Original Article

A Prospective Open-labeled Study of Tattoo Removal with Q-Switched Nd:YAG Laser Utilizing the R0 Technique and Correlation with Kirby–Desai Scale

Sanjeev J. Aurangabadkar, Swapnil D. Shah[1], Deepak S. Kulkarni[2], Madhavi S. Auragabadkar[3]

Skin and Laser Clinic, Hyderabad, Telangana, [1]Department of Dermatology, Ashwini Rural Medical College, Hospital and Research Centre, Solapur, [2]Alok Clinic, Panvel, Maharashtra, [3]Dr. J. W. Aurangabadkar New Skin Clinic, Hyderabad, Telangana, India

Abstract

Introduction: The Q-switched Nd: YAG (QSNY) laser is considered the standard device of choice for laser tattoo removal. Newer concepts such as R0 , R20 methods aided in faster clearance of tattoos. The Kerby-Desai scale [KD scale] has been proposed to predict the approximate number of sessions needed for tattoo clearance. **Objective:**

1. To access the efficacy of R0 technique for tattoo removal in skin types IV to VI
2. To evaluate the Kerby-Desai scale and its correlation to the number of sessions actually required for tattoo clearance

Material and Methods: Twenty-two patients with single colored amateur were treated using modified R0 technique and the number of sessions were corelated with Kirby Desai scale. **Results:** We found that R0 method require significantly less sessions than predicted by KD scale. **Conclusion:** Tattoo removal with the R0 technique using PFD allows faster clearing of tattoos and significantly cuts down the total treatment duration needed for tattoo removal.

Keywords: Kirby–Desai scale, Q-switched Nd-YAG laser, R0 method

Introduction

The Q-switched neodymium-doped yttrium aluminum garnet (Nd:YAG) (QSNY) laser is considered the standard device of choice for laser tattoo removal. Despite the advent of newer picosecond lasers, the QSNY remains the gold standard in patients with pigmented skin.[1] The dual wavelength (WL) of 1064 and 532 nm of the QSNY is ideally suited for the treatment of darker skin types. The addition of other WLs of 660 and 585 nm with the newer generation of QSNY has expanded its usefulness. Apart from the additional WLs, newer concepts and techniques have aided in the rapid clearing of tattoos. These include the R20 and R0 methods. The R20[2] technique involves multiple passes over the tattoo with a 20-min interval between each pass for up to four passes, whereas the R0 method[3] involves the use of a fluorocarbon compound perfluorodecalin (PFD), which is sprayed or applied over the tattoo after each pass and subsequent passes without the waiting time of R20 technique. We present a series of cases treated with the R0 technique for tattoo removal in skin types IV and V in Indian patients. The Kirby–Desai scale (KD scale)[4] has been proposed to predict the approximate number of sessions needed for tattoo clearance. It takes into consideration various factors such as Fitzpatrick skin type, location of the tattoo, color of the tattoo, amount of ink, body site, and presence of scarring. The results were subjected to this scale to evaluate the correlation of KD scale to the actual number of sessions needed.

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Address for correspondence: Dr. Swapnil Shah, Department of Dermatology, Ashwini Rural Medical College, Hospital and Research Centre, Solapur 413006, Maharashtra, India. E-mail: drswapnilshah@gmail.com

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Table 1: Master chart showing patients demographics, KD scale, actual number of treatments required, and complications

