Efficacy of Stromal Vascular Fraction Versus Topical Minoxidil in Treatment of Androgenetic Alopecia: A Simple Randomized Study

Ahmed Bakr Elazab[1*], Fayed HA[2], Shereen E. Alashry[2], Mohamed Ali Mahgoub[3]

[*1]Dermatology, Andrology & STDs, Faculty of Medicine, Suez University, Egypt.

[2]Dermatology, Andrology and STDs Department, Mansoura University Hospitals, Faculty of medicine, Mansoura University, Mansoura, Egypt.

[3]Plastic Surgery Department, Faculty of Medicine, Mansoura University, Mansoura, Egypt

*Corresponding Author:

Ahmed Bakr Elazab

Email ID: Ahmed.bakr.mohamed@gmail.com

ABSTRACT

Background: Androgenic alopecia (AGA) is a kind of hair loss that may affect both males and females . AGA results from a combination of hormonal imbalances and genetic predisposition. We aims to estimate the topical minoxidil versus stromal vascular fraction (SVF) efficiency in the AGA treatment. Adipocytes, smooth muscle cells, endothelial cells, blood cells, stem cells, and extracellular matrix are excluded from the SVF, which encompasses all cellular components of the adipose tissue. For both male and female patients with AGA, Topical minoxidil is the first-line medication that has been revealed to be efficacious in a multitude of randomized double-blind and case-control studies.

Methods: This randomized study was performed on 70 Egyptian males and females cases, aged from 18 to 45 years old, with all androgenetic alopecia grades based on basic and specific classification. Two equal groups of patients were randomly assigned: Group A received SVF as single injection in the scalp frontal area under strict sterile conditions, with 0.1 ml/cm2 of SVF administered intradermally utilizing 30 G syringes. Group B was treated with minoxidil 5% topically twice daily for men and 2%minoxidil for women for a period of six months.

SVF preparation was done applying Coleman's technique (2006) was utilized for fat grafting, First, Klein's,(1996) The 6-month follow-up visit included a comprehensive evaluation. Digital and trichoscopic examinations of the scalp were conducted on all patients using the Dlite STR CA_USA.

Results: Regarding group (A), there was highly significant improvements at 6 months compared to baseline regarding hair shaft density, diameter and the T/V hair ratio (P <0.001).These findings highlight the SVF treatment efficacy in improving both objective hair parameters .Regarding group (B) there was highly significant improvements at 6 months compared to baseline regarding hair shaft density ,diameter and the T/V hair ratio (P <0.001).Regarding patient satisfaction , in patient satisfaction there was statistically significant difference (p = 0.011) between both groups .SVF may offer a more satisfactory treatment experience but there was insignificant improvement in hair shaft diameter, density, T/V hair ratio between both groups. Regarding improvement at six months, using SVF; A significant positive correlation was indicated between hair shaft diameter and hair shaft density (p = 0.023), the T/V ratio also correlates with Hair shaft diameter (p=0,009) and hair shaft density (p=0,013). using topical minoxidil; hair shaft diameter shows a moderate positive correlation with hair shaft density (p=0,007), and the terminal to vellus hair ratio (T/V ratio) (p = 0.009). Hair shaft density also correlates with the T/V ratio (p =0.002). Additionally Gender does not significantly influence any outcomes in both groups, suggesting that SVF and topical minoxidil effects are consistent across genders.

Conclusion: The study shows that while both the SVF and Minoxidil treatments appear to beneficial over 6 months, there were insignificant differences between the two treatment groups regarding hair characteristics but SVF showed more satisfactory treatment experience, individual responses may vary.

Keywords: Stromal Vascular Fraction; Topical Minoxidil; Terminal to vellus; Androgenetic Alopecia

1. INTRODUCTION

Androgenetic alopecia (AGA), which is more commonly known as male pattern hair loss (MPHL) or female pattern hair loss (FPHL), is the most prevalent type of alopecia worldwide. The progressive terminal hair loss that occurs after puberty is its distinguishing characteristic. Caucasians are the most frequently affected, followed by Asians and African Americans, and finally Native Americans and Eskimos. The disease affects at least 80% of men and 50% of women by the age of 70, and its rate increases with age.[1].

The adipose tissue and adipose tissue-derived stem cells (ADSCs) implementation in regenerative medicine becomes increasingly prevalent in all medical fields. Numerous investigations regarding the impact of ADSCs on hair growth have demonstrated a correlation between these two cell treatments and its development. Consequently, theses tissues have been demonstrated to have a critical component of the naturally occurring hair cycle.[2].

Two ADSCs are responsible for the majority of SVF's activity, and these cells engage in continuous intercellular cross-talk and signaling.[3].

Two strategies are available for the acquisition of SVF: chemical and mechanical. Enzymatic digestion with collagenase is employed in chemical methods, and it is subsequently deactivated. The mononuclear cells pool is subsequently isolated by centrifugation and filtration. As a result, ADSCs can be cultured using this chemical SVF.[4]. Mechanical methods typically involve physical disruption, as shaking, sonification, and vortexing, then filtration and filtration . Along with the cells, they contain extracellular matrix fragments.[5].

For decades, minoxidil has been employed as a managment for hair loss . The medication enhances hair growth and reduces hair loss by affecting follicular cells. Hair loss progresses within 12 to 24 weeks following the cessation of treatment. [6,7].

 The sulfotransferase activity in removed follicles can be used to predict the theraby response to minoxidil topically. In a subsequent study that utilized this assay, it was observed that the sulfotransferase enzyme activity in hairs stabilized during the eighth week of topical minoxidil treatment. This discovery suggests that minoxidil-responsive patients will not develop resistance to the present dosage, and conversely, non-responsive patients will not evolve into responders.[8]

The study aim was to establish the difference in the SVF efficacy versus topical minoxidil in AGA treatment Via: Injection of SVF in group A and follow up the patients before and after 6 months by clinical and digital trichoscopic assessment, and topical minoxidil for group B and follow up the cases before and after 6 months by clinical and digital trichoscopic assessment.

