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Morphometric and Aesthetic Analysis of People Following Application of Platelet Rich Plasma for Neck Rejuvenation

Análisis Morfométrico y Estético de Personas tras la Aplicación de Plasma Rico en Plaquetas para el Rejuvenecimiento del Cuello

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SUMMARY: Several studies have shown beneficial effects of platelet-rich plasma. However, there are very few studies investigating the effectiveness of PRP in the neck region. We aimed to assess the efficacy of PRP injection for neck rejuvenation in females aged 40-55. Fifty-two female consecutive participants had PRP injected and roller applied in three sessions at 3-week intervals. Evaluations were blindly performed by comparing the improvements from the pre- to post-application assessments of anatomical measurements of the neck area based on before and after photography of the participants by two anatomists and three medical aesthetic doctors. The Fitzpatrick Skin Scale, Fitzpatrick Goldman Scale, Wrinkle Assessment Scale (Dedo classification system) and patient satisfaction scale were used for assessment. Additionally, skin stiffness and elasticity, cervicomental angle and jawline angle measurements were performed to analyze anatomical changes in the neck area. The study enrolled 52 volunteers with a mean age of 48.60±5.35 years, mean body weight of 63.21±8.43 kg and mean height of 163.25±4.56 cm. Significant differences were found in the elasticity, jawline angle, cervicomental angle, wrinkling, elasticity G and patient satisfaction scores before and after the treatment. When the results of anatomical parameters and scales are compared, it was revealed that PRP is effective in neck rejuvenation.

KEY WORDS: Anatomy; Elasticity; Rejuvenation; Neck; Platelet-rich plasma; Wrinkling.

INTRODUCTION

In developed countries, interest in cutaneous aging is largely the result of a progressive, dramatic rise over the past century in the absolute number and the proportion of the population who is elderly (Smith *et al*., 2001). Briefly, chronologically aged skin appears dry and pale with fine wrinkles, displaying a certain degree of laxity and a variety of benign neoplasms (Yaar *et al*., 2002). Skin aging is a complex process determined by the genetic endowment of the individual as well as by environmental factors (Saco-Mera & Hernández-Patiño, 2019). Simple wrinkle severity evaluation systems have been produced that rely on comparisons of photographs. Although somewhat subjective, these methods are popular among clinicians (Shoshani *et al*., 2008). However, we think that evaluations will be healthier with anatomical factors and morphometric measurements in addition to the photographic method. Therefore, in our study, we evaluated the efficacy of treatment using skin elasticity and morphometric angle measurements.

Platelet-rich plasma (PRP) is an autologous concentration of human platelets in a small volume of plasma. It contains growth factors, especially epidermal growth factor, platelet-derived growth factor, transforming growth factor beta (TGF-b), and vascular endothelial growth factor (El-Taieb *et al*., 2019). In the literature, it has been reported that PRP improves skin homogeneity, texture, barrier function, hydration, elasticity and tone (Redaelli *et al*., 2010; Dhillon *et al*., 2012). There are publications examining the use of PRP in wound treatment, maxillofacial surgery, soft tissue injuries, periodontal and oral surgery, orthopedic and trauma surgery, gastrointestinal surgery, burns, cosmetic and plastic surgery. PRP has specifically attracted the attention of dermatologists in the aesthetic field for skin rejuvenation

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(Banihashemi & Nakhaeizadeh, 2014; Elnehrawy *et al*., 2017). Folds are the result of overlapping skin caused by genetic laxity, intrinsic aging, loss of tone, bony atrophy, gravity, and consequent sagging. They occur as upper and lower lid folds in blepharoptosis, as nasolabial folds in midface sagging, and as horizontal neck folds in lax skin (Lemperle *et al*., 2001). Currently available options to improve the appearance of the neck include injectable dermal fillers, neurotoxins, chemical peels, photodynamic therapy, intense pulsed light, and a variety of laser treatments, including the 595-nm pulse dye laser, thulium laser, alexandrite laser, microfocused ultrasound with visualization (MFU-V), radiofrequency, nonablative fractionated lasers, and ablative fractionated lasers alone or in combination (Boen *et al*., 2020). There are very few studies in the literature on the effectiveness of PRP application alone in neck rejuvenation. One study introduced "subincions" as a technique to stimulate collagen production in depressed scars and skin wrinkles in 1995 (Orentreich & Orentreich, 1995). Therefore, we believe that PRP application in the neck region will be effective with subincion and dermaroller procedures. The aim of this study was to improve the effects of aging in the neck area with PRP application in women aged 40-55 years. Additionally, in the 2011 American Academy of Orthopedic Surgery PRP session, it was concluded that "PRP is a treatment option, but it is still unproven." In this context, we think that our study will contribute to the literature on neck region rejuvenation with PRP application. When the existing studies are examined, the effectiveness of PRP in skin rejuvenation remains uncertain due to the low level of evidence. Double-blind, randomized, placebo-controlled studies with large numbers of participants are limited. For this reason, we believe that we will contribute to increasing the level of evidence regarding the effects of PRP on rejuvenation by increasing the number of participants from the range of 23-40 participants in the literature to 52 participants in this study. There are very few studies in the literature on the efficacy of PRP application in the neck region. In this respect, we plan to contribute to the literature.

MATERIAL AND METHOD

Participants. There were 55 women volunteers in the study. Three volunteers did not continue after the first session, and our study was completed with 52 volunteers aged 40-55.

Exclusion criteria

1) Volunteers who underwent surgery, rejuvenation therapy (Botox, dermal filler, laser therapy, etc.) in the neck area.
2) Volunteers with critical thrombocytopenia (platelet count lower than 105/μl), platelet dysfunction syndrome, cancer, ongoing anticoagulant therapy, chronic or acute infections, chronic liver failure and septicemia.
3) Body mass index (BMI) variation was greater than ± 1 during the study period.

Demographic data of the volunteers, such as age, height, body weight, occupation, blood type, smoking status and sports participation, were recorded. Based on the literature, evaluation parameters such as the Fitzpatrick skin scale, wrinkle assessment scale and patient satisfaction score scalewere completed by the participants. Additionally, anatomical parameters (skin stiffness and elasticity, cervical angle, and jawline angle measurements) were evaluated. The first evaluation was made before the patient started the procedures. The second evaluation was performed 3 weeks after the first PRP application. The third evaluation was performed 3 weeks after the second PRP application. The fourth evaluation was performed 3 weeks after the third PRP application. The experimental procedures were conducted in accordance with the Declaration of Helsinki. The relevant guidelines and regulations were strictly followed when conducting the study. The study protocol was approved by the ethics committee of Cukurova University (116/31). Each participant signed an informed consent form prior to participation. The research study was explained to each participant prior to data collection, and each participant gave informed consent.