Forearm Number	Age (years)	Sex	Location	Skin type	Location score	Colors	Amount of ink	Scarring and tissue change	Layering of tattoos	Total score and predicted number of sessions	Actual R0 sessions	Grade of improvement	Complications
1	18	M	Arm	4	4	1	2	0	0	11	2	5	Ghost image
2	18	M	Forearm	4	4	1	2	0	0	12	3	5	Ghost image
3	42	F	Forehead	4	1	1	1	1	0	8	2	5	
4	21	M	Arm	5	4	1	2	0	0	12	3	5	Transient depigmentation
5	17	M	Hand	5	5	1	1	0	0	12	2	5	
6	22	M	Forearm	6	4	1	2	0	0	14	2	5	
7	20	M	Forearm	5	4	1	2	0	1	14	3	5	Scarring
8	25	F	Forearm	4	4	1	2	1	0	13	4	3	
9	28	F	Forehead	4	1	1	1	0	0	7	1	5	
10	38	F	Forehead	5	1	1	1	0	0	8	1	5	Ghost image
11	32	F	Forearm	4	4	1	1	0	0	10	2	5	
12	28	F	Forearm	4	4	1	1	0	0	10	2	5	
13	34	M	Forearm	5	4	1	2	0	0	12	3	5	
14	23	F	Forearm	5	4	1	2	0	0	12	3	5	Confetti depigmentation
15	26	F	Forehead	5	1	1	1	0	0	8	1	5	
16	31	F	Forehead and root of nose	5	1	1	1	0	0	8	2	5	
17	26	M	Chest	4	2	2	1	0	0	9	3	4	Ghost image
18	22	F	Wrist	5	5	1	2	0	0	13	4	4	Scarring
19	25	F	Forehead	5	1	1	1	0	0	8	2	5	
20	27	F	Forehead	5	1	1	1	0	0	8	1	5	
21	28	F	Forearm	5	4	1	1	0	0	11	2	4	
22	36	F	Forehead	4	1	1	1	0	0	7	1	5	

Figure 1: (A) A tattoo on arm. (B) Grade 5 improvement in two R0 sessions

Objectives

The two primary objectives of the study were as following:

1. To access the efficacy of R0 technique for tattoo removal in skin types IV to VI.

Figure 2: (A) A tattoo on forearm. (B) Grade 5 improvement with three R0 treatments

2. To evaluate the KD scale and its correlation to the number of sessions actually required for tattoo clearance.

Materials and Methods

Twenty-two patients were treated with a QSNY laser (Spectra XT; Lutronic, South Korea). All patients had amateur tattoos, which were monochromatic (black in color). After thorough counseling, written informed consent was obtained from each individual. Standard clinical photographs (Canon EOS DSLR, similar exposure, fixed distance and background) were taken before the onset of therapy.

Inclusion criteria were fresh tattoos, previously untreated with any other method.

Exclusion criteria were as follows: patients with keloidal tendency, bleeding disorders, local infection, pregnancy/lactation, and tan.

Tanned patients were primed with sunscreen lotion of 30 sun protection factor at least 15 days before the onset of therapy. They were also asked to apply