2. PATIENTS AND METHODS

This randomized study was performed on 70 cases (33 male and 37 female) ranged in age from 18 to 45 years old, both sexes, AGA grades regarding basic and specific classification (BASP).

The patient provided informed written consent . The research was conducted with the approval of the Research Ethics Committee of the Faculty of Medicine at Mansoura University.

(MD.2307.791:) during the period from July 2023 till November 2024.

The following are the exclusion criteria for the study: patients aged 18 or older or those aged 45 or older, cases who took minoxidil or any other oral and topical medications (containing herbal medications) within 6 months prior to the procedure for group A, finasteride or dutasteride within 12 months of the research, or injection procedures for hair loss within 6 months prior to the study. a history of keloidal scarring, anticoagulant therapy, or aspirin should be discontinued at least 3 days prior to the procedure, any patient who received systemic hair treatment in the previous 6 months, systemic use of corticosteroids should be discontinued one month prior to the study, cases with hematological disorders, severe chronic illnesses , malignancy, allergic or autoimmune diseases, pregnant or lactating women, and dermatological conditions or significant scarring in the treatment area.

3. GROUPING AND RANDOMIZATION

A computer-generated system was utilized to perform simple randomization. The patient's consent was obtained, and the list was concealed in sealed envelopes that were numbered and opened sequentially. The patients were randomly allocated to two equal categories using computer-generated randomization tables: The frontal area of the scalp was intradermally administered with 0.1 ml/cm2 of SVF under strict sanitary conditions using 30 G syringes in Group A, while Group B was treated with minoxidil 5% twice daily topically for men and for 6 months 2% minoxidil for women.

All patients underwent a comprehensive history-taking process, which included a general history to rule out any other dermatological diseases, AGA duration, history of thinning and shedding, and use of cosmetic formulas (e.g., gel, dyes, and chemicals),onset (sudden - gradual),course (progressive, regressive, stationary), family history,general and dermatological examinations to exclude other scalp diseases, BASP, and routine laboratory investigations.

4. SVF PREPARATION

Coleman's technique was utilized for fat grafting [9].First, Klein's [10] The tumescent technique is employed for local anesthesia. utilizing(25 ml of 2% lidocaine, 500 ml of 0.9% sodium chloride, and 0.5 ml of epinephrine), a tumescent anesthesia solution was administered. Subsequently, a 20-ml Luer-Lock syringe was used to extract adipose tissue in conjunction with a Sorensen harvester cannula (Tulip Medical Inc.). A constant negative pressure will be employed to accomplish suction. Upon the 80 ml of fat harvesting , the condensation process commenced with the lipoaspirate centrifugation at 500 g-force for 2 minutes utilizing an 80–1 Electric Centrifuge from Jiangsu Jinyi Instrument Technology Company Limited. This was adequate to separate the tumescent fluid and blood constituents in the lowest layer , which were then discarded.

Tulip Nano Transfer kit was employed to mechanically emulsify the lipoaspirate following centrifugation. In order to achieve effective fat mechanical micronization, the lipoaspirate was mechanically emulsified utilizing the Tulip NanoTransfer kit through 2.4, 1.4, and 1.2 mm Luer-to-Luer connectors, respectively. with 30 passes through each connector using minimal pressure force in order to achieve successful mechanical micronization of the fat.Another centrifugation at 1200 g-force for 3 minutes was performed on the micronized fat to remove the oil. Next, the remaining emulsified fat was filtered by passing one time through a double-layered filter with a pore size of 400 and 600 μm. The product was centrifuged at 1200 g-force for 6 minutes for the last time. This procedure resulted in the formation of three layers, with the SVF pellet located at the bottom. The frontal area of the scalp was intradermally administered with 0.1 ml/cm2 of SVF under strict sterile conditions after SVF isolation using 30 G injectors.

One week following the fat harvesting procedure, patients were evaluated for the presence of any adverse effects, including pain, edema, and/or bruises .A comprehensive evaluation was conducted during the six-month follow-up visit.

5. RESPONSE TO TREATMENT

Before treatment, all cases underwent a scalp digital and trichoscopic examination (utilizing the Dlite STR CA_USA) to assess hair shaft thickness, hair density, and terminal to vellus hair ratio (T/V ratio). This assessment was conducted at the 6-month follow-up visit. A headband and a tapeline will be employed to capture digital images at reference points. as proposed by [11].Also, global photography was assessed by 2 independent non-treating blinded dermatologists who were asked to subjectively compare digital photographs which were taken by the same photographer at the same distance each time using Canon digital camera (EOS 800EF-S 18-55 mm F4-5.60 IS STM lens-24.2MP DSLR) at 6 months after treatment with baseline photographs regarding hair condition as follows:Great worsening =-3,moderate worsening = -2,Slight worsening =-1,Stabilization = 0, Slight improvement = 1, Moderate improvement = 2, Great improvement = 3.

Patient satisfaction:

All cases were asked to assess their satisfaction level by giving themselves a score between 0 and 3 marks (0 representing "highly dissatisfied," 1 representing "dissatisfied," 2 representing "satisfied," and 3 representing "highly satisfied").

Sample size:

Power Analysis and Sample Size Software (PASS 2020) was employed to determine the sample size (NCSS, LLC. Kaysville, Utah, USA, ncss.com/software/pass). The minimum total hypothesized sample size of 70 eligible Egyptian females and males with AGA [35 per group] is required to ascertain the SVF efficacy versus topical minoxidil in the androgenetic alopecia treatment. This is based on an effect size of 15%, a significance level of 5%, and a power of 80%, as determined by the Chi square test.[12, 13].

