Fractional radiofrequency treatment in acne scars: Systematic review of current evidence

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To link to this article: https://doi.org/10.1080/14764172.2016.1225964

Accepted author version posted online: 03 Sep 2016.
Published online: 13 Oct 2016.

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Fractional radiofrequency treatment in acne scars: Systematic review of current evidence

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**ABSTRACT**

Fractional radiofrequency (FRF) is renowned for its use in cosmetic dermatology, with regard to the treatment of rhytides, striae, scarring and cellulite. We have systemically analysed its evidence for the use of FRF in acne scars. Our search identified 15 articles, one single-blinded randomised controlled trial, two split-face trials and thirteen prospective clinical studies, mostly single-centred. Case reports were excluded. In total 362 patients were treated. The longest follow-up was for 210 days, and on average the follow-up was for three months, varying between one and seven months. This review has found that there are many small studies showing promising results for the use of FRF in acne scars, either as an adjunct or more importantly as the sole treatment. There is however a need for larger trials against ablative and non-ablative lasers, in order to affirm the evidence present already. This is the first systematic review on the use of FRF in acne scars.

**Introduction**

Acne scars are common and have a high association with reduced quality of life and psychological detriment (1,2). Treatment can be challenging with variable inter-individual responses (3). Acne scars can be classified as keloidal, hypertrophic or atrophic with the latter further being sub-classified into boxcar, ice-pick and rolling scars (3,4). Conventional treatments vary depending on the subtype and include corticosteroid injections, surgical excision, dermabrasion, chemical peels, subcision, punch excision and laser therapy (5). Laser treatments for acne scars are generally considered a relatively recent intervention and include ablative and non-ablative modes. Ablative lasers in general provide more superior results, albeit at the expense of a higher risk of side effects and often longer social downtime (6). Ablative lasers primarily target the epidermis, as opposed to the dermis, which non-ablative lasers target (7). Fractional radiofrequency (FRF) targets both the epidermis and dermis, though the ablation is often minimal in comparison to the coagulation effect (8). This pattern of thermal injury offers the benefits of non-ablative therapy with a degree of epidermal ablation. Great interest has been culminating over the recent years for the use of FRF in acne scars and rejuvenation due to the absence of scattering and the absence of chromophore-specific targets – predominantly melanin, hence it has a higher safety profile in darker skin types (8). In this article we review the current evidence for FRF in the treatment of acne scars.

**Methods**

A literature search was performed in November 2015, to review the current evidence on FRF in acne scars. PubMed and Google Scholar searches were carried out, with the search criteria ‘Radiofrequency’, ‘Fractional Radiofrequency’ and ‘Acne scars’. Articles were selected depending on their relevance, which is treatment of acne scars with FRF alone or as an adjunct. Only articles related to acne scarring and those published in English were selected. Case reports were excluded.

**Results**

Our search identified 15 articles, with most studies being single-centred and non-blinded. There were one randomised controlled trial, two split-face trials comparing FRF against alternative treatment methods, and 12 prospective studies using FRF as a sole treatment (Table 1). In total 362 patients were treated. The reported side effects appeared to be similar across all studies and included transient erythema, oedema and pain. One case of post-inflammatory hyperpigmentation (PIH) was seen in the erbium-doped arm of a study comparing FRF and 1,550-nm fractional erbium-doped glass and PIH was 6.5% in another study where FRF was used as an adjunct to fractional laser treatment (9).

The average number of treatment sessions with FRF in acne scarring was three. Eight of the studies included used FRF as monotherapy and three used it as an adjunct. Four of
Table 1. Summary of all studies using fractional radiofrequency on acne scars.

