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# The Association Between Scalp Laxity, Elasticity, and Glidability and Donor Strip Scar Width in Hair Transplantation—A New Elasticity Measuring Method

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## INTRODUCTION

Careful assessment of the donor area is crucial when planning hair transplantation. The density, caliber, and curliness of donor hair, as well as the laxity, elasticity, and glidability of the scalp are important factors in this assessment. However, a simple, accurate method of assessing scalp laxity, elasticity, and glidability in a clinical setting is lacking. Accurate evaluation of donor scalp parameters expedites the choice of a suitable surgical method, preoperative planning, and prediction of surgical outcome, including width of the eventual scar.

Seery described scalp laxity as the sum of elasticity and glidability, and reported that strip surgery within the range of glidability will result in a complication-free surgery.[1] In patients with hyperelastic skin, scar widening can occur, as explained by the laxity paradox.[2]

Various methods of measuring scalp laxity have been introduced, but none accurately measures elasticity and glidability in a simple manner. Wong assessed vertical laxity by pushing the scalp upwards and downwards when determining the width of the donor strip.[3] To determine strip size, he measured scalp laxity repeatedly at the initial consultation, at the preoperative examination, and just before application of anesthesia to the donor area. Feldman assessed tissue elasticity by injecting saline and measuring the degree of tissue ballooning.[4] The Mayer-Pauls scale is a reproducible and objective method of measuring scalp elasticity, based on the following formula:

$$\text{Scalp elasticity} = (50\text{mm} - x)(100\%)/50\text{mm}$$

where x is the distance during maximum compression between two marks made at a horizontal distance of 5 cm on the occipital scalp. Mayer suggested that if elasticity according to this scale is > 30%, then the scalp laxity paradox can occur.[5] In these cases, the surgeon should be aware of the possibility of a wide (> 4–6 mm) scar at the donor site.

Mohebi developed a mechanical device called the Laxometer in 2008 and a second-generation model in 2012.[6] The Laxometer is designed to mark the maximum extent of scalp mobility.[7] Pathomvanich and colleagues measured laxity with a crossbeam laser while moving the scalp in the vertical plane.[8]

Glidability refers to the area through which the galea layer glides, whereas elasticity refers to the stretching of the skin due to the elastic dermal component. Therefore, to accurately measure elasticity, one should fix the galea layer to prevent gliding while at the same time stretching the skin.[9]

Hyperelastic skin plays a crucial role in the formation of wide strip scars, which preclude patients from wearing short hairstyles and necessitate scar revision surgery or secondary grafting on the donor scar. Therefore, elasticity has clinical significance in predicting donor scar formation with hair transplantation via the strip method. However, current methods only allow measurement of scalp laxity; a simple and effective technique to measure elasticity has not yet been described.

## MATERIALS AND METHODS

The medical charts of 88 patients (54 men, 34 women; mean age 31.1 years, range 21-57) who underwent strip surgery from February 2014 to February 2015 at Dana Plastic Surgery Clinic, Seoul, Korea were re-

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viewed. All male patients suffered from male pattern baldness. Among the women, 31 patients underwent hairline correction surgery and 3 had female pattern hair loss. Patients with incisions shorter than 15cm in length or with a history of previous hair transplantation surgery, any type of trauma or surgery of the occiput, or face-lift surgery were excluded from the study.

Measurements of laxity, elasticity, and glidability were taken at the time of surgery and compared with scar width measured 10 months after surgery at the following three points: the mid-occipital point and the two mastoid process points lying 5-6cm to the right and left off center.

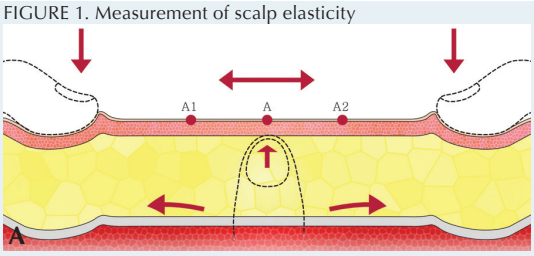
### *Measurement of scalp laxity, elasticity, and glidability*

The Laxometer II was used to measure scalp laxity. Upward laxity was evaluated for more precise measurements.