Statistical analysis:

Statistical analysis was performed employing SPSS v28 (IBM©, Armonk, NY, USA). The normality of the data distribution was evaluated utilizing the Shapiro-Wilks test and histograms. An unpaired student t-test was employed to analyze the quantitative parametric data, which were then presented as the mean and standard deviation (SD). In order to analyze quantitative non-parametric data, which were presented as the median and interquartile range (IQR), the Mann Whitney test was implemented. Qualitative variables were analyzed using the Chi-square test or Fisher's exact test, and they were presented as frequency and percentage (%) as applicable. The Spearman correlation coefficient (r) was implemented to establish a correlation between two quantitative variables within a single group. P values with a two-tailed probability of less than 0.05 were used to determine statistical significance.

6. RESULTS

In this study,94 patients were evaluated for eligibility ; 16 cases did not satisfy the criteria, and 8 cases declined to contribute. The remaining 70 cases (33 male and 37 female) were randomly allocated to two groups, each consisting of 35 cases. Group A comprises sixteen males and nineteen females, while Group B comprises seventeen males and eighteen females. The statistical analysis and follow-up of all allocated patients were conducted.
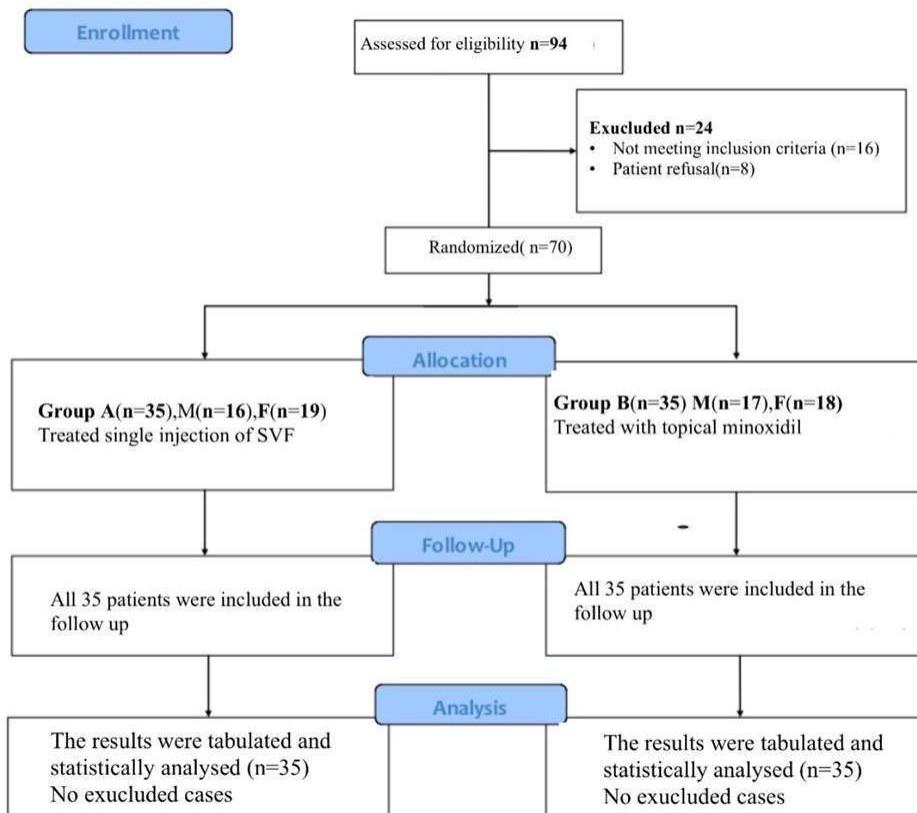
Figure 1: CONSORT flowchart of studied patients.

Table 1 reveals highly significant improvements at 6 months compared to baseline regarding hair shaft density, diameter and the T/V hair ratio (P <0.001).These findings highlight the efficacy of the SVF treatment in improving both objective hair parameters .

Table 1: Comparisons of group A regarding trichoscopic findings, in patients using SVF injection (n=35)

Variable	Baseline	6 months	Statistical test value	P value
Hair density(hair/cm2) (SVF) Median (IQR) Range	98 (15.5) (82-120)	140 (33.8) (96-183)	-4.107717	<0.001 ($3.996*10^{-5}$) [a]
Hair shaft diameter micrometer (SVF) Median (IQR) Range	26.5 (19) (10-45)	70 (29.25) (20-100)	-4.109071	<0.001 ($3.973*10^{-5}$) [a]

(T/V ratio)				
Median	1.1	3	-3.409146	<0.001 (0.000652) [a]
(IQR)	(2)	(4.45)		
Range	(0.5-5.4)	(0.6-14)		

Data are presented as median (IQR) ,range. T/V: Terminal to vellus hair ratio.p value (<0.001) was considered highly significant (a) using when you can apply the Wilcoxon signed rank .

Table 2 shows highly significant improvements at 6 months compared to baseline regarding hair shaft density, diameter and the T/V hair ratio (P <0.001). These findings highlight the topical minoxidil treatment efficacy in improving both objective hair parameters.

Table 2: Comparisons of group B regarding digital trichoscopic findings, in patients topical minoxidil (n=35

Variable	Baseline	6 months	Statistical test value	P value
Hair density(hair/cm2)				
Median	96	134.5	-4.108529	<0.001 (3.982*10^{-5}) [a]
(IQR)	(14.5)	(35.3)		
Range	(80-125)	(90-178)		
Hair shaft diameter (micrometer)				
Median	20	76.5	-4.11287	<0.001 (3.908*10^{-5}) [a]
(IQR)	(21)	(28.25)		
Range	(10-50)	(45-102)		
Terminal to vellus hair ratio (T/V ratio)				
Median	0.7	2.9	-3.29739	<0.001 (0.0009759) [b]
(IQR)	(1.8)	(4.75)		
Range	(0.4-5.1)	(0.5-14.3)		

Data are presented as median (IQR),range. T/V: Terminal to vellus hair ratio.p value (<0.001) was considered highly significant (a) using when you can apply the Wilcoxon signed rank .