PRP Preparation Procedure. PRP (Vacusera PRP Kit with Gel) application was applied three times at three-week intervals. PRP with gel kits, which contain a cell-separating gel, are based on the principle of allowing the easy collection of the PRP layer formed on the gel after centrifugation and several inversions. The obtained PRP is pure and dense since the undesirable blood components remain under the cell-separating gel after centrifugation. The transfer device and Luer-lock injector system included in the kit made PRP collection very easy and safe. For this experimental protocol, first, 20 mL of the patient's blood was drawn from the superficial saphenous vein. Next, the blood sample was centrifuged at 4000 rpm for ten minutes to separate the blood into layers of red blood cells, a buffy coat of leukocytes, and plasma. Finally, the PRP was collected with a transfer holder. All cell collection was performed under hygienic conditions without opening the tube. The patient was brought to the operating room and anesthetized by analgesic cream in 15 minutes. Then, the face and neck of the patient were sterilized. Then, we injected the PRP into the jawline line and neck region. First, the buffy coat part was injected under the skin with a 30 G, 13 ml needle, and then the application was continued along the jawline and over the neck area by using rollers.

Photography Design. All profile photographs were acquired using a digital SLR camera with fixed shooting values (Canon EOS 80D; ISO 100 f/4.5). Natural head positioning (approximating the Frankfort horizontal plane) was created by asking subjects to look straight ahead to a point at eye level on the wall. The photographic setup consisted of a tripod. The tripod height was adapted to each subject's body height. In a standing position, each subject was asked to relax and was positioned relative to a Frankfort plane. The Frankfort horizontal plane was chosen to determine the angles related to the face. This plane is described as the reference plane and defined by the lowest point of the orbita and the superior point of the external auditory meatus (Hegde, 2005). Acquired images were then transferred to a computer. The measurement scale was divided into degrees, digital measurements were made on a computer screen, and estimates were expressed as degrees. Measurements were made using ImageJ 1.52a with 1/100 mm sensitivity. By using the measurement feature of the software (ImageJ 1.52a with 1/100 mm sensitivity), first, the distal point of the angle is chosen, and a line is drawn to the mid position of the angle measurement based on where the mouse button was positioned. The second line was drawn by moving the mouse to the third point, and the angle measurement results were recorded. A comparison was made by taking measurements before and after the PRP application. All measurements were made three times by the same person.

Procedures for Assessment Scale Evaluations. Scale evaluations were determined by the common evaluations of two anatomists (MGB) and AGK) and three medical aesthetic doctors (DSE, GTG, and MCE). The Fitzpatrick skin scale has been most commonly used to analyze sun sensitivity in population-based and case-control studies related to the causes of skin cancer, exposure to UV radiation, tanning, and protective behaviors. This measure was obtained with a single questionnaire item requiring subjects to categorize their skin as Fitzpatrick types I through VI on the basis of color and tanning propensities. Protection from the sun offers significant prevention of photoaging in skin types IV-V. Skin types I-III are at increased risk of sun damage, photoaging, and melanoma and nonmelanoma skin cancers (Fors *et al*., 2020).

Fitzpatrick skin types:

Type I: hair color is red or blond; Eye color is blue, gray or green; skin color is very pale white or pale white with freckles.
Type II: hair color is blond, red or light brown; Eye color is blue, gray or green hazel; skin color is pale white.
Type III: hair color is chestnut or dark blond; eye color is brown, blue, gray, green or hazel; skin color is white or light brown.
Type IV: hair color is brown, medium brown or dark brown; eye color is hazel or brown; skin color is medium brown or dark brown.
Type V: hair color is dark brown; eye color is brown; skin color is dark brown.
Type VI: hair color is black; eye color is brown; skin color is black.
Fitzpatrick-Goldman Scale (Wrinkling and Elasticity G Assessments).

Neck wrinkling was assessed by a blinded evaluator at baseline and at each visit with the Fitzpatrick-Goldman wrinkle scale. The assessments were performed in person and used previous photographs for comparison. Wrinkling and degree of elasticity scores are as follows.

Fine wrinkles and mild (fine textural changes with subtly accentuated skin lines); evaluated as mild with scores of 1-3.

Fine to moderate-depth wrinkles and a moderate number of lines (distinct popular elastosis individual papules with yellow translucency under direct lighting and dyschromia); evaluated as moderate with scores of 4-6.

Fine to deep wrinkles, numerous lines, with or without redundant skin folds (multipapular and confluent elastosis (thickened yellow and pallid) approaching or consistent with cutis rhomboidalis); evaluated as severe with scores of 7-9 (Boen *et al*., 2020).

Horizontal neck folds (HF) (Dedo classification system):This wrinkle assessment scale should be an excellent tool in the hands of every aesthetic surgeon or dermatologist to objectively assess the short-term and long-term effects of an injected product and to establish a real price/value relationship for patients. Horizontal neck folds are classified into 6 categories as follows (Dedo, 1980):

0: no wrinkles.
1: Just perceptible wrinkles.
2: Shallow wrinkles.
3: Moderately deep wrinkles.
4: Deep wrinkles well-defined edges.
5: Very deep wrinkles redundant fold.

We grouped the horizontal fold evaluations in our study as follows:

HF1: Before starting PRP application.
HF2: After the first session of PRP application.
HF3: After the second session of PRP application.
HF4: After the third session of PRP application.

Patient Satisfaction Scores: Before each PRP application, the volunteers were asked about their satisfaction. Ratings were scored on a scale from 1-10 points (1; not at all satisfied, 10; very satisfied).

Assessment of anatomical parameters. Understanding the superficial anatomy of the neck is critical not only to selecting and planning the appropriate procedure but also to documenting physical findings.

Skin Stiffness and Elasticity: After collecting anthropometric measures, the measurements of skin stiffness and elasticity were made using the MyotonPro® device (Myoton AS, Tallinn, Estonia). These tests were conducted in a sitting position on a chair with hands placed over knees. The subjects were asked to adopt a comfortable sitting position typical for everyday activities and to focus their eyes on the face-to-face screen for a few minutes. Initially, the sternocleidomastoid muscle was examined. The measurements were initially performed on the right side and then on the left side of the neck (Fig. 1). The point marked on the SCM (sternocleidomastoid) was examined at a point midway between insertion on the anterior surface of the manubrium sterni and the mastoid process of the temporal bone at a site where the two muscle heads connect. For each measurement, the probe of the device was placed perpendicular to the surface of skin with constant preload. Measurements of mechanical muscle parameters were performed once by the same assessor (Kocur *et al*., 2019).

