BENHA MEDICAL JOURNAL bmj
Print ISSN 1110-208X.
Online ISSN 2357-0016

Original article

Botulinum Toxin A versus Dutasteride Mesotherapy Versus Platelet-Rich Plasma in the Treatment of Androgenetic Alopecia

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Received:3 November 2025

Accepted:4 January 2026

Abstract:

Background: Androgenetic alopecia (AGA), a non-cicatricial type of hair loss, is the most frequent form of hair loss. It is marked by the increasing miniaturization of hair follicles (HFs) and a diminution of the cycle for hair growth. **Purpose of the study:** to evaluate the efficacy of botulinum toxin A versus mesotherapy with dutasteride versus PRP in the management of AGA. **Patients and methods:** 60 patients were diagnosed clinically and by dermoscope as AGA. They were split into three groups: Group I was treated with botulinum toxin A, an injection in the scalp (100 U/3 ml), for one session; Group II was treated with dutasteride intradermal injection in the scalp (0.005 mg/ml). Sessions were done (weeks 0, 1, 2, 3, 5, 7, and 11). Group III was treated with platelet-rich plasma (PRP) in one session every month for three months. All patients were assessed clinically (Ludwig and Sinclair classification) and by dermoscope at baseline and after 3 and 6 months of treatment. **Results:** There was no statistically significant difference between the studied groups regarding the Ludwig scale, Sinclair classification, and dermoscopic features at baseline and after 3 months ($P > 0.05$). However, after 6 months, a statistically significant difference was observed between the groups in the Ludwig scale ($P = 0.06$) and dermoscopic features, including hair diversity, vellus hair, yellow dots, and the peripilar sign ($P < 0.05$). **Conclusion:** All three treatment options are effective in reducing hair loss and increasing hair density to a variable extent after 6 months.

Keywords: Androgenetic Alopecia; Botulinum Toxin; Platelet-Rich Plasma; Dutasteride

Introduction

Androgenetic alopecia (AGA), a non-cicatricial alopecia, is the most common form of alopecia. AGA is characterized by increasing miniaturization of hair follicles (HFs) and shortening of the hair growth cycle [1]. Also, it is known as male or female pattern baldness and affects at least 80% of men and 50% of women by age 70, with increased incidence with age [2]. Its origin is primarily hereditary and reliant on androgen hormones. However, several factors have also been implicated, including oxidative stress and continuous micro-inflammation [3]. Compared to non-bald parts, bald areas in AGA have decreased oxygen levels and some microvascular insufficiency. Additionally, it is said that low oxygen settings are the most efficient for the conversion of testosterone to dihydrotestosterone (DHT) [4]. To stop the proliferation of follicular epithelial cells, DHT causes dermal papilla cells (DPCs) to produce more transforming growth factor-beta 1 (TGF-ß1). TGF-ß1, which stimulates apoptosis, results in scalp fibrosis and stiffness [5]. Furthermore, the primary dermoscopic findings of AGA are hair diversity, the peripilar sign, yellow patches, a higher proportion of vellus hairs, and many follicular units with a solitary hair shaft [6]. Minoxidil and finasteride are two common medications that increase blood flow and oxygen to the follicles by blocking the formation of DHT through the inhibition of 5-alpha-reductase [7]. Botulinum toxin (BTA) also increases blood flow in the area through its potent blockade of acetylcholine production. It stops muscles from contracting, which may lower pressure on the surrounding blood vessels and increase blood flow [8, 9]. This may help hair grow by extending the anagen development phase and increasing the oxygen supply to the follicles [7]. Platelet-rich plasma (PRP) therapy is recognized in many categories, especially as a therapeutic modality of AGA. Platelets emit several growth factors (GFs) that help cells develop, make collagen, and form new blood vessels. GFs include vascular endothelial growth factor (VEGF) and platelet-derived growth factor (PDGF) [10, 11]. PRP improves the hair growth cycle, which leads to an increase in density of hair and shaft diameter, particularly the development of densely pigmented terminal hair [10, 12].