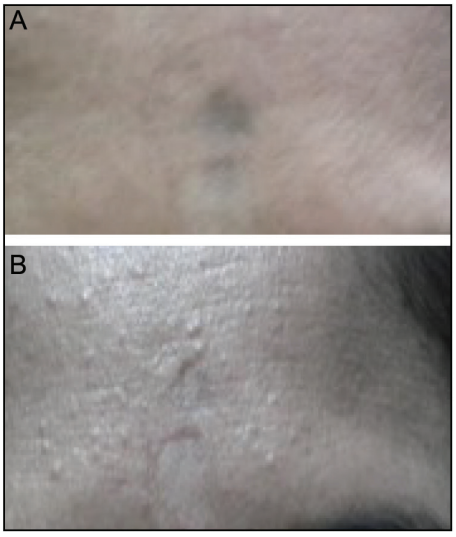

Figure 3: (A) Forehead tattoo. (B) Grade 5 improvement with single R0 treatment

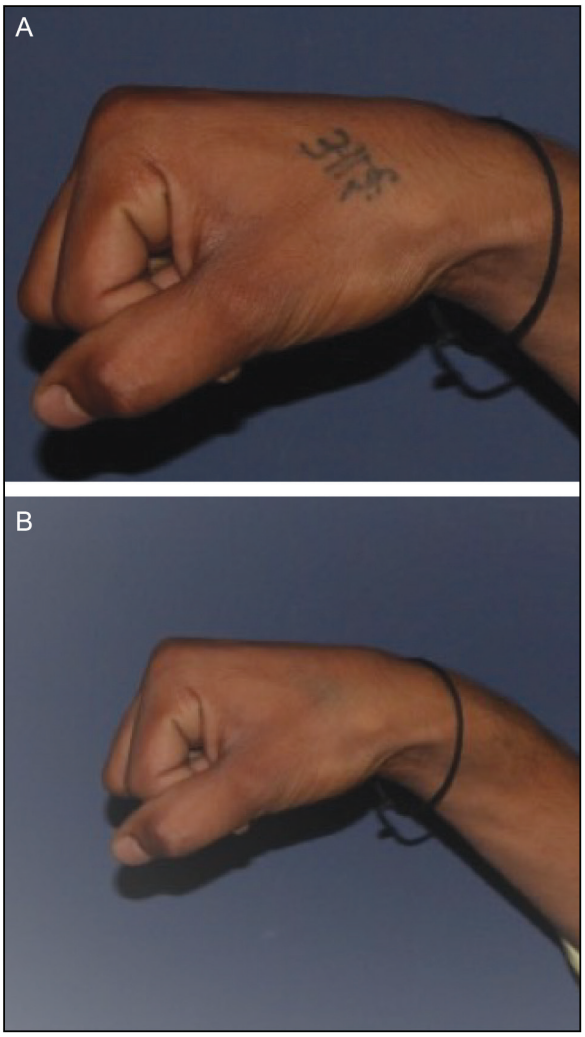

Figure 5: (A) A tattoo on hand. (B) Grade 5 improvement with three R0 treatments

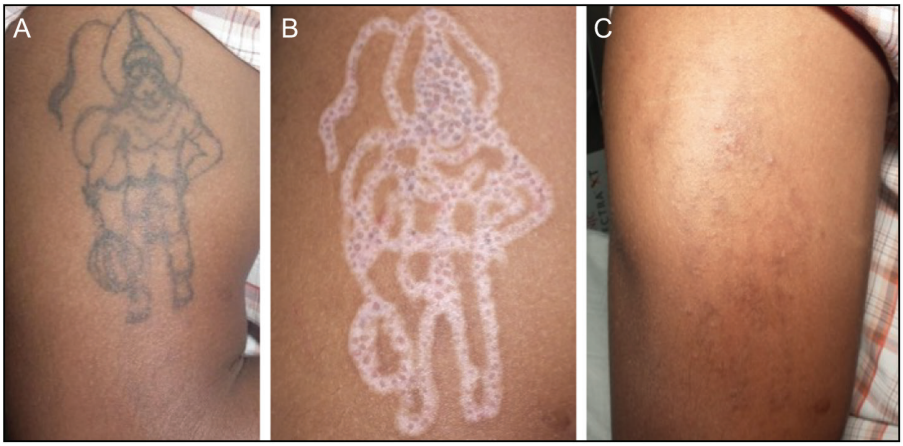

Figure 4: (A) A tattoo on arm. (B) Temporary depigmentation after one session of R0. (C) Grade 5 improvement with 3 R0 treatments with complete repigmentation

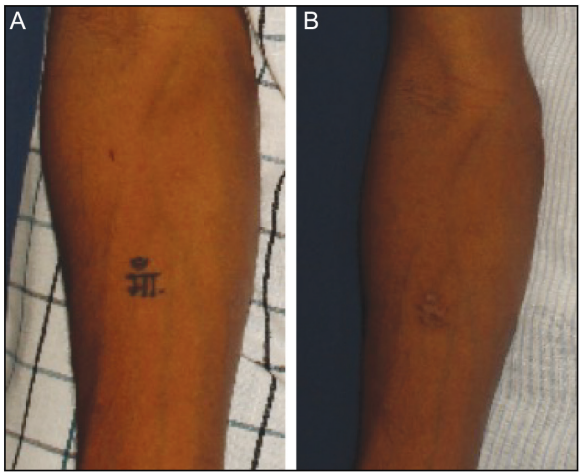

Figure 6: (A) A tattoo on forearm. (B) Grade 5 improvement with two R0 treatments