Cervicomental angle (CA) measurement: One submental line and one line that was tangential to the neck at the subcervical region intersection were created. The innermost point between the submental area and the neck was measured (Tollefson & Sykes, 2007) (Fig. 1).

Jawline angle (JA) measurement: This was measured as the angle formed by the base of the mandible and the posterior margin of the ramus with a protractor, which was placed over the angle of the mandible in such a way that the base of the protractor coincided with the base of the mandible. The angle was recorded in degrees. The jawline angle is the angle between the helical point, mandibular angle and submental line (Moradi *et al*., 2019) (Fig. 1).

Statistical Analysis. SPSS 21.0 was used for statistical analysis of the measurement results. From these measurements, means, standard deviations (SD), minimum and maximum values were calculated; $p<0.001$, $p<0.01$ and $p<0.05$ were considered statistically significant. Skewness and kurtosis statistics were used to determine the normality of the data distribution. Values between +1.5 and -1.5 were considered to be in accordance with the normal distribution. Pearson analyses were used for correlation analyses with data showing a normal distribution, and Spearman analyses were used for data that did not fit anormal distribution. In addition, data with a normal distribution were evaluated by using ANOVA, and data not without a normal distribution were evaluated by using the Mann–Whitney Utest.

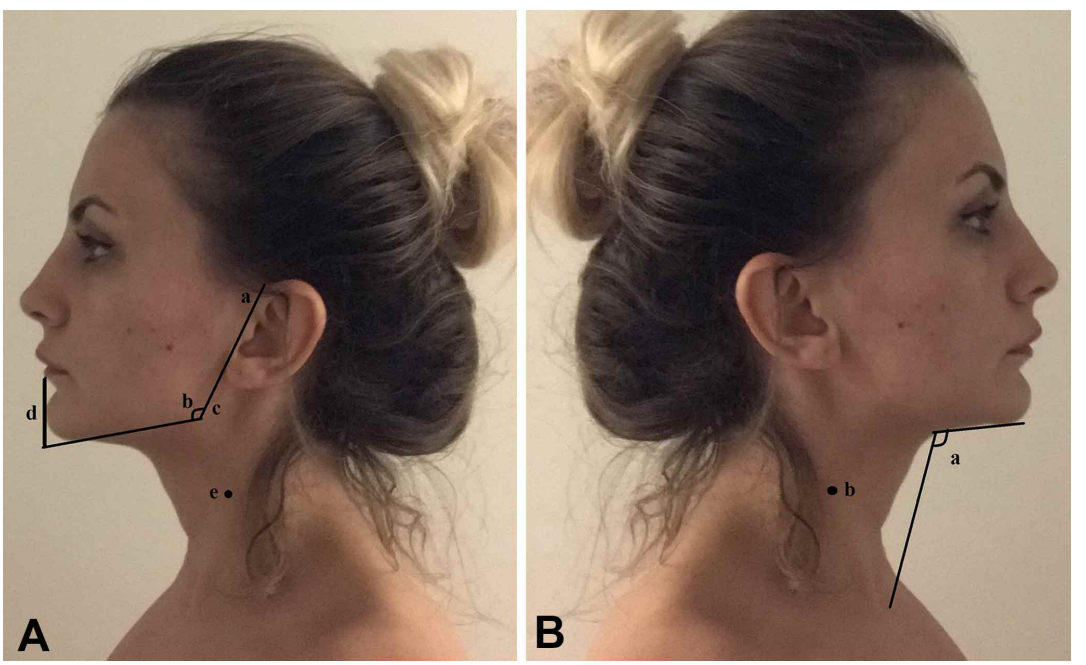

Fig 1. Definitions of landmarks in the figure A are a;hellical point, b;jawline angle, c;mandibular angle, d; vermilion border line, e;point on the scm muscle. Definitions of landmarks in the figure B are a;cervicomental angle, b;point on the scm muscle.

RESULTS

Fifty-two out of fifty-five participants completed the study. The mean age of the participants was 48.60±5.35 years, mean body weight was 63.21±8.43 kg, and mean height was 163.25±4.56 cm. The results were evaluated 6 weeks after the last session by comparing the improvement from the pre- to post-treatment anatomical measurements of the neck area by the satisfaction questionnaire and with impressions and double-blind evaluations of pre and post PRP application photographs by doctors (two anatomists and three medical aesthetic doctors). Significant differences were found between measures of elasticity, jawline angle (JA), cervicomental angle (CA), wrinkling, elasticity G and patient satisfaction scores (PSS) from before to after the treatment (Figs. 2 and 3). While increases were observed in elasticity, elasticity G and PSS measures after treatment, there were decreases in JA, CA and wrinkling values (Table I). Additionally, changes in the horizontal fold parameter across PRP sessions are given in Table II. In addition, comparisons of the correlations between angles (JAand CA), elasticity, wrinkling parameters and body weight, smoking status, sports participation, blood group, and FSS, HF1, HF2, HF3, and HF4 measures from the before, first, second and third sessions are also shown in Table III and Table IV. Additionally, volunteers' satisfaction scores increased after PRP treatment (Table I).

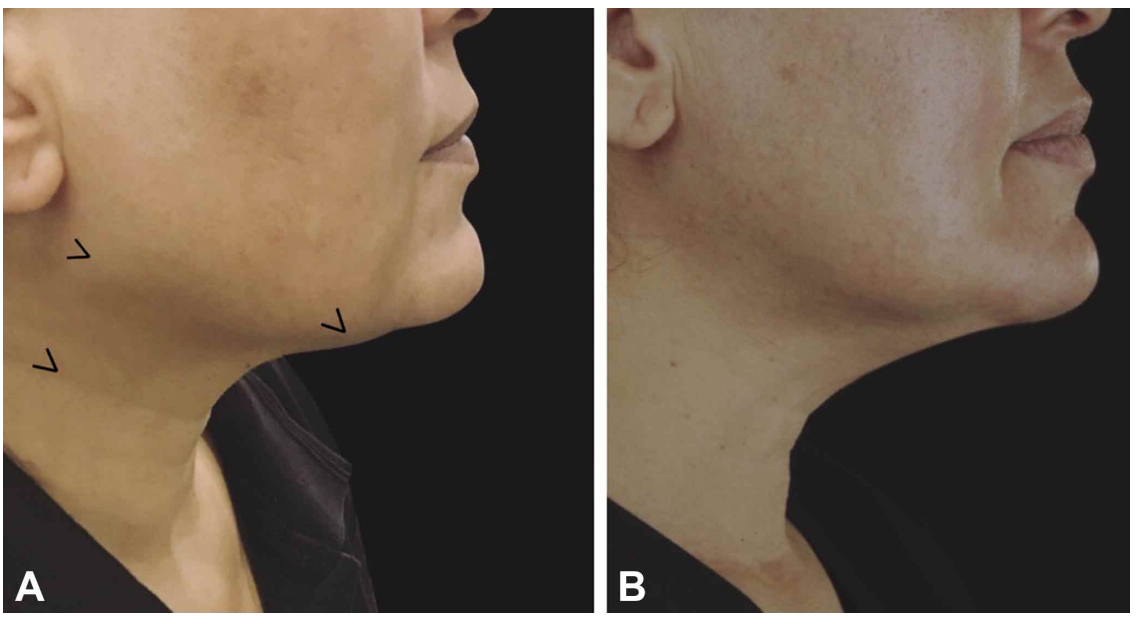

Fig 2. Change in 41-year-old volunteer before starting PRP application (A) after three sessions of PRP application (B).