Table 3 There was statistically significant difference regarding patient satisfaction (p = 0.011) was observed between both groups,SVF may offer a more satisfactory treatment experience but there was no significant improvement in hair shaft diameter, T/V hair ratio, hair shaft density between both groups.

Table 3: Comparison between both groups regarding patient trichoscopic findings, satisfaction and improvement at 6 months (n=70)

Variable		Group A (n=35)	Group B (n=35)	P value
Percent change	**Hair shaft density (Hair/cm2)**	38,32%	42,959%	**>0,05 (0,6556)**
	Hair shaft diameter (micrometer)	187,9%	250%	**>0,05(0,8451)**
	T/V ratio	216,498%	206,97%	**>0,05(0,8845)**
Patient satisfaction	**Highly dissatisfied**	8(22.9%)	11 (31.4%)	<0.05
	Dissatisfied	14(40%)	12 (34.3%)	
	Satisfied	9 (25.6%)	7(20%)	
	Highly satisfied	4 (11.4%)	5 (14.3%)	
Improvement	**Stable(No**	8 (22.85%)	8 (22.85%)	>0.05

response)		
Slightly improved	14 (40%)	12 (34.32%)
Moderately improved	9 (25.71%)	10(28.57%)
Greatly improved	4 (11.42%)	5 (14.28%)

Data are presented as number (%). T/V: Terminal to vellus hair ratio,** p value (<0.05) was considered significant (b) using when you can apply the Monte Carlo test.

Table 4: At baseline regarding SVF group, There was statistically significant positive correlation was noted between hair shaft density and hair shaft diameter ($\rho=0.365$,$p=0.031$). A moderate positive correlation was found between hair shaft density and the (T/V ratio)($\rho=0.536$,$p=0.001$).However, no significant correlation was noted between hair diameter and the (T/V ratio) ($\rho=0.232$,$p=0.180$). Gender did not show statistically significant correlations with hair density ($\rho=0.115$,$p=0.510$), hair shaft diameter ($\rho=-0.043$,$p=0.806$), or (T/V ratio) ($\rho=-0.309$,$p=0.071$).At baseline regarding topical minoxidil ,a highly significant positive correlation was observed between hair density and hair shaft diameter ($\rho=0.563$,$p<0.001$). Between hair shaft density and the (T/V ratio) a significant positive correlation was detected ($\rho=0.355$,$p=0.037$). Insignificant correlation was observed between hair shaft diameter and the (T/V ratio) ($\rho=-0.021$,$p=0.906$).Gender did not show statistically significant correlations with hair density ($\rho=-0.059$,$p=0.738$), hair shaft diameter ($\rho=-0.045$,$p=0.797$), or (T/V ratio) ($\rho=-0.166$,$p=0.340$).

Table (4): Correlation between baseline hair shaft diameter, density , terminal to vellus ratio and gender in both groups.

Baseline		Hair shaft density (hair/cm2)	Hair shaft diameter(μm)	(T/V ratio)	Gender
			Group A		
Hair shaft density (hair/cm2)	r	1	**0.365**	**0.536**	0.115
	p	-	**0.031***	**0.001***	0.510
Hair shaft diameter(micrometer)	r	**0.365**	1	0.232	0.043
	p	**0.031***	-	0.180	0.806
(T/V)	r	**0.536**	0.232	1	0.309
	p	**0.001***	0.180	-	0.071
Gender	r	0.115	0.043	0.309	1
	p	0.510	0.806	0.071	-

		Group B			
Hair shaft density (hair/cm2)	r	1	**0.563**	**0.355**	-0.059
	p	-	**≤.001***	**0.037***	0.738
Hair shaft diameter(μm)	r	**0.563**	1	-0.021	0.045
	p	**≤.001***	-	0.906	0.797
(T/V ratio)	r	**0.355**	-0.021	1	-0.166
	p	**0.037***	0.906	-	0.340
Gender	r	-0.059	0.045	-0.166	1
	p	0.738	0.797	0.340	-

r: correlation coefficient, T/V: Terminal to vellus hair ratio, *: significant as P value < 0.05, **: highly significant as P value <0.001.

Table 5 Regarding SVF treatment at 6 months a significant positive correlation was observed (tau_b = 0.384, p = 0.023) between hair shaft density and hair shaft diameter,the (T/V ratio) demonstrates a moderate positive correlation with hair shaft density (tau_b = 0.416, p = 0.013) and hair shaft diameter (tau_b = 0.433, p = 0.009).For patient satisfaction a significant positive correlation was observed with hair density(tau_b = 0.454, p = 0.006) and hair shaft diameter (tau_b = 0.380, p = 0.024) .Perceived improvement shows significant positive correlation with hair density (tau_b = 0.356, p = 0.041)and a highly significant positive correlation with hair shaft diameter (tau_b = 0.629, p =< 0.001) ,highlighting that improved hair thickness and density are a key driver of patient-reported outcomes. Additionally, gender does not significantly influence any outcomes, suggesting SVF's effects are consistent across genders. Regarding topical minoxidil treatment at 6 months,hair shaft density demonstrates a moderate positive correlation (tau_b =0.447, p =0,007) with hair shaft diameter, and (T/V ratio) (tau_b =0.501, p =0,002),hair shaft diameter demonstrates a moderate positive correlation with (T/V ratio) (tau_b =0,433 p =0,009) also hair density shows a significant positive correlation with patient satisfaction (tau_b =0.551, p =0,001) and supposed improvement (tau_b =0.525, p =0,002).Gender does not significantly influence any outcomes, suggesting that topical minoxidil effects are consistent across genders.

Table (5): Correlation between hair shaft diameter, density, terminal to vellus ratio, satisfaction ,improvement and gender after 6 months in both groups.

