application [34,53]. In our study, patients were instructed on each return visit on the correct application of the product and no patient developed hypertrichosis.

Recently, the use of lasers for alopecia in general, including AAG, has become popular and has been used as a local treatment option and also as a preventative measure against AAG, as there is evidence that laser light stimulates hair growth at some wavelengths and can prevent the recurrence of hair loss [6,54]. The use of light or laser-based technologies is widely used to treat skin abnormalities such as scars, rhytids and depigmentation and, with the advent of laser hair removal, there has been a large increase in the number of laser procedures carried out worldwide, which has meant that several reports have begun to emerge about the paradoxical induction of hair growth after its use [55,56].

There is some evidence to support that fractional laser therapy alone can aid hair growth in patients with AAG [31], although few studies. Furthermore, we did not find studies with the same design as ours in literature.

Laser studies on rats helped establish treatment protocols (laser settings, treatment frequency). Using similar settings, human studies have shown efficacy and safety [31]. In AAG, fractional ablative CO2 lasers [28] and fractional non-ablative Er:glass lasers [27,24,29] and thulium lasers [23,30] have been used in human trials, but only the Er:glass and thulium lasers have been shown to be effective in regrowing hair on their own [31]. The ablative fractional CO2 laser has been shown to be effective with the addition of topical therapies [31]. The common side effects of all laser treatments are mild, transient pain and itching, which are generally minimal, and patients tend to tolerate treatments well [31].

The Erbium:YAG 2940 nm laser is an ablative fractionated laser whose chromophore is water. It is successfully applied for facial rejuvenation and for the treatment of acne scars [57,58]. By creating microscopic thermal injury zones and triggering wound healing, the fractionated Erbium:YAG laser can also induce hair growth [59]. In a randomized clinical trial with 88 mice, it was found that both the Erbium:YAG laser and topical minoxidil induced anagen faster than induction in an untreated control group. In addition, the authors found that Wnt-10b and catenin levels were higher in the laser and combined treatment groups, further supporting the findings that lasers promote hair growth, at least partially, through the Wnt-10b and catenin pathways which results in the transition from the telogen phase to the anagen phase [31,59]. Although this study was conducted on mice, the results are strongly in favor of further studies on humans [31]. Until recently, the 2940 nm Erbium:YAG fractional ablative laser had not yet been investigated in human hair disorders. Tanakol, et al. (2020) [60], recently published a study using this laser modality for patients with chronic alopecia areata unresponsive to conventional treatment. In this study, 25 patients with AA underwent 3 sessions of ablative fractionated Erbium:YAG laser, each 4 to 6 weeks apart. A total of 16 patients with AA of the scalp showed 27.8 ± 31.3% regrowth and 5 patients with AA of the beard had 39 ± 34.2% regrowth, suggesting that this laser modality may be a good therapeutic alternative. The side effects of this laser were mild and included transient erythema in all patients and folliculitis in two patients.

In our study using the Erbium:YAG laser on patients with AAG, the laser was well tolerated by all patients, and of the side effects investigated (discomfort/pain, itching, scaling and erythema), no patient had scaling, and the other side effects when present were graded as very mild, with 37.5% reporting having had more side effects on the minoxidil side.

Furthermore, from the patient's point of view, 87.5% said they were very satisfied with the laser treatment and 75% with the minoxidil. 100% reported no difficulties with the laser treatment and 62.5% had some difficulties with the use of the minoxidil (37.5% forgot to apply it a few times and 25% forgot to apply it and didn't like the cosmetics).

6. Conclusion

The use of the Erbium:YAG laser as a complementary local therapy to systemic anti-androgen treatment showed good tolerance and similar results (although not statistically significant) to the use of topical 5% minoxidil.

In view of this, this study could pave the way for an alternative treatment for patients who can not tolerate the use of topical minoxidil, which is now a widespread therapeutic option and is considered to be one of the first-line treatments for AAG. However, it does have some drawbacks, such as the risk of developing irritant or allergic contact dermatites in the scalp, with itching and scaling; impairment of hair cosmetics due to changes in hair texture; acute telogen effluvium, which develops in

the first few months after use; the care required at the time of application; the need for continuous, daily use with a dosage of 1-2 applications a day and the risk of developing hypertrichosis, which are some of the factors that compromise adherence to treatment and lead to irregular treatments. In this way, the use of the Erbium:YAG 2940 nm laser could be a valid option for patients who are poorly adherent or allergic to the daily use of minoxidil, as a potential alternative for maintaining regular treatment, making it possible to obtain better clinical results for this profile of patients, as well as possibly being a good option for adjunctive use to oral minoxidil in these cases.

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