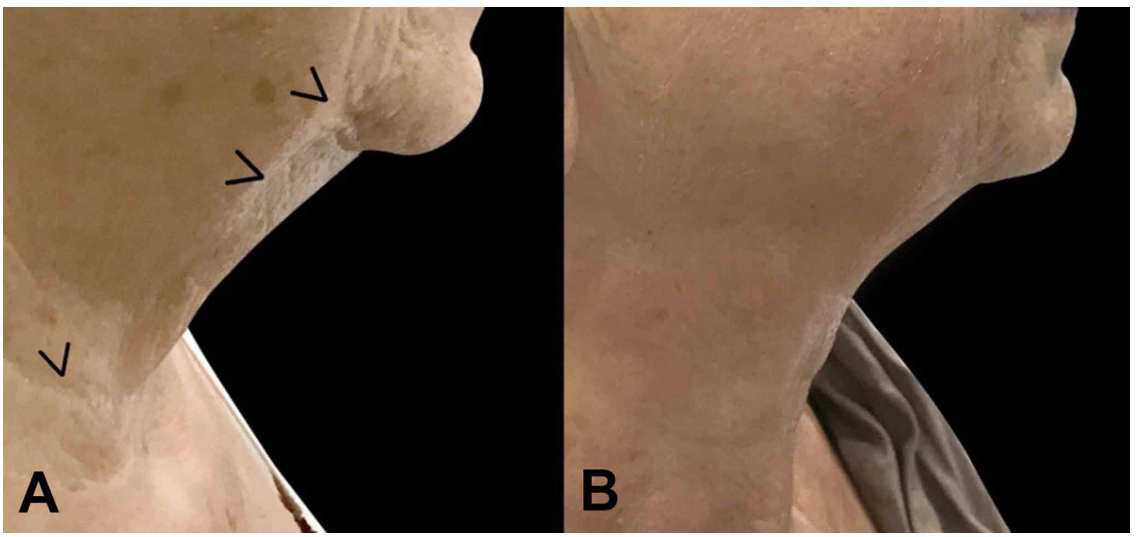

Fig 3. Change in 55-year-old volunteer before starting PRP application (A) after three sessions of PRP application (B).

Table I. Anatomic and Fitzpatric and Goldman scale parameters values of pre and post PRP application in three session.

Parameters	BA Mean±SD (Min-Max)	AFA Mean±SD (Min-Max)	ASA Mean±SD (Min-Max)	ATA Mean±SD (Min-Max)	P
Elasticity (R)	3.90±0.09 (2.00-6.00)	4.30±0.60 (3.00-5.00)	4.80±0.50 (4.00-6.00)	5.30±0.50 (5.00-6.00)	0.001
Elasticity (L)	3.90±1.00 (2.00-6.00)	4.40±0.70 (3.00-6.00)	4.90±0.40 (4.00-6.00)	5.23±0.46 (4.00-6.00)	0.002
JA (R)(º)	128.26±3.33 (116.6-135.88)	127.14±3.14 (115.05-134.71)	126.01±2.99 (113.05-131.30)	123.48±2.71 (112.36-128.56)	0.003
JA (L)(º)	128.02±3.17 (116.92-134.64)	126.66±2.88 (115.61-132.82)	125.47±2.93 (114.30-131.30)	123.38±2.62 (112.56-129.11)	0.013
CA (R) (º)	126.91±7.40 (97-139)	125.80±6.81 (97-138)	125.26±6.59 (96-135.81)	122.56±5.64 (96.30-129.85)	0.000
CA (L) (º)	126.87±6.85 (98.77-139)	125.66±6.45 (98-136.91)	124.86±6.22 (97-134)	122.56±5.55 (96.52-129.66)	0.005
Wrinkling	5.81±1.31 (3-9)	5.27±1.34 (2-8)	4.75±1.22 (2-8)	4.17±1.10 (2-7)	0.000
ElasticityG	2.41±1.43 (1-6)	3.94±1.30 (2-7)	4.90±1.27 (2-8)	6.00±1.36 (3-8)	0.000
PSS	3.38±1.65 (1-7))	5.62±1.01 (3-7)	6.94±0.64 (5-8)	7.46±1.06 (1-8)	0.000

BA; Before Application, AFA; After First Application, ASA; After Second Application, ATA; After Third Application, JA; Jawline Angle, CA; Cervicomental Angle,ElasticityG and Wrinkling; Score of Fitzpatrick and Goldman Scale,PSS; Patient Satisfaction Score, SD; Standard Deviation, Min; Minimum, Max; Maximum, R; right, L;left. The p values are obtained with the Anova test. The significance level is 0.05.

Table II. Distribution of Fitzpatrick Skin Scale and horizontal fold (HF) type values.

Parameters	1 n (%)	2 n (%)	3 n (%)	4 n (%)	5 n (%)	6 n (%)
Fitzpatrick Skin Scale	3 (5.8)	7 (13.5)	14 (26.9)	18 (34.6)	10 (19.2)	0 (0)
HF 1	0 (0)	0 (0)	12 (23.1)	20 (38.5)	13 (25)	7 (13.5)
HF 2	0 (0)	3 (5.8)	13 (25)	25 (48.1)	9 (17.3)	2 (3.8)
HF 3	3 (5.8)	9 (17.3)	22 (42.3)	15 (28.8)	2 (3.8)	1 (1.9)
HF 4	3 (5.8)	11 (21.2)	27 (51.9)	10 (19.2)	1 (1.9)	0 (0)

n;The number of participants. For Fitzpatrick Skin Scale; 1;Type 1, 2;Type 2, 3;Type3, 4;Type4, 5;Type5, 6; Type6. For horizontal fold; 1;0, 2;1, 3;2, 4;3, 5;4, 6;5.