After 6 m		Hair shaft density (hair/cm2)	Hair shaft diameter (micromete r)	(T/V ratio)T/V	Satisfaction	Improvement	Gender
		Group A					
Hair shaft density (hair/cm2)	r	1	**0.384**	**0.416**	**0.454**	**0.357**	0.096
	p	-	**0.023***	**0.013***	**0.006***	**0.041***	0.582
Hair shaft diameter (micrometer)	r	**0.384**	1	**0.433**	**0.380**	0.629	-0.257
	p	**0.023***	-	**0.009***	**0.024***	**≤0.001***	0.137
(T/V)	r	**0.416**	**0.433**	1	0.263	0.063	0.148
	p	**0.013***	**0.009***	-	0.126	0.728	0.396
Satisfaction	r	**0.454**	**0.380**	0.263	1	**0.666**	0.069
	p	**0.006***	**0.024***	0.126	-	**≤0.001***	0.693
Improvement	r	**0.357**	**0.629**	0.063	0.666	1	-0.159
	p	**0.041***	**≤0.001***	0.728	**≤0.001***	-	0.377
Gender	r	0.096	-0.257	0.148	0.069	-0.159	1
	p	0.582	0.137	0.396	0.693	0.377	-
		Group B					
Hair density (hair/cm2)	r	1	0.447	0.501	0.551	0.525	-0.046
	p	-	**0.007***	**0.002***	**0.001***	**0.002***	0.793
Hair diameter	r	**0.447**	1	**0.467**	0.276	0.301	0.149
	p	**0.007***	-	**0.005***	0.109	0.094	0.392
(T/V ratio)	r	**0.501**	**0.467**	1	0.009	**0.560**	0.033
	p	**0.002***	**0.005***	-	0.957	**0.001***	0.849

Satisfaction	r	**0.551**	0.276	0.009	1	0.333	-0.033
	p	**0.001***	0.109	0.957	-	0.063	0.851
Improvement	r	**0.525**	0.301	**0.560**	0.333	1	-0.049
	p	**0.002***	0.094	**0.001***	0.063	-	0.792
Gender	r	-0.046	0.149	0.033	-0.033	-0.049	1
	p	0.793	0.392	0.849	0.851	0.792	-

r: correlation coefficient, T/V: Terminal to vellus hair ratio, *: significant as P value < 0.05, **: highly significant as P value <0.001.

Case presentation:

Male patient 24 years old complaining of hair loss 4years duration before. **Figure 2**
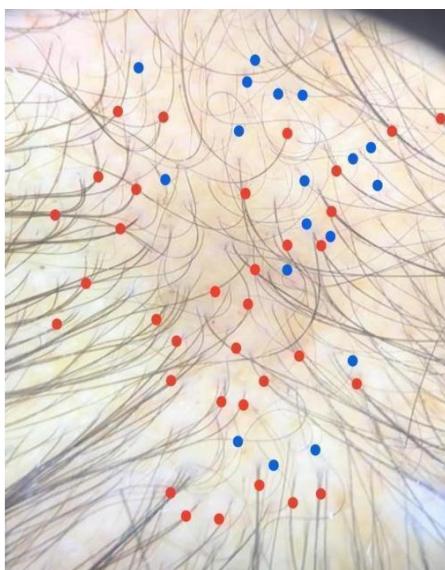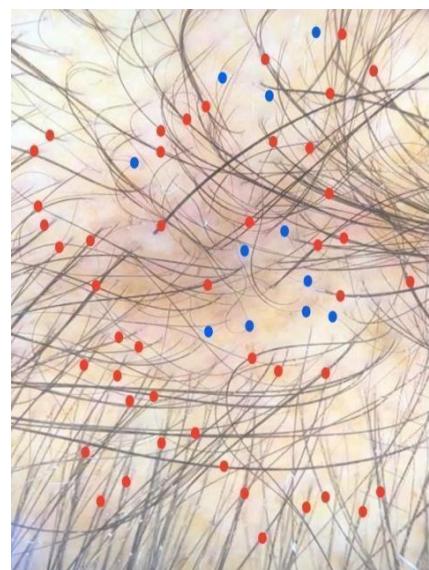
Figure 2: (A) treated with single dose SVF showing improvement (B) after 6 m duration, and trichoscopic examination before (C) Showing improvement in hair shaft thickness and density and T/V ratio after (D) 6 months after single injection of SVF; red dots: Terminal hair, and blue dots: vellus hair

Female case 23years old complaining of hair loss 2 years duration before. **Figure 3**
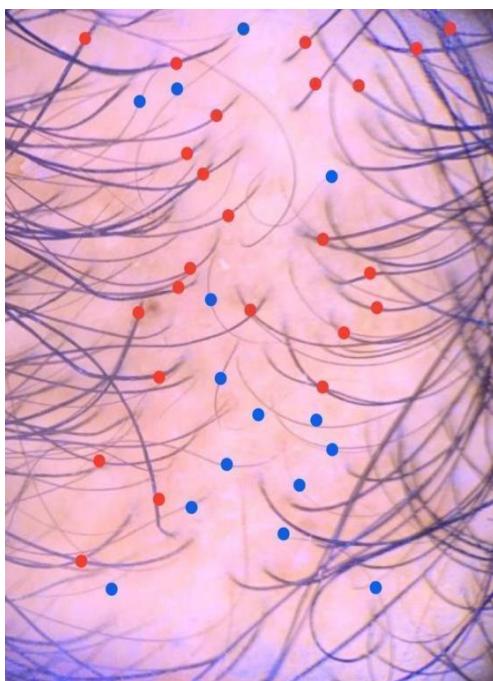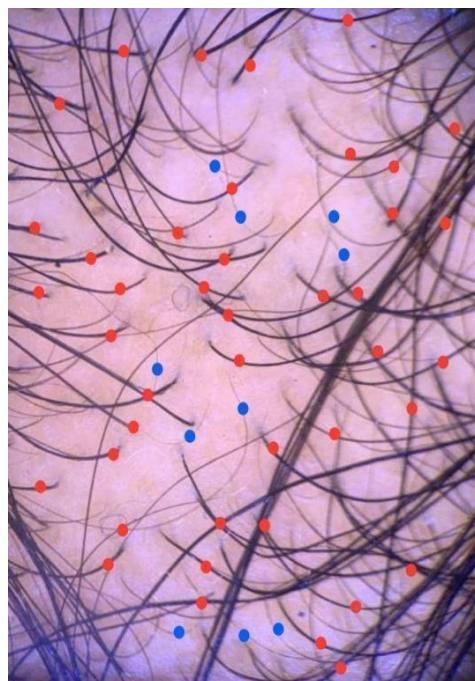
Figure 3: (A) treated with single dose SVF showing improvement (B) after 6 m duration, and trichoscopic examination before (C) Showing improvement in hair shaft diameter and density T/V ratio after (D)6 months after single injection of SVF; red dots: Terminal hair, and blue dots: vellus hair