<table>
<thead>
<tr>
<th>Study</th>
<th>Aim</th>
<th>Method</th>
<th>Result</th>
<th>Discussion</th>
</tr>
</thead>
</table>
| Alster et al. (2007) | Prospective case series of fractional laser photothermolysis to treat atrophic acne scars | • 53 patients  
• Mild to moderate atrophic acne scars  
• Fitzpatrick I–V  
• Ages 19–78 years  
• Using 1,550-nm erbium-doped fibre laser  
• Monthly treatments  
• Follow-up at each treatment and after 6 months | • Blinded observers found 51–75% improvement in 90% of patients  
• No SE of PIH, ulceration or scarring | • Use of blinding  
• Sample size large in comparison to majority of other previous studies  
• Again, no control arm |
| Hruza et al. (2009) | To assess the safety and clinical efficacy of RF device for wrinkles | • RF to skin of patients awaiting abdominoplasty or RF to face  
• Fitzpatrick II–IV  
• Caucasian  
• 35 subjects  
• Age: 52 ± 8 years  
• 3 treatment sessions given for facial RF  
• Follow-up: 1 month | • Improvement in overall skin complexion  
• 80% patient subjective satisfaction  
• Histological findings of ablation/coagulation/necrosis dependent on energy parameters  
• Objective improvement > 40% in more than half of patient cohort | • Small sample size  
• No control arm  
• Histological findings show that it can safely alter thermal energy depending on treatment/patient subtype  
• Limited to Caucasian patients only |
| Cho et al. (2010) | Randomised split-face study of non-ablative 1550-nm erbium-doped fractional photothermolysis systems and CO2 fractional laser | • East Asian demographic  
• 8 patients  
• Age: 20–23 years  
• Mild to severe atrophic scars  
• 1 treatment session  
• Split-face trial  
• Follow-up: 3 months | • Clinical assessment showed mean grade improvement to be:  
• 2.0 ± 0.8 for CO2, FS, 3 months post treatment  
• Crusting/scaling and post erythema also assessed and found to be longer in side treated with CO2, FS  
• Found safety and efficacy of both treatment models  
• Benefit of being a split-face trial, allowing comparison  
• Benefit of blinded evaluation  
• Overall 87.5% of patients thought CO2 laser to be subjectively better  
• Authors appreciated risk of subject bias, due to different post treatment responses  
• Male-only study  
• Overall shown to be safe  
• Authors concluded side effects are operator dependent  
• Costly due to disposable tips  
• Treated with broad-spectrum antibiotics prior to treatment, clouding outcome of results | |
| Ramesh et al. (2010) | Efficacy of matrix-tunable RF in acne scars | • 30 Indian patients  
• Mixed acne scars  
• Fitzpatrick I–V  
• Up to 4 treatments, at 1-month intervals with fractional bipolar RF  
• used visual analogue scale to assess improvement  
• Follow-up: 2–6 months | • Improvement in scars evaluated at 2 and 6 months.  
• 60% improvement in 4/30  
• 35–60% improvement in in 18/30  
• <35% in 8/30.  
• Ice-pick scar category – best results  
• No PIH reported  
• Authors appreciated risk of subject bias, due to different post treatment responses  
• Male-only study  
• Overall shown to be safe  
• Authors concluded side effects are operator dependent  
• Costly due to disposable tips  
• Treated with broad-spectrum antibiotics prior to treatment, clouding outcome of results | |
| Peterson et al. (2011) | Evaluation of fractional laser with RF and fractionated RF in acne scars | • Single-site prospective study  
• 15 patients  
• Age: 20–72 years  
• Fitzpatrick I–V  
• 5 treatment sessions at 30-day intervals  
• Follow-up: 210 days | • 72.3% (P < 0.001) decrease in acne scar scores  
• No change in patient satisfaction  
• No PIH  
• Overall improved texture and acne scar pigmentation  
• Rolling and boxcar scars yield better result than ice-pick scars  
• Results evaluated at 4 and 12 weeks after the last treatment  
• Goodman scar scale used  
• Both treatments effective in superficial and deep acne scars  
• Significant improvement at 1 month after 3 sessions  
• No significant side effects  
• Authors appreciated risk of subject bias, due to different post treatment responses  
• Male-only study  
• Overall shown to be safe  
• Authors concluded side effects are operator dependent  
• Costly due to disposable tips  
• Treated with broad-spectrum antibiotics prior to treatment, clouding outcome of results | |
| Taub et al. (2011) | Treatment of acne scars with sublative fractional bipolar RF and bipolar RF combined with diode laser | • Prospective single-centre study  
• Fractional bipolar RF and bipolar RF combined with diode laser.  
• Fitzpatrick II–V  
• 20 patients  
• Facial or neck areas treated  
• Age: 40.7 ± 10.5 years  
• Up to 5 sessions  
• Follow-up: 12 weeks | • Results evaluated at 4 and 12 weeks after the last treatment  
• Goodman scar scale used  
• Both treatments effective in superficial and deep acne scars  
• Significant improvement at 1 month after 3 sessions  
• No significant side effects  
• Authors appreciated risk of subject bias, due to different post treatment responses  
• Male-only study  
• Overall shown to be safe  
• Authors concluded side effects are operator dependent  
• Costly due to disposable tips  
• Treated with broad-spectrum antibiotics prior to treatment, clouding outcome of results | |