DISCUSSION

Evaluating skin quality is important, and the neck skin often shows similar signs of sun damage to those seen on the face; however, the neck skin is thinner and has fewer dermal appendages, making it less resilient to resurfacing efforts. Because there are numerous physical examination findings and specific chief complaints with respect to the aging neck, a discussion of indications for intervention should focus on the specific anatomical changes encountered in the aging neck (Pérez & Hohman, 2021). The growing demand to overcome skin aging has led to the development of a variety of skin rejuvenation technologies. Aesthetic facial rejuvenation, particularly nonoperative procedures, is in high demand. Platelet-rich plasma has been used for tissue regeneration, accelerating wound healing and various other fields of medicine in recent years (Banihashemi *et al*., 2021).

In recent years, a variety of rejuvenation techniques have become popular in medical aesthetic applications. A number of these neck biorevitalization and skin rejuvenation approaches have been described in the literature: mesotherapy; hyaluronic acid; carbon dioxide; deoxycholic acid injection; peptides; vitamin C; combined use of soft tissue filler, suspension threads and botulinum toxin; a new cohesive polydensified matrix hyaluronic acid filler; calcium hydroxylapatite fillers; absorbable barbed threads; a polycaprolactone-based collagen stimulator; a poly-L-lactic acid; a poly-glycolic acid; polynucleotides; glycosaminoglycans; elastin; extracellular vesicles as nanoscale membranous vesicles containing DNAs, RNAs, lipids and proteins; light emitting diode device; carbon dioxide laser; fractional laser; helium plasma; proprietary

Table III. Correlation analysis results of elasticity and wrinkling.

	Body Weight	Smoking r (p)	Sport r (p)	Blood groupr (p)	FSS r (p)	HF 1 r (p)	HF 2 r (p)	HF 3 r (p)	HF 4 r (p)
Elasticity1 (R)	-0.063	-0.179	-0.235	0.307	-0.141	0.131	0.132	0.173	0.170
	(0.658)	(0.205)	(0.093)	(0.027)	(0.319)	(0.355)	(0.352)	(0.221)	(0.230)
Elasticity1 (L)	0.050	-0.303	-0.249	0.235	0.077	0.218	0.211	0.183	0.133
	(0.723)	(0.029)	(0.075)	(0.093)	(0.586)	(0.120)	(0.134)	(0.195)	(0.349)
Elasticity2 (R)	-0.043	-0.019	-0.305	0.284	-0.092	0.221	0.134	0.224	0.132
	(0.762)	(0.896)	(0.028)	(0.042)	(0.516)	(0.115)	(0.342)	(0.111)	(0.352)
Elasticity2 (L)	0.021	-0.352	-0.075	0.212	-0.053	0.131	0.249	0.229	0.250
	(0.881)	(0.011)	(0.596)	(0.131)	(0.707)	(0.355)	(0.075)	(0.102)	(0.074)
Elasticity3 (R)	-0.112	-0.176	-0.136	0.242	-0.110	-0.21	-0.016	0.023	-0.007
	(0.431)	(0.212)	(0.337)	(0.084)	(0.437)	(0.881)	(0.908)	(0.869)	(0.961)
Elasticity3 (L)	0.036	-0.092	-0.246	0.133	-0.121	0.157	0.218	0.181	0.172
	(0.801)	(0.517)	(0.079)	(0.346)	(0.391)	(0.266)	(0.121)	(0.200)	(0.223)
Elasticity4 (R)	-0.104	-0.150	-0.066	0.371	0.049	0.133	0.127	0.222	0.121
	(0.465)	(0.288)	(0.643)	(0.007)	(0.729)	(0.348)	(0.369)	(0.114)	(0.391)
Elasticity4 (L)	-0.027	-0.287	-0.134	0.119	-0.028	-0.020	0.157	0.140	0.254
	(0.847)	(0.039)	(0.342)	(0.402)	(0.841)	(0.890)	(0.266)	(0.322)	(0.069)
ElasticityG1	0.170	0.133	-0.077	-0.058	-0.135	0.153	0.022	0.097	-0.142
	(0.229)	(0.347)	(0.587)	(0.681	(0.341)	(0.278)	(0.879)	(0.493)	(0.314)
ElasticityG2	0.083	0.249	-0.170	-0.105	-0.220	0.244	0.061	0.080	0.027
	(0.558)	(0.075)	(0.228)	(0.457)	(0.116)	(0.081)	(0.667	(0.571)	(0.849)
ElasticityG3	0.059	0.167	-0.056	-0.139	-0.076	0.117	-0.044	0.026	-0.057
	(0.680)	(0.235)	(0.696)	(0.326)	(0.590)	(0.407)	(0.756)	(0.857)	(0.689)
ElasticityG4	-0.002	0.198	-0.097	-0.074	-0.154	0.251	0.112	0.214	0.000
	(0.990)	(0.159)	(0.492)	(0.603)	(0.277)	(0.072)	(0.428)	(0.127)	(1.000)
Wrinkling1	0.025	-0.256	0.013	-0.236	0.024	-0.307	-0.152	-0.275	-0.077
	(0.860)	(0.067)	(0.926)	(0.092)	(0.866)	(0.027)	(0.283)	(0.048)	(0.588)
Wrinkling2	0.055	-0.217	-0.022	-0.111	-0.009	-0.224	-0.055	-0.128	-0.090
	(0.696)	(0.123)	(0.877)	0.435	(0.947)	(0.110)	(0.699)	(0.365)	(0.525)
Wrinkling3	-0.018	-0.230	0.070	-0.132	-0.011	-0.383	-0.241	-0.338	-0.018
	(0.901)	(0.101)	(0.619)	(0.350)	(0.940)	(0.005)	(0.085)	(0.014)	(0.899)
Wrinkling4	0.148	-0.194	0.029	-0.205	0.026	-0.230	-0.079	-0.181	-0.017
	(0.293)	(0.168)	(0.837)	(0.145)	(0.852)	(0.100)	(0.579)	(0.200)	(0.905)

FSS; Fitzpatrick Skin Scale, HF; Horizontal Fold. ElasticityG and Wrinkling; Score of Fitzpatrick and Goldman Scale. The p and r values are obtained with Pearson Correlation Analysis Test. The significance level is 0.05.

radiofrequency microfocused ultrasound with visualization (MFU-V, Ultherapy); focused and radial acoustic waves; phototherapy; facial muscle exercises; superficial muscular aponeurotic system and malar fat pad suspension technique; absorbable polydioxanone monofilament threadlift (Mint Lift) technique; autologous fat grafting; submentoplasty; sophisticated surgeries; biocompatible microneedles; and nanofat microneedling approaches (Nikolis *et al*., 2021; Lee *et al*., 2021; Moon *et al*., 2021; Righesso *et al*., 2021; Fiedler *et al*., 2021). There have also been very few studies examining the use of PRP in neck rejuvenation. In this study, we examined the effect of PRP on rejuvenation in the neck region. Fifty-two consecutive female participants had PRP injected and roller applied in three sessions separated by 3-week intervals. Evaluations were performed by anatomical measurements and by assessment scales with reference to before and after photographs.