Mesotherapy is a technique that includes injecting little amounts of pharmaceuticals into the mesoderm to bypass the limitations of locally applied therapy and deliver customized medications [13].

Dutasteride is one of the several modalities to treat AGA. It inhibits both type I and II of 5-α reductase (5-αR), which lowers DHT levels in the scalp [14, 15]. Oral dutasteride, previously approved for treatment of benign prostatic hyperplasia, may be an effective treatment option for androgenetic alopecia (AGA); however, systemic administration might result in adverse consequences, such as sexual dysfunction and gynecomastia [16]. Mesotherapy is a good option for the management of AGA, as it can prevent the systemic adverse effects associated with dutasteride [17].

Aim of the study

This study was conducted to evaluate the efficacy and safety of botulinum toxin A, dutasteride mesotherapy, and platelet-rich plasma in the treatment of androgenetic alopecia.

Patients and Methods

Subjects

This prospective, interventional clinical trial was undertaken in the Department of Dermatology, Venereology, and Andrology, Benha University Hospital, from June 2024 to September 2025.

Sixty female patients were diagnosed clinically and by dermoscope as androgenetic alopecia. They were split into three groups: Group I, comprising 20 patients, received botulinum toxin A (BTA) injection; Group II, 20 patients, received dutasteride mesotherapy; and Group III, 20 patients, received an

injection of platelet-rich plasma (PRP). Every patient gave informed written consent before being included in the study. The Human Subjects Research Ethics Committee at the Benha Faculty of Medicine has approved the study (MS 26-4-2024). All the steps followed the Helsinki Declaration of 1975 and its update in 2000.

Inclusion Criteria

All the included patients in the study underwent a complete medical history, clinical examination, and dermoscopic evaluation of the scalp.

Exclusion Criteria

Patients with severe systemic diseases, neuromuscular disorders, hormonal disorders, local skin infections, or scalp inflammation, as well as those receiving systemic or topical immunosuppressive therapy or using nonsteroidal anti-inflammatory drugs, were not included in the study. Additionally, pregnant and lactating women were excluded.

Methods

Patients with androgenetic alopecia were assessed before, during, and after treatment by photography using an iPhone 15 Pro and a Dermalite™ DL4 dermoscope. Additional assessment of the patient using the Ludwig classification of female pattern hair loss, which categorizes hair loss into three patterns from class I, which is the mildest, to class III, which is the severest [18]. A tenth of the entire number of hairs pulled (less than or equal to six hair shafts) can typically fall off when roughly 60 hair shafts are carefully tugged by the fingers. However, when additional hair is pulled out, this indicates some form of hair shedding, as seen in telogen effluvium. Except for places like the frontal hairlines, it is detrimental in AGA [19]. Also, Sinclair's classification (Women's Alopecia Severity Scale), the five-stage scale, which measures hair density in the scalp midline based on the width of the hair part, was used, considering stage one is the mildest and stage five is the severest [20].

Technique of the injection

Topical anesthesia (lidocaine 2.5% and prilocaine 2.5%) was applied to the scalp for 30 minutes before injection, and the scalp area of injection was then sterilized with 70% ethyl alcohol immediately before injection for all patients.

Group I (BTA group) included twenty patients diagnosed with AGA. Botulinum toxin type A (100 U) (Neuronox®, Medytox Inc., Seoul, Korea) diluted to 100 U/3 mL with 0.9% normal saline was used; thus, each 1 mL contains 33.3 U of Botox. A 100 U insulin syringe was used, and every large mark represents 0.1 mL, which corresponds to 3.3 U of Botox injected intradermally into the scalp via approximately 15 injections, 2-3 cm apart [21]. BTA injection was one session with follow-up after 3 and 6 months

Group II (dutasteride group) included twenty patients diagnosed with AGA. Dutasteride 1 ml intradermal injections (Dutasteride NJ® Worldwide, USA). Each ampoule of Dutasteride NJ® (0.5 mg/mL) was diluted with sterile normal saline to achieve a final concentration of 0.005 mg/mL. Using a 30-gauge needle and a 1 mL insulin syringe, 0.02–0.05 mL per injection point was delivered intradermally at a depth of 1.5–2 mm, spaced approximately 1 cm apart over the affected scalp areas (frontal, vertex, and mid-scalp). The total injected volume per session was 2 mL. Injections were administered weekly for four consecutive weeks (weeks 0, 1, 2, and 3), followed by a session every two weeks for two times (weeks 5 and 7). The last session was administered after 4 weeks (week 11). Assessment was done on week 12 [22].