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<table>
<thead>
<tr>
<th>Study</th>
<th>Aim</th>
<th>Method</th>
<th>Result</th>
<th>Discussion</th>
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<tbody>
<tr>
<td>Cho et al. (2012)</td>
<td>Efficacy of RF microneedle in acne scars</td>
<td>• Mild to moderate acne scars</td>
<td>• Improvement in acne scars and large pores in 73.3% of patients</td>
<td>Small sample size</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Age: 16–45 years</td>
<td>• No change in 23.3%</td>
<td>Evidence of small amount of sample having worsening of acne scars with</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• 2 sessions</td>
<td>• Aggravated in 3.3%</td>
<td>microneedling</td>
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<td></td>
<td></td>
<td>• 30 patients</td>
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<td></td>
<td></td>
<td>• Follow-up unknown</td>
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<tr>
<td>Gold et al. (2012)</td>
<td>Evaluation of fractional bipolar RF</td>
<td>• 15 Caucasians</td>
<td>• Overall patient satisfaction 67–92%</td>
<td>Demonstrates efficacy and safety of fractional bipolar RF</td>
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<td></td>
<td></td>
<td>• Fitzpatrick I–V</td>
<td>• 33% dropout rate</td>
<td>Small sample size</td>
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<td></td>
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<td>• Age: 35.7 + – 5.6 years</td>
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<td>Limited to Caucasians known to have lower risk of PIH (as less melanocyte</td>
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<td></td>
<td></td>
<td>• Mild to moderate acne scars</td>
<td></td>
<td>density)</td>
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<td></td>
<td></td>
<td>• 3 monthly treatments with fractional bipolar RF</td>
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<td></td>
<td></td>
<td>• Follow-up: 3 months</td>
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<tr>
<td>Yeung et al. (2012)</td>
<td>Evaluation of combined FRF and fractional laser treatment</td>
<td>• Single-centre, prospective, self-controlled clinical study</td>
<td>• Small statistical improvement in acne scar.</td>
<td>Safe and effective in Asians</td>
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<td></td>
<td></td>
<td>• 20 patients</td>
<td>• Mean grade deduction of 29% (P &lt; 0.001)</td>
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<td></td>
<td></td>
<td>• Asian</td>
<td>• Incidence of PIH 6.5%</td>
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<td>• Moderate atrophic acne scars</td>
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<td></td>
<td>• Fitzpatrick III–IV</td>
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<td></td>
<td></td>
<td>• Age: 27.7 + – 8.4 years</td>
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<td>• 3–5 sessions given</td>
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<td></td>
<td></td>
<td>• Follow-up: 3 months</td>
<td></td>
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<tr>
<td>Cameli et al. (2014)</td>
<td>Comparison of fractional laser versus fractional laser with RF to</td>
<td>• Fitzpatrick II–III</td>
<td>• Combined treatment better outcome than single,</td>
<td>Limited by excluding deep boxcar and ice-pick acne scars</td>
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<td></td>
<td>treat acne scars/photo-ageing</td>
<td>• Age: 28–55 years</td>
<td>with regard to healing time and reduction in scar depth and patient</td>
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<td></td>
<td>• 10 patients (6 with acne scars, 4 with photo-ageing)</td>
<td>satisfaction.</td>
<td>Small sample size</td>
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<td></td>
<td></td>
<td>• Follow-up: 3 months</td>
<td></td>
<td>Lacked blinding and randomisation</td>
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<td></td>
<td>No comment on ethnicity of patients</td>
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<td></td>
<td>Excluded deep boxcar, ice-pick and hypertrophic scars – it would have</td>
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<td>been useful to have these evaluated against the treatment protocol</td>
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<tr>
<td>Kim et al. (2014)</td>
<td>Evaluation of bipolar RF in acne scars and large pores</td>
<td>• 31 patients</td>
<td>• Subjective assessment found 45.16% rated overall appearance as</td>
<td>Study based mainly on subjective as opposed to objective assessment</td>
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<tr>
<td></td>
<td></td>
<td>• Korean population</td>
<td>excellent</td>
<td>Encouraging no PIH, especially in Asian population</td>
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<td></td>
<td></td>
<td>• Fitzpatrick III–IV</td>
<td>• 48.4% as good</td>
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<td>• Age: 19–38 years</td>
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<td>• 4 treatment sessions</td>
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<td>• Follow-up: 3 months</td>
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<tr>
<td>Rongsaid and Rummaneethorn</td>
<td>Comparison of fractional bipolar RF and 1,550-nm fractional erbium-</td>
<td>• 20 patients</td>
<td>• Significant improvement in acne scars at 3 months post treatment,</td>
<td>Small sample size</td>
</tr>
<tr>
<td>(2014)</td>
<td>doped glass</td>
<td>• Thai</td>
<td>but no significant difference between devices</td>
<td>Type of scars not specified: mixed picture</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Mixed-type acne scars</td>
<td>• Side effects of both devices: pain, erythema, scab formation</td>
<td>Smaller thermal energy ranges used than normal recommended: 30–50 mJ</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Fitzpatrick III–IV</td>
<td>• A case of PIH on the side treated with fractional erbium-doped glass</td>
<td>(normally up to 70mJ)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Age: 18–55</td>
<td>• Higher pain score with fractional erbium-doped glass (P &lt; .001) was</td>
<td>Pain led to a 12.5% dropout rate</td>
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<td>• Three split monthly treatments of the above</td>
<td>found</td>
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<td>• Follow-up: 4 weeks</td>
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<td>If pain control was adequate, and the 12.5% remained within the study,</td>
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<td>would this skew the results obtained?</td>
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<table>
<thead>
<tr>
<th>Study</th>
<th>Aim</th>
<th>Method</th>
<th>Result</th>
<th>Discussion</th>
</tr>
</thead>
<tbody>
<tr>
<td>Chae et al. (2015)</td>
<td>Assess the clinical efficacy and safety of a Er:glass fractional laser and FRF microneedle device in the treatment of facial atrophic acne scars</td>
<td>Randomised controlled single-blinded study • 40 patients • Age range: 29–39 years • Atrophic acne scars • Randomised to either treatment with Er:glass fractional laser or FRF • 3 treatments • Follow-up: 20 weeks</td>
<td>Improvement in both groups • No significant difference between scar severity improvement • Fractional laser more effective • FRF less side effects, more coherence from patients</td>
<td>Only RCT to date • Single-blinded • Used photographs, physician assessment and ECCA scale (to assess severity of atrophic acne scars) • Authors deduced FRF more suitable for those patients with lower pain threshold, requiring less downtime</td>
</tr>
<tr>
<td>Kaminaka et al. (2015)</td>
<td>Assess safety and efficacy of bipolar FRF of active acne and atrophic acne scars</td>
<td>Prospective comparative study • 5 sessions • 23 Japanese patients • Age range: 19–44 years • Atrophic acne scars plus mild to severe active acne • used 3D in vivo imaging analysis • Follow-up: 3 months</td>
<td>More than 50% of patients had moderate improvement in acne scars • Significant (P &lt; .005) improvement in active acne • Subjective improvement in QoL of post treatment</td>
<td>This study used 3D in vivo analysis to assess (objectively) skin roughness, scar areas and scar depth • Treatment of bilateral cheeks only • Severe acne scars did not improve; the authors deduced this could be secondary to inadequate treatment periods • First study on psychology and QoL affects with FRF</td>
</tr>
<tr>
<td>Verner (2016)</td>
<td>Assess efficacy, safety, tolerability, patient satisfaction of fractional bipolar RF</td>
<td>Prospective, open-label clinical trial • 12 Caucasian patient • Age:20–62 years • Skin type Fitzpatrick I–III • Moderate to severe acne scars • 3–5 treatments with sublative fractionated bipolar RF • Follow-up: 3 months</td>
<td>50% patients satisfied and 50% very satisfied • All patient had oedema, and transient erythema post procedure – which resolved</td>
<td>Small sample size • Small sample size • No control arm • No blinding • Every patient within the trial, at least satisfied</td>
</tr>
</tbody>
</table>