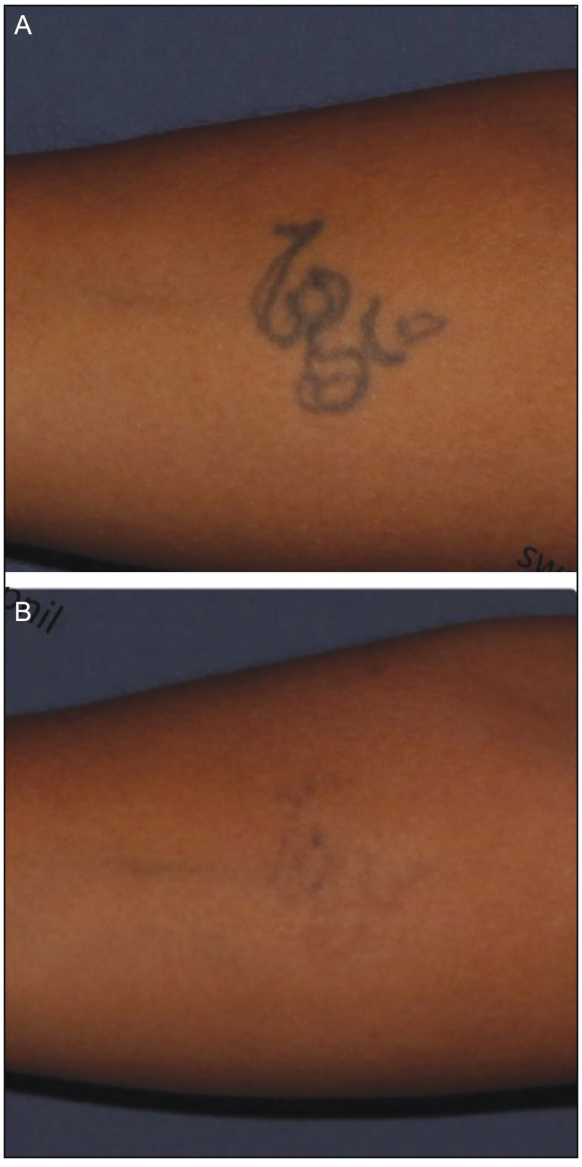

Figure 7: (A) A tattoo on forearm. (B) Grade 5 improvement with three R0 treatments

Figure 8: (A) Scarring R20 method. (B) Grade 3 improvement in four R0 sessions

Figure 9: (A) Forehead tattoo. (B) Grade 5 improvement with single R0 treatment

non-hydroquinone-based skin lightening agents (such as kojic acid, ascorbic acid, and licorice extract combination) for 2 weeks before therapy. Topical anesthesia was used