Group III (PRP group): PRP was prepared from a patient's autologous blood sample. A 10 mL venous blood sample was drawn, then collected in tubes lined with anticoagulant (Raiderma®, Spain), which were promptly put in the centrifuge to separate the blood into three layers: acellular plasma (PPP, platelet-poor plasma) in the supernatant, red blood cells

(RBCs) at the bottom, and a buffy coat layer that developed in the center, which is where platelets and leukocytes are concentrated in PRP.

Platelet-rich plasma was injected into areas of scalp with AGA using a 30 G needle or an insulin syringe in a regimen of one session monthly for 3 months [23].

Evaluation of the treatment

Three dermatologists assessed the patients at the baseline and 6 months after the first treatments. Clinical staging of AGA using Ludwig classification and Sinclair classification before and after treatment was done. Additionally, dermoscopic evaluation of the hair was performed using the Dermalite DL4, USA. Two points were marked along the midline: the first point was 18 cm from the tip of the nose at the frontal region, and the second point was 24 cm from the tip of the nose at the vertex region. Dermoscopy results showed hair diversity, vellus hair, yellow dots, and perpilar signs at baseline (0 months), 3 months, and 6 months [24]. Side effects of treatment, such as itching, pain, or no symptoms, were recorded.

Statistical analysis

Pre-coded data was processed and statistically analyzed by using the statistical package of the social science software (SPSS), version 25.0 (IBM Corp. Released 2017 IBM SPSS Statistics for Windows, Version 25.0. Armonk, NY: IBM Corp.). Data were summarized using mean and SD for normally distributed quantitative variables. Numbers and percentages were used to describe the qualitative variables. A comparison between qualitative variables was made by using the Chi-square test, while an independent Student *t*-test was used to compare normally distributed quantitative variables between groups. *P*-values ≤ 0.05 are considered statistically significant.

Results

The study included sixty female patients diagnosed with androgenetic alopecia and divided into three groups as mentioned before. The mean ages were 31.7 ± 7.19, 30.95 ± 5.12, and 25.75 ± 7.21 years in groups I (BTA), II (dutasteride), and III (PRP), respectively, and were statistically significant ($P < 0.01$). There was no statistically significant difference between the groups studied in terms of sex, body mass index (BMI), family history, or duration of hair loss ($P>0.05$). There was no statistically significant difference between the studied groups regarding the Ludwig scale at baseline and after 3 months ($P = 0.39$ and $P = 0.36$, respectively; $P > 0.05$). However, after 6 months, a statistically significant difference was observed between the groups in the Ludwig scale ($P = 0.06$), which is close to the threshold for significance, suggesting a potential clinical improvement, particularly in the dutasteride group (which reached 80% in Grade 1). All the groups showed statistically highly significant improvement in Ludwig classification in relation to each group ($P = 0.001$) (Table 1). For the Sinclair classification for AGA, there are no statistically significant differences between groups after 3 and 6 months ($P > 0.05$), which indicates that each group has similar hair loss in the same period. Nevertheless, group comparisons were considered responsive to treatment after six months. The BTA group showed a statistically significant improvement ($P=0.03$), with 75% of participants achieving Sinclair stage 2 at 6 months. This changing of stages to lesser stages indicates a marked treatment response and suggests that BTA should be the most efficacious of these three treatments. Neither the dutasteride group nor the PRP group had a significant trend over time ($P = 0.93$ and 0.98, respectively), representing a slight clinical improvement observed during the study duration. (Table 2) (Figures 1, 3, and 5).