RCM: Reflectance confocal microscopy; PIH: Post-inflammatory hyperpigmentation; MTZ: microscopic treatment zones; RCT: Randomized control trial; ECCA: échelle d’évaluation clinique des cicatrices d’acné; QoL: Quality of life. References for the table (4, 6, 9, 18, 19, 21–28).
the 15 studies compared FRF against alternative treatment methods.

Discussion

Acne scars have an array of treatment options with lasers being widely utilised (10,11). The principal effect of laser treatment in acne scars relates to the thermal effects in the dermis – with or without ablation – leading to neocollagenesis (12). FRF has been a topic of huge interest since 2004 (12), being used regularly for skin laxity, rhytides, striae, scarring and cellulite (13–15). FRF appears to acquire the pros of the ablative and non-ablative laser therapy, whilst being associated with fewer side effects than the ablative laser – making it an attractive choice by blending the benefits of both (7). FRF is not a laser. It works by generating heat through the flow of electrons in an electromagnetic field through tissue impedance resulting in a larger coagulative dermal zone in comparison to the epidermal ablative area (the impedance in the dermis is lower due to a higher water content hence the flow of current is preferentially found in the dermis) (16). The thermal injury zone it creates is pyramidal in shape, as opposed to the columnar shape of ablative lasers (8). This is associated with a favourable side effects profile in comparison to fractional ablative lasers (17).