Figure 10: (A) Forehead tattoo. (B) Grade 5 improvement with single R0 treatment

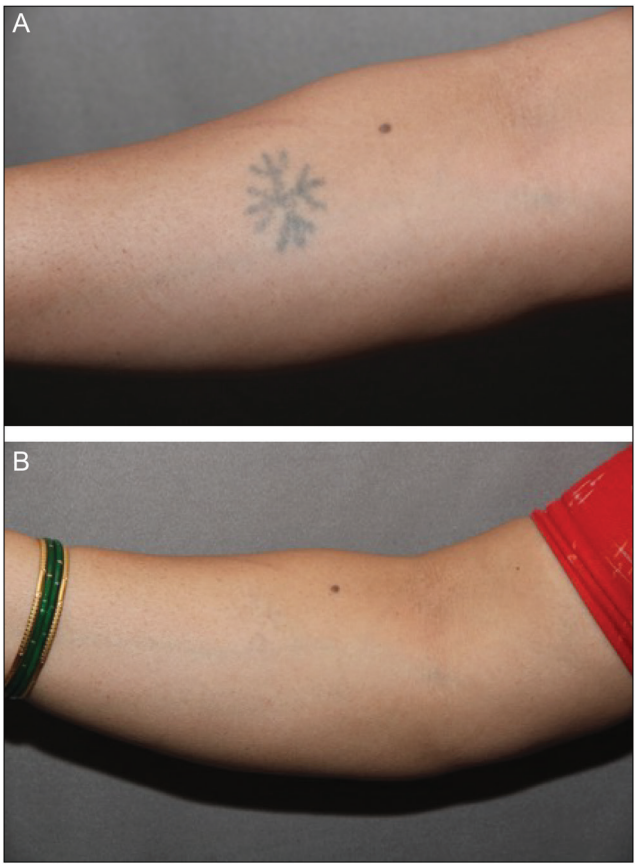

Figure 11: (A) Forearm tattoo. (B) Grade 5 improvement in two R0 sessions

45 min before the procedure. Treatment was performed with 1064 nm QSNY laser with a spot size of 5 mm, fluence of 5–6 J·cm^2, repetition rate of 5 Hz, and fixed pulse duration of 2–5 nanoseconds. We used a modified R0 technique. A single pass was performed to elicit immediate brisk whitening of the tattoo. PFD (Zero-W spray) was applied immediately after each pass on the treated area and gently rubbed in with a cotton tip applicator till the whitening (pseudo-frost) disappeared. This was followed immediately by the next pass of QSNY laser. A total of three passes (first and additional two passes) were made with similar energy as the first pass. Posttreatment ice compresses were given to cool the skin. The sessions