There was no statistically significant difference between the studied groups regarding dermoscopic features of AGA, including hair diversity, vellus hair, yellow

dots, and peripilar sign, at baseline and after 3 months for all groups. However, a statistically significant difference was found after 6 months in hair diversity, vellus hair, yellow dots, and the peripilar sign ($P < 0.05$), indicating better improvement in the BTA group compared to the others (Table 3) (Figures 2, 4, 6).

Regarding the side effects noticed during and after the treatment period, a statistically significant difference in side effects was observed between the study groups ($P < 0.01$).

Itching occurred in one patient of the BTA group (5%), five patients in the dutasteride group (25%), and ten patients in the PRP group (50%). Pain was observed in two patients in the BTA group (10%), one patient in the PRP group (5%), and no patient complained of pain in the dutasteride group. No side effects were reported in the rest of the BTA group (17 patients, equal to 85%). Fifteen patients (75%) of the dutasteride group had no side effects. Also, referring to the PRP group, nine patients (45%) had no side effects from the treatment.

Table 1: Ludwig classification among the studied groups at baseline and 3 and 6 months of treatment

	BTA Group N=20	**Dutasteride group N=20**	**PRP group N=20**	***P* value**
Ludwig scale				
At baseline				
Grade 1	2 (10.0%)	4 (20.0%)	1 (5.0%)	
Grade 2	4 (20.0%)	6 (30.0%)	8 (40.0%)	0.39
Grade 3	14 (70.0%)	10 (50.0%)	11 (55.0%)	
After 3 months				
Grade 1	13 (65.0%)	8 (40.0%)	10 (50.0%)	
Grade 2	2 (10.0%)	4 (20.0%)	6 (30.0%)	0.36
Grade 3	5 (25.0%)	8 (40.0%)	4 (20.0%)	
After 6 months				
Grade 1	14 (70.0%)	16(80.0%)	9 (45.0%)	
Grade 2	1 (5.0%)	2 (10.0%)	9 (45.0%)	0.06
Grade 3	5 (25.0%)	2 (10.0%)	2 (10.0%)	
***P* value**	**0.001***	**0.001***	**0.001***	

*P<0.001 is statistically highly significant

Table 2: Distribution of Sinclair classification between studied groups and its relation to time

	BTA Group N=20	Dutasteride group N=20	PRP group N=20	*P* value
Sinclaire				
At baseline				
stage 2	4 (20.0%)	8 (40.0%)	7 (35.0%)	
stage 3	8 (40.0%)	5 (25.0%)	6 (30.0%)	
stage 4	6 (30.0%)	4 (20.0%)	4 (20.0%)	0.46
stage 5	2 (10.0%)	3 (15.0%)	3 (15.0%)	
After 3 months				
stage 2	12 (60.0%)	10 (50.0%)	9 (45.0%)	
stage 3	4 (20.0%)	4 (20.0%)	5 (25.0%)	0.96
stage 4	2 (10.0%)	4 (20.0%)	4 (20.0%)	
stage 5	2 (10.0%)	2 (10.0%)	2 (10.0%)	
After 6 months				
stage 2	15 (75.0%)	12 (60.0%)	10 (50.0%)	
stage 3	2 (10.0%)	3 (15.0%)	5 (25.0%)	0.79
stage 4	2 (10.0%)	3 (15.0%)	3 (15.0%)	
stage 5	1 (5.0%)	2 (10.0%)	2 (10.0%)	
***P* value**	**0.03***	0.93	0.98	

**P* < 0.05 is statistically significant

Table 3: Distribution of dermoscopic findings among studied groups

	BTA Group N=20	Dutasteride group N=20	PRP group N=20	*P* value
Dermoscopic findings				
At baseline				
HD+VH +YD +PS	8 (40%)	7 (35%)	7 (35%)	
				0.93
After 3 months				
HD+VH +YD +PS	4 (20%)	4 (20%)	5 (25%)	0.90
After 6 months				
HD+VH +YD +PS	1 (5.0%)	2 (10%)	3 (15%)	0.52
***P* value**	**0.02***	**0.15**	**0.34**	

*P < 0.05 is statistically significant HD: Hair diversity, VH: vellus hair, YD: yellow dots, PS: peripilar sign