From our literature search FRF usually requires 3–5 sessions for optimal result, with only minimal side effects of pain, oedema and transient erythema. There was only one case of PIH in the erbium-doped arm of a study comparing its efficacy against FRF (18). There are no reported cases of PIH in patients treated with FRF alone in all the reported studies. Yeung et al. evaluated the combination of FRF and fractional laser treatment. The highest incidence of PIH was 6.5%, which was reported when FRF was used as an adjunct (9). It is therefore difficult to extrapolate whether this was related to the ablative laser alone or from the FRF. The average follow-up was three months with the majority of patients subjectively satisfied with the results. Of note, one study did find that fractional non-ablative laser was more effective than FRF; however FRF-treated patients had fewer side effects (19). Different assessment methods across all studies were used and these included subjective improvement, objective improvement (including 3D imaging, and an independent clinician review of photographs before and after treatment), mean grade reduction of acne scars, percentage decrease in acne scars, mean grade improvement and overall satisfaction. The longest follow-up was for seven months with an average of three months across all studies. The lack of reported PIH following FRF therapy makes this technology very attractive in the treatment of higher skin types (17,20).

Interestingly, in one study PIH was found to be more common in bony areas. The authors did not deduce a reason for this but that using lower energy in such areas was beneficial (9).

Cameli et al. compared ablative fractional laser against the combination of ablative fractional laser with FRF to treat acne scars and photo-ageing. The authors concluded that combined treatment produced better outcome as well as a shorter recovery time, with 30% of patients reporting excellent healing time versus 10% in the ablative arm alone. There was also better reduction in scar depth and overall higher patient satisfaction.

The study used in vivo reflectance confocal microscopy to assess inflammation at a cellular level and found that just seven days post treatment there was extraordinarily a complete healing of tissue. Complete healing was better in combined treatment in comparison to monotherapy. The authors suggest that the combination of an ablative fractional laser with FRF can have a synergistic effect on the outcome of acne scars (4). This is due to both heating and compaction creating a firmer skin surface, and furthermore the ability to use reduced energy parameters when using lasers in combination – hence reducing the probability of side effects.

Treatment of acne scars with FRF has become increasingly popular, particularly in parts of the world with higher skin types. The current literature provides studies with overall positive results but have their limitations in terms of sample size, randomisation, consistency of objective assessment and long-term follow-up.

The studies discussed have a varying number of treatment sessions and varying follow-up times, making it hard to directly compare the results observed. Most use photographs to rate objective clinical improvement, and questionnaires for subjective outcomes. As mentioned earlier, one study noted that PIH occurred over a bony area. This presented a question as to whether the degree of thermal energy needs to be varied depending on location. The studies do not always treat the same location within their chosen patient cohort.

It is evident that FRF is particularly useful in darker skin types, who have higher risk of developing PIH with ablative methods. Furthermore, FRF appears to be the fit medium between the ablative and non-ablative lasers (8). Further control studies combining FRF with other modalities are desirable, as postulated by some to have a synergistic effect (4).

In summary, the treatment of acne scars with FRF appears to be safe and efficacious. FRF evades the treatment downtime, often experienced with ablative lasers, by creating a triangular beam of thermal energy with minimal epidermal injury, and directs its energy towards the dermis. This mechanism enables neocollagenesis to occur with less risk of PIH and side effects typically observed by ablative and non-ablative lasers. This is the first systematic review of the use of FRF in acne scars.

What is already known about this topic?

- FRF is widely utilised in cosmetic dermatology for photo-ageing
- There is evidence to suggest that FRF is superlative to ablative or non-ablative lasers with regard to overall outcome.

What does this study add?

- We review the evidence underlying the use of FRF in acne scars
- Whilst many case reports and small split-face series are available, there are no randomised controlled trials and comparisons in the literature to date
- The use of FRF, or an adjunctive treatment, could be the optimal treatment for acne scar if further research is carried out.
Declaration of interest
The authors report no conflicts of interest. The authors alone are responsible for the content and writing of the paper.

Funding
None.

References