Male case 27years old complaining of hair loss 4 years duration before. **Figure 4**
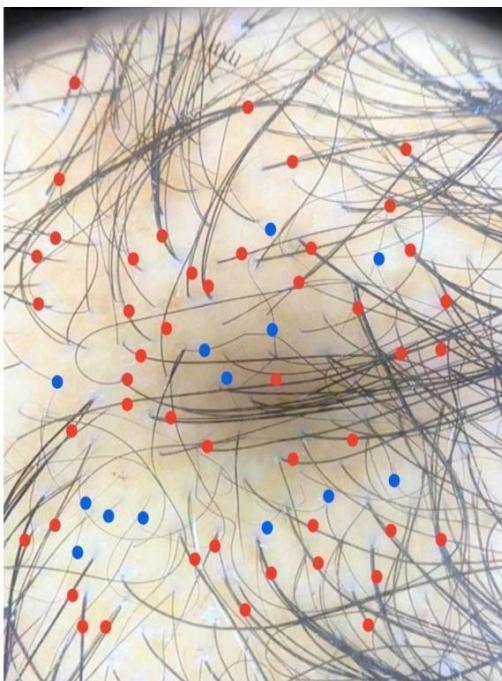
Figure 4: (A) topical minoxidil for 6 months showing improvement (B) after 6 m duration, and trichoscopic examination before (C) Showing improvement in hair shaft thickness and density terminal to vellus ratio(T/V) after (D) 6 MONTHS after topical minoxidil; red dots: Terminal hair, and blue dots: vellus hair

Female patient 27years old complaining of hair loss2 years duration before. **Figure 5**

A

B

C

D
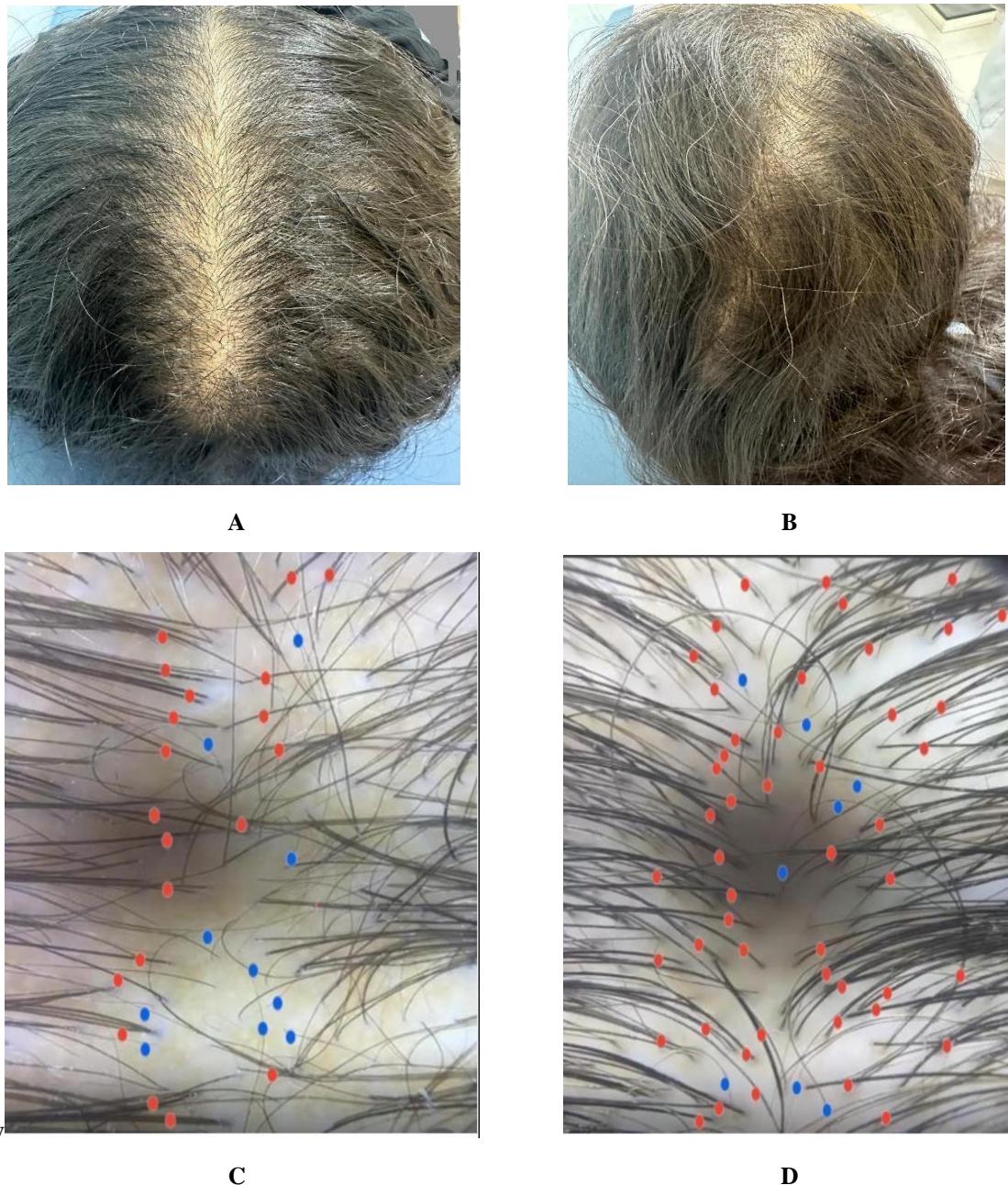
Figure 5: (A) topical minoxidil for 6 months showing improvement (B) after 6 m duration, and trichoscopic examination before (C) Showing improvement in hair shaft thickness and density T/V ratio after (D) 6 months after topical minoxidil; red dots: Terminal hair, and blue dots: vellus hair