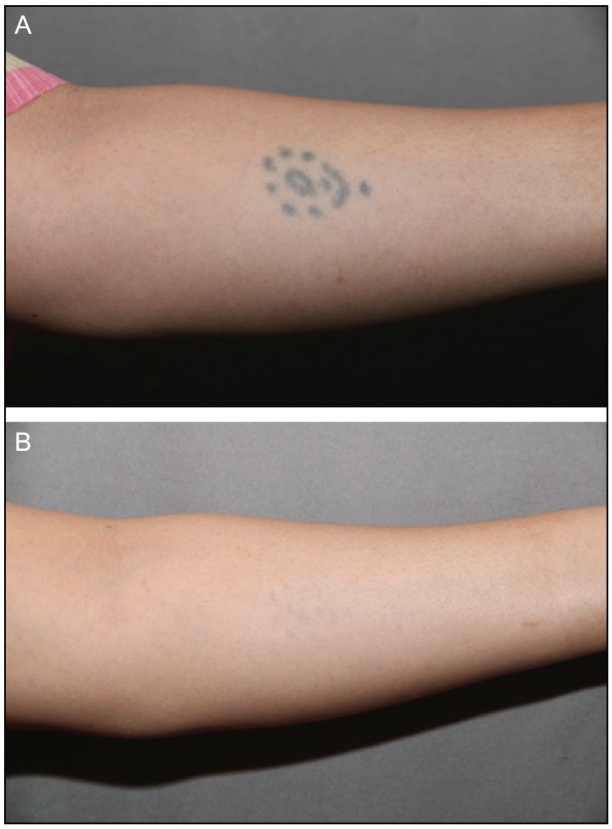

Figure 12: (A) Forearm tattoo. (B) Grade 5 improvement in two R0 sessions

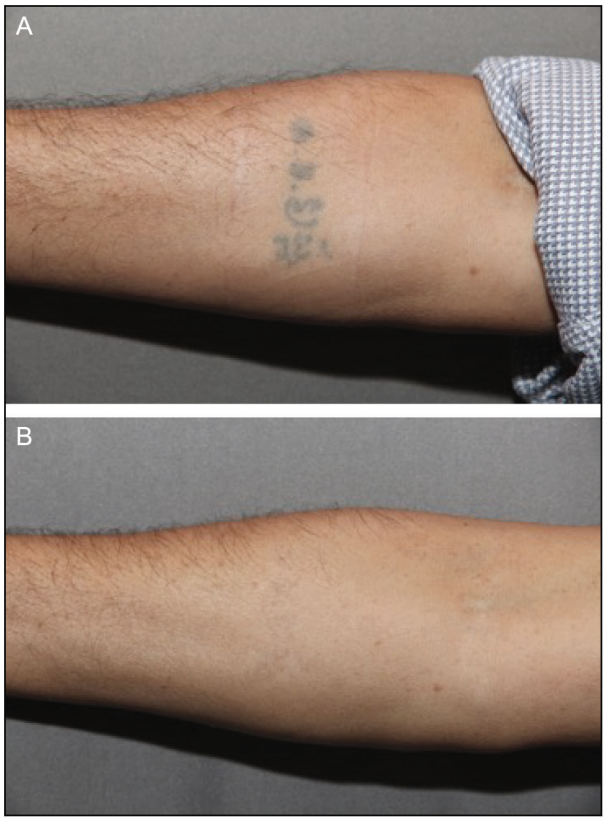

Figure 13: (A) Forearm tattoo. (B) Grade 5 improvement in three R0 sessions

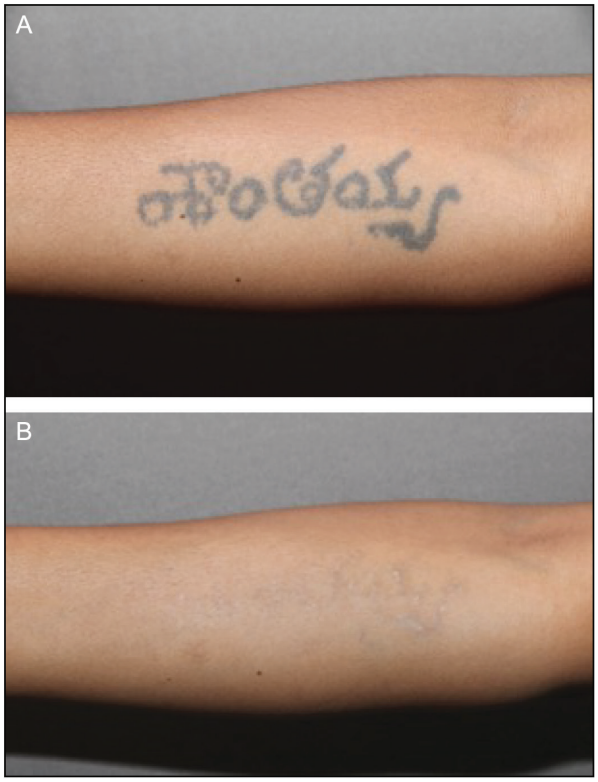

Figure 14: (A) Forearm tattoo. (B) Grade 5 improvement in three R0 sessions

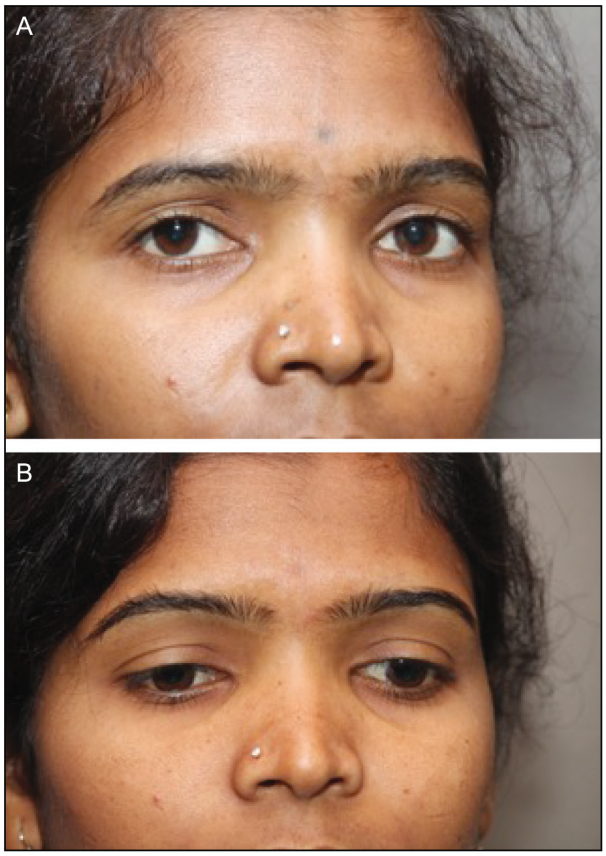

Figure 15: (A) Forehead tattoo. (B) Grade 5 improvement in single R0 session

Figure 16: (A) A tattoo on forehead and root of nose. (B) Grade 5 improvement in two R0 sessions

Figure 17: (A) A tattoo on chest. (B) Grade 4 improvement in three R0 sessions

were performed once a month until significant clearance of tattoos. Patients were followed up for 6 months after the last session and subsequent photographs were taken. Each tattoo was also subjected to analysis by the KD scale and was assigned a numerical value predicting the average number of sessions required for tattoo removal. This was correlated with the actual number of sessions actually needed for clearance at the end of all sessions.