The majority of the volunteers in our study were type 3 (26.9 %) and type 4 (34.6 %) based on the Fitzpatrick Skin Scale. There were no volunteers categorized as type 6. Based on the Dedo classification system and the horizontal neck fold classification, the "no wrinkles", “just perceptible wrinkles” and “shallow wrinkles” scores increased from 0 % to 5.8 %, from 0 % to 21.2 %, and from 23.1 % to 51.9 %, respectively (Table II). "Moderately deep wrinkle", "deep wrinkles, well-defined edges" and "very deep wrinkles, redundant fold" scores decreased from 38.5 % to 19.2 %, from 25 % to 1.9 %,and from 13.5 % to 0 %, respectively (Table II). According to the Dedo classification system, the changes in the horizontal fold classification were in favor of the volunteers.

Skin elasticity on the right side of the neck was 3.90±0.09 before the treatment and 5.30±0.50 after the

Table IV. Correlation analysis results of jawline angle and cervicomental angle.

	Body Weight	Smoking r (p)	Sport r (p)	Blood group r (p)	FSS r (p)	HF 1 r (p)	HF 2 r (p)	HF 3 r (p)	HF 4 r (p)
JA1 (R)	-0.130	0.003	**0.279**	0.092	0.021	-0.002	-0.018	0.141	0.123
	(0.359)	(0.983)	**(0.045)**	(0.518)	(0.884)	(0.988)	(0.897)	(0.318)	(0.383)
JA1 (L)	-0.096	0.037	0.246	0.036	-0.019	-0.009	-0.015	0.068	0.096
	(0.500)	(0.795)	(0.079)	(0.800)	(0.892)	(0.948)	(0.915)	(0.634)	(0.497)
JA2 (R)	-0.136	0.004	0.269	0.042	-0.020	-0.043	-0.050	0.086	0.072
	(0.335)	(0.975)	(0.054)	(0.767)	(0.888)	(0.760)	(0.725)	(0.544)	(0.613)
JA2 (L)	-0.072	0.070	**0.319**	0.088	0.037	-0.046	-0.051	0.073	0.094
	(0.614)	(0.624)	**(0.021)**	(0.536)	(0.795)	(0.747)	(0.719)	(0.608)	(0.507)
JA3 (R)	-0.113	0.118	0.249	0.082	-0.005	-0.085	-0.071	0.030	0.056
	(0.423)	(0.403)	(0.075)	(0.563)	(0.973)	(0.547)	(0.616)	(0.834)	(0.693)
JA3 (L)	-0.046	0.151	**0.298**	0.020	-0.007	-0.041	-0.053	0.052	0.123
	(0.745)	(0.285)	**(0.032)**	(0.887)	(0.960)	(0.772)	(0.707)	(0.717)	(0.386)
JA4 (R)	0.084	0.175	**0.290**	0.028	-0.017	-0.058	-0.030	0.103	0.139
	(0.554)	(0.214)	**(0.037)**	(0.841)	(0.903)	(0.682)	(0.831)	(0.469)	(0.326)
JA4 (L)	0.074	0.138	**0.294**	0.033	0.013	-0.043	0.000	0.122	0.157
	(0.601)	(0.329)	**(0.035)**	(0.814)	(0.929)	(0.762)	(0.999)	(0.387)	(0.267)
CA1(R)	-0.020	0.117	**0.294**	0.007	-0.091	0.118	0.118	0.185	0.240
	(0.890)	(0.409)	**(0.034)**	(0.962)	(0.523)	(0.404)	(0.404)	(0.189)	(0.087)
CA1(L)	-0.011	0.102	**0.311**	0.057	-0.100	0.169	0.144	0.202	0.311
	(0.940)	(0.471)	**(0.025)**	(0.686)	(0.480)	(0.231)	(0.309)	(0.152)	(0.025)
CA2(R)	0.051	0.073	**0.336**	0.021	-0.050	0.198	0.200	0.255	**0.368**
	(0.719)	(0.610)	**(0.015)**	(0.882)	(0.726)	(0.160)	(0.155)	(0.068)	**(0.007)**
CA2(L)	0.019	0.065	**0.323**	0.039	-0.043	0.240	0.218	**0.285**	**0.368**
	(0.891)	(0.647)	**(0.019)**	(0.785)	(0.762)	(0.086)	(0.121)	**(0.041)**	**(0.007)**
CA3(R)	0.082	0.102	**0.324**	0.067	-0.053	0.257	0.248	**0.289**	**0.373**
	(0.566)	(0.471)	**(0.019)**	(0.639)	(0.708)	(0.066)	(0.076)	**(0.037)**	**(0.006)**
CA3(L)	0.037	0.096	0.262	0.072	-0.069	**0.311**	0.264	**0.343**	**0.373**
	(0.795)	(0.498)	(0.061)	(0.612)	(0.627)	**(0.025)**	(0.059)	**0.013**	**(0.006)**
CA4(R)	0.077	0.036	0.225	0.200	-0.224	0.207	0.248	**0.328**	**0.383**
	(0.585)	(0.799)	(0.109)	(0.155)	(0.111)	(0.142)	(0.076)	**(0.018)**	**(0.005)**
CA4(L)	0.120	0.050	0.242	0.207	-0.221	0.221	0.263	**0.338**	**0.388**
	(0.397)	(0.726)	(0.084)	(0.141)	(0.115)	(0.115)	(0.060)	**0.014**	**(0.005)**

JA; Jawline Angle, CA; Cervicomental Angle, FSS; Fitzpatrick Skin Scale, HF; Horizontal Fold, R; Right, L; Left. The p and r values are obtained with Spearmen Correlation Analysis Test. The significance level is 0.05.

treatment, and a significant difference was obtained (p=0.001) (Table I). Similarly, skin elasticity on the left side of the neck was 3.90±1.00 before treatment and 5.23±0.46 after treatment, with a significant difference (p=0.002) (Table I). Based on the Fitzpatrick and Goldman Scale scores, the elasticity and wrinkling parameters were 2.41±1.43 and 5.81±1.31, respectively, before the treatment and 6.00±1.36 and 4.17±1.10 after the treatment (Table I). The increase in the right- and left-side elasticity parameters indicated that the neck skin tightened with PRP application. Likewise, the increase in elasticity parameters based on the Fitzpatrick and Goldman Scale scores was found to support the tightening of the neck skin. The numerical decrease in the wrinkling parameter before and after the PRP treatment also proved that the wrinkling decreased and the neck skin tightened.