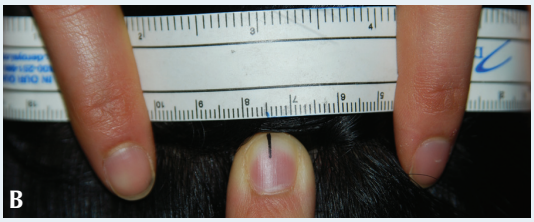
While measuring elasticity, the following method was used to limit movement of the dermis: two points separated by 5-6cm were pressed perpendicularly to prevent movement of the dermis over the pericranium. Next, the examiner placed a finger between the two points being compressed and made a small, vertical mark on the fingernail at a point parallel to a millimeter mark on a ruler. The examiner gently pressed the scalp and moved the finger from side to side to stretch the skin. The extent of movement to the right and left was measured. During this stretching, the examiner was careful not to move the fingers compressing and fixing the galea at the two outer points.

The elasticity value was subtracted from the laxity value to calculate glidability (Figure 1).

FIGURE 1. Measurement of scalp elasticity




A: Concept diagram




B: Initially, two points 5-6cm apart are compressed perpendicularly to fix the dermis.


C: A fingernail gently makes a vertical mark on the left side.


D: A fingernail gently makes a vertical mark on the right side.

### *Operative technique*

In all patients, 3-0 or 4-0 absorbable vicryl suture was used for galea plication after strip harvesting, followed by a continuous running skin suture with 3-0 or 4-0 nylon. Sutures were removed 10 days after surgery.

## RESULTS

Among the 88 patients, the average laxity was 19.59mm (range, 10-30mm), the average elasticity was 8.95mm (range, 4-24mm), and the average glidability was 10.58mm (range, 4-19mm). The average scar width was 2.7mm (range, 1-8mm) at the center, 3.18mm (range, 1-10mm) on the left side, and 3.11mm (range, 1-8mm) on the right side.

### *Differences in scar width according to elasticity category*

Elasticity was categorized as the upper 30th percentile (10mm or more) versus others (less than 10mm) to investigate differences in scar width according to the elasticity group (Table 1).

TABLE 1. Difference in scar width according to elasticity

| | Elasticity | *N* | Mean width (mm) | Standard deviation | *t* | *p* |
|---|---|---|---|---|---|---|
| Center | 10 mm or more | 27 | 3.48 | 1.2821 | 4.364 | .000*** |
| | less than 10mm | 61 | 2.38 | 1.0027 | | |
| Left side | 10 mm or more | 27 | 3.70 | 1.6828 | 2.425 | .017* |
| | less than 10mm | 61 | 2.96 | 1.1413 | | |
| Right side | 10 mm or more | 27 | 3.63 | 1.3053 | 2.849 | .005** |
| | less than 10mm | 61 | 2.88 | 1.0535 | | |

*$p < .05$ **$p < .01$ ***$p < .001$

Test results revealed a significant difference in scar width in the two elasticity groups at the center ($t = 4.364$, $p < .001$), on the left side ($t = 2.425$, $p < .05$), and on the right side ($t = 2.849$, $p < .01$).

According to subgroup analysis, the group with an elasticity of 10mm or more had a higher average scar width at the center (3.48mm) than the group with an elasticity of less than 10mm (2.38mm). The scar width on the left side was greater (3.7mm) among those with elasticity of 10mm or more than among those with an elasticity of less than 10mm (2.96mm). On the right side, the average value was also higher for those with an elasticity of 10mm or more (3.63mm) than for those with an elasticity of less than 10mm (2.88mm).

In particular, the group with an elasticity of less than 10mm had only 2 patients out of 61 (3.3%) with scar widths of 4mm or wider, whereas the group with an elasticity of 10mm or more had 13 patients out of 27 (48%) with scar widths of 4mm or wider. Of the 13 patients with wide scars, 1 had a scar 10mm wide at the center and at the left mastoid area and 8mm wide at the right mastoid area; the scars of the remaining 12 patients were 4-5mm in width.

### *Correlations between variables*

Pearson correlation analysis was conducted to define the relationships between variables, the results of which are shown in Table 2.