Fig. (1) (A) patient at baseline before treatment. (B) Patient after 3months of BTA treatment. (C) After 6 months of BTA treatment, the patient shows marked clinical improvement in hair growth

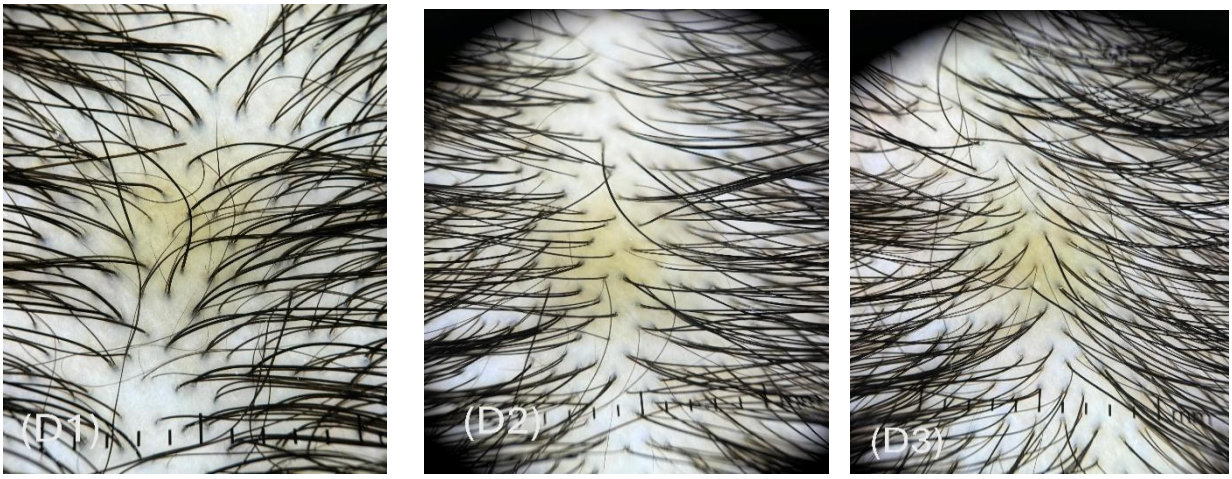

Fig. (2) Dermoscopic photo before (D1), after 3 months (D2), and after 6 months (D3) of BTA treatment of AGA shows an increase in hair density and low diversity of hair

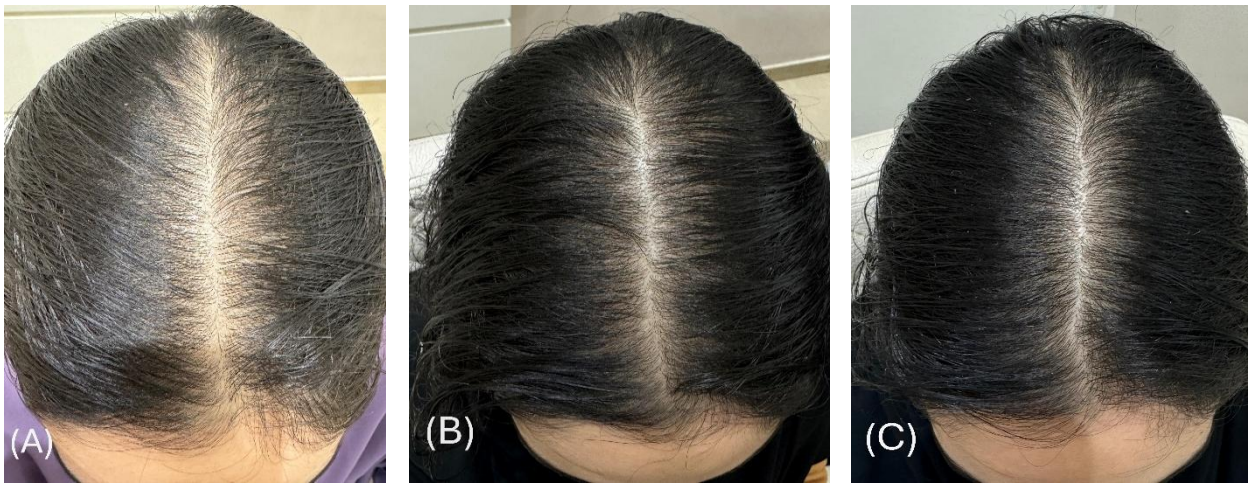

Fig. (3) Clinical improvement of patient's hair density from before dutasteride treatment (A) to 3 months (B) and 6 months (C) after treatment