Before PRP treatment, there were very weak negative correlations of the elasticity (R) with the body weight, smoking status, sports participation and FSS parameters, very weak positive correlations with the HF1, HF2, HF3, HF4 parameters and a weakly positive significant relationship with blood group. Before PRP treatment, there were weak positive correlations of the elasticity (L) with the blood group, FSS, HF1, HF2, HF3, and HF4 parameters, a moderate degree of correlation with body weight, a very weak negative correlation with sports participation, and a weakly negative significant relationship with smoking status. After the first PRP session, there was a weakly significant positive correlation of elasticity (R) with body weight, very weak positive relationships with HF1, HF2, HF3, and HF4 parameters, very weak negative relationships with body

weight, smoking status, and FSS parameters, and a weakly significant negative correlation with sports participation. Additionally, after the first PRP session, there were very weak positive correlations of the elasticity (L) with the body weight, blood group, HF1, HF2, HF3, and HF4 parameters, very weak negative correlations with the sports participation and FSS parameters and a weakly significant negative correlation with smoking status. After the second PRP session, there were very weak positive correlations of the blood group and HF3 parameters with elasticity (R), and therewere very weak negative correlations between smoking status, sports participation, FSS, HF1, HF2, and HF4 parameters and elasticity (R). After the second PRP session, there were very weak positive correlations between body weight, blood group, HF1, HF2, HF3, and HF4 parameters and elasticity (R) and very weak negative correlations between smoking status, sports participation, and FSS parameters and elasticity (R). Similarly, after the third session, there were very weak positive relationships between the FSS, HF1, HF2, HF3, and HF4 parameters and elasticity (R), very weak negative relationships between body weight, smoking status, and sports participation and elasticity (R), and a weakly significant positive correlation between blood group and elasticity (R). After the third session, there were very weak positive relationships between the blood group, HF2, HF3, and HF4 parameters and elasticity (L), very weak negative correlations between the sports participation, FSS, and HF1 parameters and elasticity (L), a weak negative relationship between body weight and elasticity (L) and a weakly significant negative correlation between smoking status and elasticity (L). When these results were evaluated, it was seen that the effect of PRP on flexibility was higher in those who engaged in sports activities and those who did not smoke. When elasticity was examined based on the Fitzpatrick and Goldman Scale, it was found that there were very weak positive correlations between the body weight, smoking status, HF1, HF2, and HF3 parameters, and a very weak negative correlation with the sports participation, blood group and HF4 parameters before the PRP treatment. After the first session, a very weak positive correlation was found between elasticity G and the body weight, smoking status, HF1, HF2, HF3, and HF4 parameters, and very weak negative correlations were found between elasticity G and the sports participation, blood group, and FSS parameters. In addition, after the second session, very weak positive correlations were found between elasticity G and the body weight, smoking status, and HF1, and HF3 parameters, while very weak negative correlations were found between elasticity G and the sports participation, blood group, FSS, HF2, and HF4 parameters. After the fourth PRP session, there were very weak negative correlations between elasticity G and the body weight, sports participation, blood group, and FSS parameters, while there were very weak correlations between the elasticity G and the smoking, HF1, HF2, HF3, and HF4 parameters. In addition, since PRP treatment was applied following centrifugation of the participant's own blood, we also included blood groups in the evaluation parameters. It was found that the participants with blood groups “A positive” and “0 positive” in the neck skin elasticity parameter were more positively affected, and there was more tightening of the neck skin.

When wrinkling was examined based on the Fitzpatrick and Goldman Scale score, before the PRP session, very weak positive relationships were found between wrinkling and the body weight, sports participation, and FSS parameters, very weak negative relationships between wrinkling and the smoking, blood group, HF2, and HF4 parameters, and weakly significant relationships between wrinkling and the HF1 and HF3 parameters. After the first PRP session, there was a very weak positive correlation between wrinkling and body weight, while very weak negative correlations were found between wrinkling and the smoking, sports participation, blood group, FSS, HF1, HF2, HF3, and HF4 parameters. Similarly, after the second PRP session, a very low positive correlation between wrinkling and sports participation, very low negative correlations between wrinkling and the body weight, smoking, blood group, FSS, HF2, and HF4 parameters, and weakly significant negative relationships between wrinkling and the HF1 and HF3 parameters were found. After the last PRP session, very weak positive correlations were found between wrinkling and the body weight, sports participation, and FSS parameters, and very weak negative relationships were found between wrinkling and the smoking, blood group, HF1, HF2, HF3, and HF4 parameters. When all these results were examined, it was found that the PRP treatment was more effective on the wrinkling parameter in the participants with a greater horizontal fold depth.

When looking at the jawline angle, it was 128.26±3.33 and 128.02±3.17 on the right and left sides of the neck, respectively, before the treatment, while it was 123.48±2.71 and 123.38±2.62, respectively, after the treatment (Table I). There was a significant decrease in the jawline angle on both the right ($p=0.003$) and left ($p=0.013$) sides of the neck from before to the end of the PRP treatment. Before the PRP session, there were very weak positive correlations between the jawline angle (R) and the smoking status, blood group, FSS, HF3, and HF4 parameters, a weakly significant positive correlation between the jawline angle (R) and sports participation, and very weak negative correlations between the jawline angle (R) and the body weight, HF1, and HF2 parameters; there were very weak positive correlations between the jawline angle (L) and the smoking status, sports participation, blood group, HF3, and HF4 parameters and very weak negative correlations

between the jawline angle (L) and the body weight, FSS, HF1, and HF2 parameters. After the first PRP session, there were very weak positive correlations between the jawline angle (R) and the smoking status, blood group, HF3, and HF4 parameters, a weakly significant positive correlation between the jawline angle (R) and sports participation, very weak negative correlations between the jawline angle (R) and the body weight, FSS, HF1, and HF2 parameters; there were very weak positive correlations between the jawline angle (L) and the smoking status, blood group, FSS, HF3, and HF4 parameters, a weakly significant positive correlation between the jawline angle (L) and sports participation, very weak negative correlations between the jawline angle (L) and the body weight, HF1, and HF2 parameters. Similarly, after the second session, there were very weak positive correlations between the jawline angle (R) and the smoking, sports participation, blood group, HF3, and HF4 parameters, very weak negative correlations between the jawline angle (R) and the body weight, FSS, HF1, and HF2 parameters, while there were very weak positive relationships between the jawline angle (L) and the smoking, blood group, HF3, and HF4 parameters, a weak significant positive relationship between the jawline angle (L) and sports participation, very weak negative relationships between the jawline angle (L) and the body weight, FSS, HF1, and HF2 parameters. After the last PRP session, there were very low positive correlations between the jawline angle (R) and the body weight, smoking status, blood group, HF3, and HF4 parameters and a very weak negative correlation between the jawline angle (R) and HF1 and HF2 parameters. On the other hand, there were very weak positive correlations between the jawline angle (L) and the body weight, smoking status, blood group, FSS, HF2, HF3, and HF4 parameters, while there was a very weak correlation between the jawline angle (R) and HF1 parameter. In addition, weak positive correlations were found between the jawline angle and sports performance on both the right and left sides. It was determined that the jawline angle parameter revealed more effective results from the PRP sessions in those who do engaged in sports activities.

