The Effectiveness of Ablative Fractional Carbon Dioxide Laser with Autologous Platelet Rich Plasma Combined Resurfacing for Hypertrophic Scar of the Shoulder

INTRODUCTION

Scar formation following surgery or trauma is common, and some scars gradually become reddish, hard, or hypertrophic. Scars are classified as hypertrophic, keloid, atrophic, or acne scars. Hypertrophic scars are firm and protrude due to increased collagen expression, but unlike keloid scars they do not extend beyond the margin of the original wound [1].

Laser treatment for scars has improved over the past three decades. Autologous platelet-rich plasma (PRP) derived from whole blood is immunologically inert and contains a proper ratio of growth factors and cytokines. Here we describe the case of a 29-year-old female patient with a hypertrophic scar on her right shoulder caused by an operation performed in 2012. The patient underwent 11 laser therapy sessions with a fractional carbon dioxide (CO₂) ablative laser system (LineXel) and two PRP injections. Her scar was evaluated with the Vancouver Scar Scale (VSS), and the baseline and post-treatment scores were 11 and 3, respectively. After treatment, the dimensions and volume of the scar were diminished, and contour, texture, and pigmentation had also improved compared to baseline. The patient reported less pain, swelling, and pigmentation following PRP combination ablative laser therapy. This case provides further evidence of the potential benefits of PRP as an adjuvant to fractional laser in reducing hypertrophic scars.

Keywords Hypertrophic scar, Fractional laser, Platelet-rich plasma

CASE REPORT

Patient

The patient was a 29-year-old female with a hypertrophic scar on her right shoulder from an orthopedic operation (open reduction...
and internal fixation of a humeral head fracture) performed in October 2012. Prior to the initial, the patient’s medical history was unremarkable. The patient’s scar was elevated and reddish. The length, width, and height were 15 cm, 1.8 cm, and 0.5 cm, respectively. The patient felt stiffness and irritation that felt like a stretching sensation on the operation side. She also experienced pain when moving shoulder.

We digitally photographed the hypertrophic scar beginning in December 2012. The patient has undergone 11 laser therapy sessions including two where PRP was injected immediately afterward. Each laser treatment was administered at regular interval monthly. In general, scars caused by operation or trauma are improved by laser resurfacing 6 to 8 weeks after injury because collagen is remodeled at that time [3]. Autologous PRP was injected into the scar in May and September 2012. PRP was injected after the fourth and eighth laser therapy sessions. After the PRP injection, an additional three laser therapies were performed progressively, with the final laser treatment administered in January 2014.

Method
To extract PRP from whole blood, we used the SmartPReP system (Harvest Technologies, Plymouth, MA, USA). Prior to the procedure, we drew 54 mL whole blood from the patient and centrifuged the sample at 2,160 to 2,650 rpm for 14 minutes to yield 10 mL PRP [4]. Two-thirds of the plasma was platelet poor and was removed. The remaining one-third was mixed with a calcium chloride/thrombin mixture to activate the PRP, which was then injected into the patient’s scar.

The Vancouver Scar Scale (VSS) is widely used to score scars. This scale assesses pigmentation (0 = normal, 1 = hypopigmented, 2 = mixed pigmentation, and 3 = hyperpigmented), pliability (0 = normal, 1 = supple, 2 = yielding, 3 = firm, 4 = ropes, and 5 = contracture), height (0 = flat, 1 = < 2 mm, 2 = 2–5 mm, 3 = ≥ 5 mm), and vascularity (0 = normal, 1 = pink, 2 = red, and 3 = purple) [5]. The score of each parameter was measured, and total score is the sum of each score. We measured the pliability score and the height by observing clinical photographs and medical records.

Results
After two PRP injections, the pliability, pigmentation, and height of the scar were considerably improved. When comparing pre- with post-PRP photographs, we observed that PRP combination laser treatment resulted in better outcomes in pigmentation, vascularity, and pliability than laser treatment alone (Fig. 1 and 2). We also noted fewer side effects of ablative laser with PRP, including less erythema, edema, and postinflammatory hyperpigmentation. Moreover the total healing time was shorter for combination treatments than with ablative laser alone.

After 2 years, the length and width of the scar have shrunk even more. The scar volume has diminished, and texture and pigmentation have also improved compared to baseline (Fig. 3). Although irritation on the cutaneous scar has not completely resolved, the patient’s satisfaction regarding scar treatment is increased. Side effects such as wound disruption, ulceration, and dyspigmentation

Fig. 1. Pre- and post-platelet-rich plasma (PRP) injection photographic findings of 1st PRP injection. [A] is 3rd laser treatment, [B] is 4th laser treatment (Just before 1st PRP injection) and [C] is 5th laser treatment (Next follow up time after 1st PRP injection).
have not been reported.

The VSS score was 11 (pigmentation 3, pliability 4, height 2, vascularity 2) before treatment and had decreased to 3 (pigmentation 2, pliability 0, height 0, vascularity 1) after the final treatment. The patient was objectively and subjectively satisfied with the results.

**DISCUSSION**

Scar treatment has evolved over time. In the past, surgical excision was the most common treatment for hypertrophic scars, but more than half of these cases relapsed. Furthermore, this invasive procedure was unpleasant and painful.

Fractional ablative CO\(_2\) laser improves rhytides, dyschromia, and textural irregularities and inhibits early stage scar progression. In addition, it was recently reported that ablative fractional CO\(_2\) laser can resurface mature burn scars to correct abnormal texture, thickness, and stiffness [6]. Compared to the previous ablative resurfacing technique, this procedure is less invasive and allows more rapid recovery.

Ablative CO\(_2\) laser devices deliver more intense power to the scar tissue than non-ablative fractionated devices. It can ablate both the epidermis and dermis with significant heating of the adjacent...
Fig. 4. Schematic figure that demonstrates actions of platelet-rich plasma and its bioactive molecules. PRP, platelet-rich plasma; PDGF, platelet-derived growth factor; TGF, transforming growth factor.

Less erythema
Rapid epithelization
Biologic glue
Less hyperpigmentation
PRP
Laminin
Collagen IV
Tenascin
Reduce hyperpigmentation
Epi
dermis and dermis regeneration

Fig. 4.

Can be used as biologic glue [10]. All these reactions are depicted in Fig. 4. According to a previous study on PRP, it is effective and safe treatment for atrophic scars with short downtime and good tolerability [11]. Based on the findings in that report, we hypothesized that the laser/PRP combination therapy could be applied to hypertrophic scars. Indeed, the patient reported less pain, swelling, edema, erythema, and pigmentation and a shorter epithelization period.

The shoulder is the joint most frequently affected by trauma or burn injury, and this can lead to significant functional limitations [13]. As we did not expect spontaneous resolution in this patient, laser management was performed to prevent functional loss.

Our study has two limitations. First, the photographer did not take pictures with the same light brightness at the same location, so result interpretation is subjective. Second, there was no decrease in irritation, and the length and width of the scar did not change. To clarify the clinical outcome and the mechanism of synergistic effects, additional studies using PRP injection and fractional CO2 laser should be performed.

In summary, the volume, contour, and pigmentation of the scar improved after combined therapy with 1 PRP injections and 11 fractional CO2 laser treatments. This case provides evidence of the potential benefits of using PRP as an adjuvant to fractional laser in the treatment of hypertrophic scars. The superiority of the combination was clearly evident in several aspects, including the rapidity and degree of scar improvement, fewer side effects, and shorter downtime.

PATIENT CONSENT

Patients provided written consent for the use of their images.
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