Scar width and its subdivisions (center, left side, and right

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TABLE 2. Correlations between variables

| | | Scar | Center | Left side | Right side | Laxity | Elasticity | Glidability | Incision width | Incision length |
|---|---|---|---|---|---|---|---|---|---|---|
| Scar width | *r* | 1 | | | | | | | | |
| | *p* | | | | | | | | | |
| Center | *r* | .920 | 1 | | | | | | | |
| | *p* | .000*** | | | | | | | | |
| Left side | *r* | .946 | .806 | 1 | | | | | | |
| | *p* | .000*** | .000*** | | | | | | | |
| Right side | *r* | .922 | .765 | .816 | 1 | | | | | |
| | *p* | .000*** | .000*** | .000*** | | | | | | |
| Laxity | *r* | .312 | .335 | .267 | .270 | 1 | | | | |
| | *p* | .003** | .001** | .012* | .011* | | | | | |
| Elasticity | *r* | .257 | .332 | .163 | .231 | .758 | 1 | | | |
| | *p* | .016* | .002** | .128 | .030* | .000*** | | | | |
| Glidability | *r* | .079 | .009 | .153 | .047 | .385 | −.304 | 1 | | |
| | *p* | .465 | .934 | .154 | .667 | .000*** | .004** | | | |
| Incision width | r | .102 | .139 | .065 | .085 | .615 | .479 | .213 | 1 | |
| | *p* | .347 | .199 | .550 | .435 | .000*** | .000*** | .048* | | |
| Incision length | r | .224 | .222 | .202 | .202 | .435 | .369 | .128 | .503 | 1 |
| | *p* | .037* | .039* | .060 | .061 | .000*** | .000*** | .239 | .000*** | |

*$p < .05$; **$p < .01$; ***$p < .001$

side width) share the same factors, and thus had a significant positive correlation. A significant positive correlation also existed between scar width and laxity ($r = .312$, $p < .01$), elasticity ($r = .257$, $p < .05$), and incision length ($r = .224$, $p < .05$).

### *Relationship between scalp elasticity and scar width after strip harvesting*

There was a significant association between elasticity and scar width ($t = 2.465$, $p < .05$). The positive value of the unstandardized coefficient indicates that elasticity has a positive correlation with scar width; that is, the greater the scalp elasticity, the wider the scar after strip harvesting.

## DISCUSSION

Accurate assessment of scalp laxity is extremely important to surgeons performing hair transplantation, and laxity should be measured accurately during consultations for surgical planning. In many cases, large numbers of grafts are transplanted in a single session, so the importance of accurate measurement of scalp laxity and its components, elasticity and glidability, cannot be overemphasized.

The purpose of this study was to evaluate the clinical importance of this novel method of measuring scalp laxity, elasticity, and glidability and to assess the relationship between elasticity and donor scar width.

Our method allowed measurement of elasticity without much difficulty, unlike in the past when there was no simple way to clinically measure elasticity.

Based on this study, scalp scar width appears to be influenced by scalp laxity and scalp elasticity. Defining hyperelastic skin as scalp elasticity in the upper 30th percentile, patients with hyperelastic skin had scar widening at all three measurement points. In patients with hyperelastic scalp skin, trichophytic closure or scar revision would not prevent scar widening, leaving patients and surgeons with disappointing results. Therefore, it is imperative to inform patients about the laxity paradox, which can easily occur if elasticity is 10mm or higher. The follicular unit extraction method can be considered in patients who are more susceptible to wider donor strip scars. Also in such cases, trichophytic closure is not always recommended. Conversely, in scalps with greater glidability and lower elasticity, the strip method is expected to leave narrow scars.

According to this study, as components of laxity, elasticity constitutes 45% and glidability constitutes 55%. However, this proportion has interpersonal variations. Because the difference in this proportion serves as a major factor in predicting clinical outcome, preoperative measurement is very important.

Further evaluation and discussion is necessary regarding techniques to prevent donor scar widening in patients with hyperelastic skin undergoing strip surgery. Because of the different characteristics of scalp skin according to race, additional research with different racial populations is also required.

## CONCLUSION

Scalp laxity, elasticity, and glidability have great clinical importance in strip method hair transplantation. The present novel method of measuring elasticity helps predict the degree of donor site scar widening.

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