Fig. (4) Dermoscopic photos of AGA patient (D1) before treatment, (D2) after 3months of dutasteride mesoinjection, and (D3) after 6 months of treatment with dutasteride show increased hair density and thickening of hair shaft

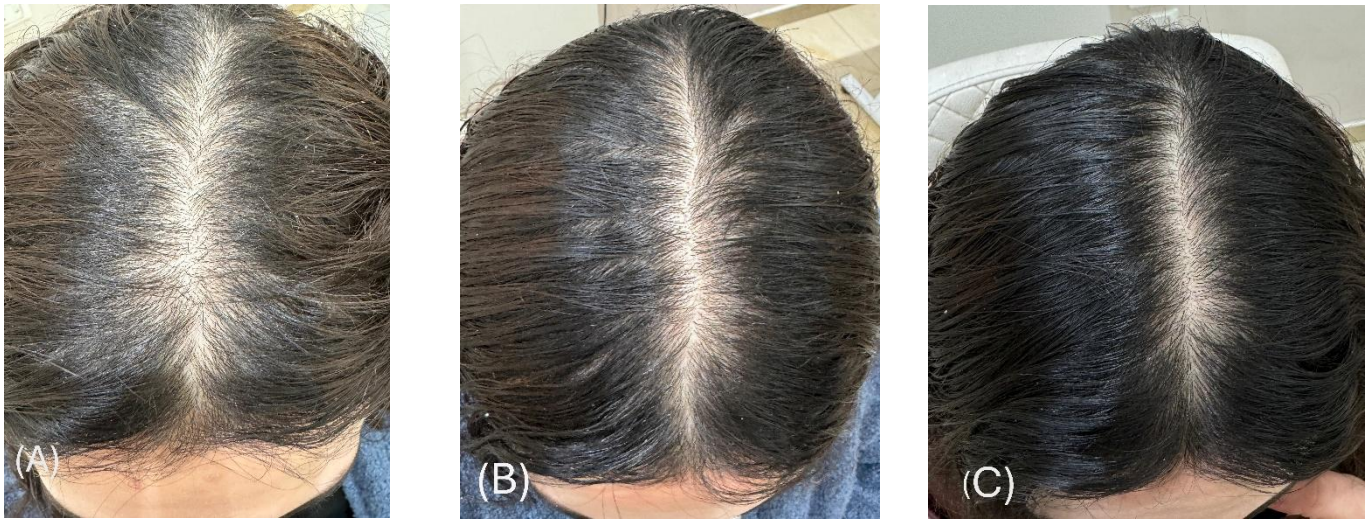

Fig. (5) Clinical improvement of patient's hair density from before PRP treatment (A) to 3 months (B) and 6 months (C) after treatment