7. DISCUSSION

Androgenetic Alopecia is the progressive hair loss most prevalent form in humans. The primary potential causes are regarded as hormonal factors and genetic predisposition. In recent years, there have been numerous advancements in molecular biology and genetics that have expanded our understanding of the processes of hair loss in AGA. The primary objective of AGA treatment is to stop the progression and prevent further thinning. Nevertheless, it may not always be possible to accomplish regrowth and development.[14].

Stromal vascular fraction contains a different regenerative cell, (RCs) such as mesenchymal stem cells (MSCs), that are pluripotent stem cells that are extremely proliferative and possess immunomodulatory and immunosuppressive properties. By homing to the hair follicles and exerting different paracrine effects, SVF can have a major influence on miniaturized hair follicles [15,16]. For adult Egyptian individuals ,**A.A. Abdullatif et al** [17] showed that Regarding the vertex, the hair thickness ranged from 0.041 to 0.109 with mean 0.071, and the hair density ranged from 69 to 164 with mean 109.50 .Regarding the temporal, the hair thickness ranged from 0.048 to 0.11 with mean 0.076, and the hair density ranged from 62 to 161 with mean 108.54.

In the current study, it was found that there was a significant improvement in all measured parameters in patients injected by SVF over six months. Hair shaft diameter increased from 10-45 **µm** (median 26.5,IQR 19) to 20-100 **µm** (median 70,IQR 29.25) ($p < 0.001$, test value –4.109071). Hair shaft density improved from 82-120 hair/cm2 (median 98 ,IQR 15.5) to 96–183 hair /cm2 (median 140,IQR 33.8) ($p < 0.001$, test value –4.107717). The (T/V ratio)elevated from 0.5-5.4 (median 1.1,IQR 2) to 0.6-14 (median 3,IQR 4.45), indicating significant growth in terminal hairs ($p < 0.001$, test value – 3.409146).Gender did not show statistically significant correlations with hair density ($\rho=0.166,p=0.462$), hair shaft diameter ($\rho=-0.291,p=0.201$), or (T/V ratio) ($\rho=-0.062,p=0.840$). gender did not significantly influence these hair parameters among participants using SVF.

A study by **Perez-Meza et al.** [18] showed cases who received fat injections in conjunction with SVF exhibited a mean elevation of 31 hairs/cm2, whereas the single participant who received fat injections alone experienced a mean increase of 14 hairs/cm2. They determined that although fat alone may be an effective treatment for AGA, the addition of SVF may enhance the effectiveness of the therapy .

Despite the fact that numerous studies have shown the single treatment session with SVF effectiveness in enhancing AGA, it is conceivable that SVF may have a significant impact in comparison to the baseline if a single session is effecient.[18,19].

The recommended first-line pharmacologic treatment for both male and female patients with AGA is topical minoxidil, which has been proven to be effective through numerous randomized double-blind and case–control studies [20]. Although the precise mechanism of action is uncertain, it is hypothesized that minoxidil stimulates hair growth through numerous pathways[21]. Initially, it exerts a vasodilatory action by increasing the flow of cutaneous blood and supplying the hair follicle with additional growth factors and oxygen. This is achieved by upregulating vascular endothelial growth factor (VEGF). [22].

In the current study, it was found also that there was a significant improvement in all measured parameters in patients using topical minoxidil over 6 months .Hair shaft diameter increased from 10-50 **µm** (median 20, IQR 21) to 45-102 **µm** (median 76.5 , IQR 28.25), with a p–value < 0.001 with test statistic of –4.11287. Hair shaft density improved from 80–125 hairs/cm² (median 96, IQR 14.5) to 90–178 hairs/cm² (median 134.5, IQR 35.5), also significant at $p < 0.001$ with test statistic of – 4.108529. The (T/V) hair ratio highet from 0.4-5.1 (median 0.7, IQR 1.8) to 0.5-14.3 (median 2.9, IQR 4.75), with a highly significant p–value < 0.001 with test statistic of –3.29739.indicating a substantial increase in terminal hairs. Additionally, These findings highlight the efficacy of the treatment in improving both objective hair parameters.Gender did not show statistically significant correlations with hair density ($\rho=0.058,p=0.799$), hair shaft diameter ($\rho=-0.016,p=0.945$), or (T/V ratio) ($\rho=-0.083,p=0.786$). This implies that, in this sample, gender did not significantly influence these hair parameters among participants using topical Minoxidil.

In the present study, it was found that regarding patient satisfaction and improvement at 6 months, For patient satisfaction, a statistically significant difference ($p = 0.011$) was observed, SVF led to better overall patient satisfaction.Conversely, for patient improvement, no statistically significant difference was noted between the two groups ($p = 0.440$). Both groups exhibited comparable distributions across improvement categories, with most patients reporting "Slight improvement" or "Moderate improvement."