In addition, the pre and post treatment values of the cervicomental angle were 126.91±7.40 and 122.56±5.64 (p=0.000) on the right side and 126.87±6.85 and 122.56±5.55 (0.005) on the left side, respectively. Regarding the cervicomental angle, a significant difference was obtained in the measurements before and after treatment on both sides. The decreases in jawline and cervicomental angles as a result of PRP treatment were indications of the sharpening of the angle lines and tightening of the neck skin. Before the PRP session, there were very weak positive correlations between the cervicomental angle and the smoking status, blood group, HF1, HF2, HF3, and HF4 parameters on both the right and left sides, while there were very weak negative correlations between the cervicomental angle and the body weight and FSS parameters. In addition, weakly significant positive correlations were found between the right- and left-side cervicomental angles and sports participation. After the first PRP session, there were very weak positive correlations between both right side and left side cervicomental angles and the body weight, smoking status, blood group, HF1, and HF2 parameters, while there was a very weak negative correlation between the cervicomental angle and FSS parameter. Similarly, it was found that there were weakly significant positive correlations between both the right and left cervicomental angles and the sports participation and HF4 parameters. In addition, after the second session, there were very weak positive correlations between the cervicomental angle and the body weight, smoking status, blood group, and HF2 parameters on the right and left sides, while there was a very weak negative correlation between the cervicomental angle parameter and the FSS parameter. In addition, it was found that there were weakly significant positive correlations between the cervicomental angles on both the right and left sides and the HF3 and HF4 parameters. After the last PRP session, there were very weak positive correlations between the cervicomental angle and the body weight, smoking status, sports participation, blood group, HF1, and HF2 parameters on both the right and left sides, while there was a very weak negative relationship between the cervicomental angle and the FSS parameter. At the same time, there were weakly significant positive correlations between both right side and left side cervicomental angles and the HF3 and HF4 parameters. When all correlation analyses were examined, with regard to the cervicomental angle, PRP treatment was more effective in those who had a deep horizontal fold in the neck region and those who performed sports. On the other hand, in addition to the parameters evaluated in our study, one of the important factors that will alter neck anatomy is digitalization across all aspects of life. This digital revolution is one of the biggest challenges for global and national education, social life and work systems. Especially in online education, working processes and daily routines, the exposure time to technological tools has increased due to the pandemic. Thus, the neck flexor muscles are overworked, and the neck fold tends to deepen and become permanent based on the position of the head. Therefore, we think that PRP application will make a significant contribution to both the prevention and treatment of neck folds.

Additionally, the satisfaction results of the volunteers also supported the positive effects of PRP on anatomical parameters. In addition to numerical objective measurements, we looked at patient satisfaction, and this measure of satisfaction of the volunteers about their necks increased from 3.38±1.65 to 7.46±1.06.

CONCLUSION

This is, to our knowledge, the first clinical study to date to evaluate the efficacy of PRP with a focus on the neck region with anatomical parameters, and this study included a higher number of participants than previous papers in the literature. When the results of anatomical parameters and scales are compared, it was revealed that PRP was effective in neck rejuvenation. We suggest that PRP, which is a less expensive treatment than other methods in the literature, should be used for neck rejuvenation. It remains to be seen how long the benefit of such treatment may last and to what extent repeated sessions of PRP administration can maximize the extent and/or persistence of the effect.

Ethics approval and consent to participate. A voluntary consent form was obtained from the case to share her data and photos. Approval was obtained from Çukurova University Faculty of Medicine Clinical Ethics Committee (116/31).

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KABAKCI, A. G. ; EREN, D. S.; GEYLANI, E. G.; EREN, C. M. & BOZKIR, M. G. Análisis morfométrico y estético de personas tras la aplicación de plasma rico en plaquetas para el rejuvenecimiento del cuello. *Int. J. Morphol.,40(3)*:839-850, 2022.

RESUMEN: Varios investigaciones han demostrado los efectos beneficiosos del plasma rico en plaquetas. Sin embargo, existen muy pocos estudios que investiguen la efectividad del PRP en la región del cuello. Nuestro objetivo fue evaluar la eficacia de la inyección de PRP para el rejuvenecimiento del cuello en mujeres de 40 a 55 años. A cincuenta y dos mujeres participantes consecutivas se les inyectó PRP y se les aplicó rodillo en tres sesiones a intervalos de 3 semanas. Las evaluaciones se realizaron a ciegas comparando las mejoras de las evaluaciones previas y posteriores a la aplicación de las medidas anatómicas del área del cuello basadas en fotografías de antes y después de los participantes realizadas por dos anatomistas y tres médicos especialistas en cirugía estética. Para la evaluación se utilizaron la escala de piel de Fitzpatrick, la escala de Fitzpatrick Goldman, la escala de evaluación de arrugas (sistema de clasificación Dedo) y la escala de satisfacción del paciente. Además, se realizaron mediciones de rigidez y elasticidad de la piel, ángulo cervicomentoniano y ángulo de la línea de la mandíbula, para analizar los cambios anatómicos en el área del cuello. El estudio inscribió a 52 voluntarios con una edad media de 48,60±5,35 años, un peso corporal medio de 63,21±8,43 kg y una altura media de 163,25±4,56 cm. Se encontraron diferencias significativas en las puntuaciones de elasticidad, ángulo mandibular, ángulo cervicomentoniano, arrugas, elasticidad G y satisfacción del paciente antes y después del tratamiento. Cuando se compararon los resultados de los parámetros anatómicos y las escalas, se reveló que el PRP es eficaz en el rejuvenecimiento del cuello.

PALABRAS CLAVE: Anatomía; Elasticidad; Rejuvenecimiento; Cuello; Plasma rico en plaquetas; Arrugas.

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