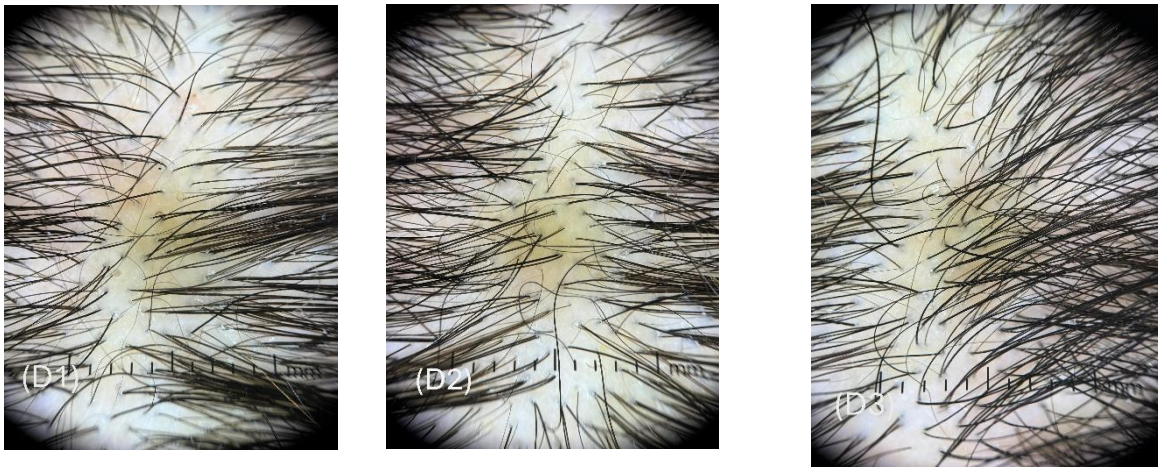

Fig. (6) Dermoscopic photos of AGA patient (D1) before treatment, (D2) after 3months of PRP mesoinjection, and (D3) after 6 months of treatment with PRP show increased hair density and thickening of hair shaft

Discussion

Considering its cosmetic concern, AGA has a substantial psychosocial impact, often associated with lowered self-esteem and quality of life. Current different modalities of treatment, including topical minoxidil, oral finasteride, and other anti-androgenic agents, introduce partial improvements and require persistent effort over time for maintenance [25]. Consequently, other therapeutic modalities such as PRP mesotherapy and BTA are being discovered to promote follicular growth and scalp microcirculation as possible alternatives to conventional therapy [5, 26].

Our study results have revealed that the mean age in the BTA group was 31.7 ±7.19, 30.95 ±5.12 in the dutasteride group, and 18.45 ±1.66 in the PRP group. All patients were females, as the cosmetic concern is more prominent in females.

The current study shows pronounced clinical improvement in AGA among patients who received BTA, dutasteride, and PRP, as indicated by decreases in Ludwig stages following six months of

treatment. All groups had highly significant within-group improvement (P = 0.001); however, the dutasteride group had the most notable, followed by BTA and PRP, resulting in moderate improvement. The Ludwig classification is considered a simple classification for AGA that clearly describes the severity of AGA.

No significant difference was observed between the groups ($P > 0.05$), suggesting that the three modalities can improve the severity of AGA but with different efficacies. These results are consistent with earlier reports showing that dutasteride, a dual inhibitor of 5-α-reductase, is more effective than finasteride in male and female pattern hair loss [25, 27].

Considering the Sinclair scale, a significant difference was observed among the study groups ($P = 0.001$). The Sinclair scale is considered more sensitive in the diagnosis of early disease than the Ludwig classification and better for disease monitoring. Most patients in the PRP and dutasteride groups were classified as Stage 2, indicating a notable increase in visible hair density compared with baseline. In contrast, a higher proportion of patients in the BTA group remained at Stage 3 or 4, suggesting a comparatively milder clinical response. These findings agree with earlier reports in which PRP promotes follicular proliferation by delivering autologous growth factors such as PDGF, VEGF, and EGF, which enhance dermal papilla cell viability and angiogenesis [26, 28]. Similarly, dutasteride demonstrated substantial improvement in hair density, likely due to its potent inhibition of both type I and type II 5α-reductase isoenzymes, leading to a more profound suppression of DHT compared with finasteride [25]. The intradermal administration in the present study might have also increased local bioavailability but reduced systemic exposure, corroborating the increasing amount of evidence for mesotherapy with dutasteride in AGA [29]. In contrast, BTA has a specific selectivity but is less prominent than the other methods. The suggested action of botulinum toxin in AGA is relaxation of the scalp musculature, which improves microcirculation and decreases perifollicular hypoxia and local neurogenic inflammation [30, 5]. Nevertheless, this late onset of action, as well as its mode of action different from angiogenic therapy, may explain why Sinclair stage 2 responses were less than in more pharmacodynamically driven therapies like PRP and dutasteride.