El-Khalawany et al. [15]revealed that after six months of SVF injection,approximately three cases (10%) reported a minor improvement, five cases (16.7%) reported a moderate improvement, sixteen cases (53.3%) reported a significant improvement, and six cases (20%) reported a marked improvement.

We recommend providing multicenter cooperation with larger sample size to confirm our results, both SVF and topical minoxidil are promising in treatment of AGA, and additional research is recommended to generalize our findings.

Limitations: In order to adequately describe our findings, it is necessary to consider the small sample size, single-center study, and absence of research that compares topical minoxidil to SVF in the AGA treatment

8. .CONCLUSION

The study indicates that while both the SVF and Minoxidil treatments led to significant improvements in patient satisfaction over 6 months, there were insignificant differences between the two treatment groups regarding hair characteristics., Overall, both treatments appear to be beneficial, but individual responses may vary.

REFERENCES

[1] Ho CH, Sood T & Zito PM.Androgenetic Alopecia. StatPearls. Treasure Island (FL) companies. Disclosure: Tanuj Sood declares no relevant financial relationships with ineligible companies. Disclosure: Patrick Zito declares no relevant financial relationships with ineligible companies.: Copyright © 2024, StatPearls Publishing LLC.

[2] Festa E, Fretz J, Berry R, Schmidt B, Rodeheffer M, Horowitz M, et al. Adipocyte lineage cells contribute to the skin stem cell niche to drive hair cycling. Cell. 2011;146:761-71.

[3] Banyard DA, Sarantopoulos CN, Borovikova AA, Qiu X, Wirth GA, Paydar KZ, et al. Phenotypic Analysis of Stromal Vascular Fraction after Mechanical Shear Reveals Stress-Induced Progenitor Populations. Plast Reconstr Surg. 2016;138:237e-47e.

[4] Oberbauer E, Steffenhagen C, Wurzer C, Gabriel C, Redl H, Wolbank S. Enzymatic and non-enzymatic isolation systems for adipose tissue-derived cells: current state of the art. Cell Regen. 2015;4:7.

[5] van Dongen JA, Stevens HP, Harmsen MC, van der Lei B. Mechanical Micronization of Lipoaspirates: Squeeze and Emulsification Techniques. Plast Reconstr Surg. 2017;139:1369e-70e.

[6] Deepak SH, Shwetha S. Scalp roller therapy in resistant alopecia areata. J Cutan Aesthet Surg. 2014;7:61-2.

[7] Mori O, Uno H. The effect of topical minoxidil on hair follicular cycles of rats. J Dermatol. 1990;17:276-81.

[8] Jimenez-Cauhe J, Vaño-Galvan S, Mehta N, Hermosa-Gelbard A, Ortega-Quijano D, Buendia-Castaño D, et al.(2024).Hair follicle sulfotransferase activity and effectiveness of oral minoxidil in androgenetic alopecia. Journal of Cosmetic Dermatology.

[9] Coleman SR. Structural fat grafting: more than a permanent filler. Plast Reconstr Surg. 2006;118:108s-20s.

[10] Klein JA. Tumescent technique for local anesthesia. West J Med. 1996;164:517.

[11] Lee EH, Kang JS, Kang DS, Han CS, Oh SH, Cho SB. Facilitated scalp measuring using phototrichogram with a headband and tapeline. Dermatol Surg. 2011;37:1150-2.

[12] Elnokrashy IM, Attia S, El-khalawany M. Efficacy of Nano fat versus Non-Enzymatic Stromal Vascular Fraction in the Treatment of Androgenetic Alopecia. Al-Azhar International Medical Journal. 2022;3:152-8.

[13] Muralidharan K. On sample size determination. Mathematical Journal of Interdisciplinary Sciences. 2014;3:55-64.

[14] Behrangi E, Rahimi ST, Zare S, Goodarzi A, Ghassemi M, Khodadad F, et al. Evaluation of the effects of adding an adipose tissue-derived stromal vascular fraction to platelet-rich plasma injection in the treatment of androgenetic alopecia: A randomized clinical trial. Skin Res Technol. 2024;30:e13700.

[15] El-Khalawany M, Rageh MA, Elnokrashy I, Ibrahim SMA. Efficacy of autologous stromal vascular fraction injection in the treatment of androgenic alopecia. Arch Dermatol Res. 2023;315:1269-76.

[16] Kowe PA, Madke B, Bansod SH. Oral minoxidil in trichology: a review. Indian Journal of Drugs in Dermatology. 2022;8:1-6.

[17] A.A. Abdullatif et al. Evaluation of Hair Density and Hair Diameter in the Adult Egyptian Population using Quantitative Trichoscopic Analysis/ Al-Azhar International Medical Journal 4 (2023) 353e357.

[18] Perez-Meza D, Ziering C, Sforza M, Krishnan G, Ball E, Daniels E. Hair follicle growth by stromal vascular fraction-enhanced adipose transplantation in baldness. Stem Cells Cloning. 2017;10:1-10.

[19] Kim M, Lee Y, Lee J, Kim JH, Kim DH, Do YH, et al. Innovative Method of Alopecia Treatment by Using Adipose-derived Stromal Vascular Fraction (SVF) Cells. 2021.

[20] van Zuuren EJ, Fedorowicz Z, Schoones J. Interventions for female pattern hair loss. Cochrane Database Syst Rev. 2016;2016:Cd007628.

[21] Gupta AK, Talukder M, Williams G. Comparison of oral minoxidil, finasteride, and dutasteride for treating androgenetic alopecia. J Dermatolog Treat. 2022;33:2946-62.

[22] Gressenberger P, Pregartner G, Gary T, Wolf P, Kopera D. Platelet-rich Plasma for Androgenetic Alopecia Treatment: A Randomized Placebo-controlled Pilot Study. Acta Derm Venereol. 2020;100:adv00247.