Considering the dermoscopic features of AGA before and after treatment, our study results have revealed that both the dutasteride and PRP groups showed improvement; however, their within-group differences were statistically insignificant ($P = 0.15$ and $P = 0.34$, respectively). The modest dermoscopic improvement seen with dutasteride can be attributed to its hormonal mechanism of action, which primarily suppresses DHT levels and thereby halts further follicular miniaturization rather than directly reversing it [25]. The response to PRP is variable and may depend on platelet concentration, patient-specific factors, and injection techniques [32].

Regarding dermoscopic feature improvement, there were no significant differences between the studied groups ($P > 0.05$), indicating that all three treatments contributed to the improvement of AGA, at different degrees. The relatively better dermoscopic improvement in the BTA group is attributed to the vascular mechanism in AGA therapy, combined with hormonal and regenerative approaches. These findings are consistent with the idea that improving scalp perfusion and reducing perifollicular tension can enhance follicular growth.

In the current study, mild and transient side effects were observed in all groups that differed significantly in relation to their number and type. Itching was the most reported side effect with the PRP group (50%), followed by the dutasteride

group (25%), and it was minimal in the BTA group (5%). This was statistically significant (P = 0.01), which reveals an increased chance of scalp irritation related to intradermal injection of PRP. Injection site pain was also mild and transient in both groups (10% of patients receiving BTA and 5% of those treated with PRP). However, the dutasteride group had no pain reported. Consequently, the BTA group had the best safety profile, with 85% of patients reporting no side effects, compared to 75% in the dutasteride group and 45% in the PRP group. These results indicated that while all modalities were generally well-tolerated and safe, PRP was associated with a higher rate of minor local irritation. In contrast, BTA showed the most favorable tolerability. Similarly, Kowing et al. [33] reported negative consequences of madarosis and facial baldness after receiving 100-unit injections of botulinum toxin every three months. Some studies have even noted that the hairline may become more recessed [21, 34]. In contrast, both Shon et al. [5] and Singh et al. [4] didn't report any adverse effects in their studies after using botulinum toxin in AGA treatment. Side effects associated with botulinum toxin were predominantly mild and included headache, pain at injection sites, and erythema. Overall, botulinum toxin seems to be a safe therapeutic option for androgenetic alopecia; however, it currently lacks the necessary evidence to be established as a usual recommended therapy [35]. In Abdallah et al.'s [36] study, using mesotherapy with dutasteride-containing products, they found only headache and scalp tightness as side effects. PRP has become a promising, minimally invasive option for patients with AGA. According to Verma et al. [37], the overall risk of side effects is low.

The current study has a few limitations that need to be kept in mind while interpreting the results. A bigger sample size and a more extended follow-up period will be required to establish the cumulative efficacy and safety of botulinum toxin A, dutasteride mesotherapy, and PRP in AGA.

Conclusion

In conclusion, these findings support the effectiveness of all three treatment options in reducing hair loss and increasing hair density, with PRP and dutasteride showing superior results on the Sinclair scale. In contrast, dutasteride has the most significant response in the Ludwig classification after 6 months of treatment. On the other hand**,** study findings have revealed that BTA showed the most significant dermoscopic improvement over 6 months. Dutasteride ranked second, with moderate but non-significant improvement. PRP showed the least dermoscopic improvement. Generally, the dermoscopic features reinforce clinical observations and suggest that combining morphological assessment with clinical grading provides a more comprehensive evaluation of treatment efficacy in AGA. Additional studies with larger sample sizes, longer follow-up durations, and standardized dermoscopic scoring systems are recommended to confirm these results and clarify the relative advantages of each treatment.

Funding

None

Conflicts of interest

No conflict of interest has been reported by the authors of this study

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To cite this article: Asmaa M. Al Refai , Rana A. Farag, Eman M. Hassan. Botulinum Toxin A versus Dutasteride Mesotherapy Versus Platelet-Rich Plasma in the Treatment of Androgenetic Alopecia. BMFJ XXX, DOI: 10.21608/bmfj.2026.438697.2756.