Patients were evaluated by two independent dermatologists, and improvement was graded on scale ranging for 0–5 as follows: Grade 0: no improvement, Grade 1: 1%–25% clearing of ink, Grade 2: 26%–50% clearing, Grade 3: 51%–75% clearing, Grade 4: 76%–90% improvement, and Grade 5: more than 90% to complete clearing of ink.

Results

Patients' demographics and results are present in Table 1. Of the 22 patients, 14 (63.6%) were female and 8 (36.4%) were male. The age of patients ranges from 17 to 42 years. Average time from placement of tattoo to the time of seeking treatment was 2 years, least being 8 weeks. Nine patients (40.9%) had skin type IV, 12 (54.5%) were of type V and 1 (1%) was of type VI. The most common sites for tattoos in our patients were 9 (40.9%) on the forearm, followed by forehead (36.3%), 2 (9%) each on arm and hand, and 1 (1%) on the chest. The predicted number of sessions according to KD scale ranges from 7 to 14 sessions with an average of 9.7 sessions for satisfactory clearance of tattoos. The actual number of sessions required for satisfactory clearance of tattoos by using R0 method was from 1 to 4 sessions. Eighteen of our patients (81.8%) showed Grade 5 improvement, 3 (13.6%) showed Grade 4, and 1 (1%) with scarring showed Grade 3 improvement. Grade 5 improvement was achieved in one session by five patients, two sessions by eight patients, and three sessions by five patients. Grade 4 improvement was achieved by one patient each by one, two, three, and four sessions. Only one patient showed Grade 3 improvement in four sessions and refused further treatment. This was the patient who had scarring resulting from previous session of R20 [Figures 1–22].

The side effects were minimal, the most common being leftover ghost image. One patient showed transient depigmentation, which improved over 2 weeks without any scarring. A patient with a tattoo on wrist showed a slight amount of scarring, which was cosmetically acceptable to her.

Discussion

Tattoo removal using the conventional method of multiple sessions spaced over a number of months has many

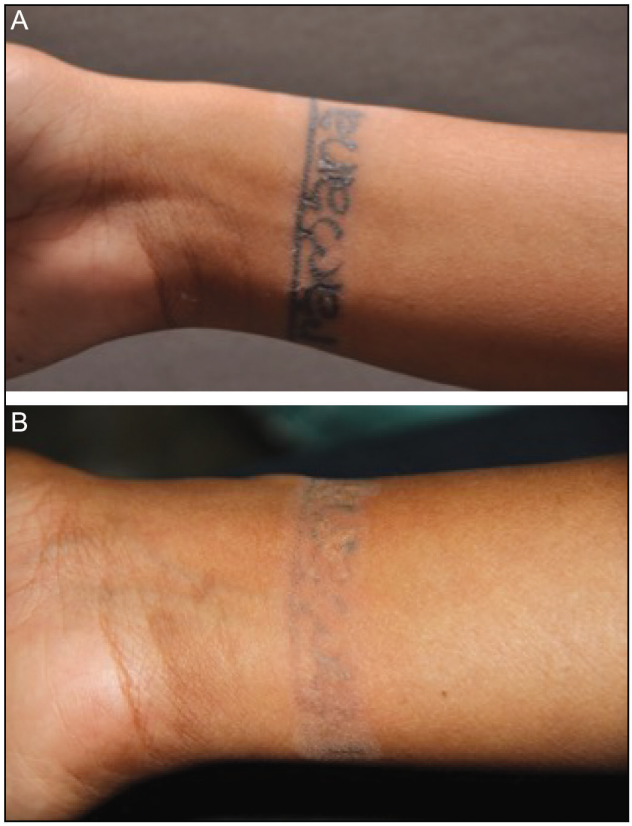

Figure 18: (A): A tattoo on wrist. (B) Grade 4 improvement in four R0 sessions with slight scarring

Figure 19: (A) Forehead tattoo. (B) Grade 5 improvement in a single R0 session

Figure 20: (A) Forehead tattoo. (B) Grade 5 improvement in a single R0 session

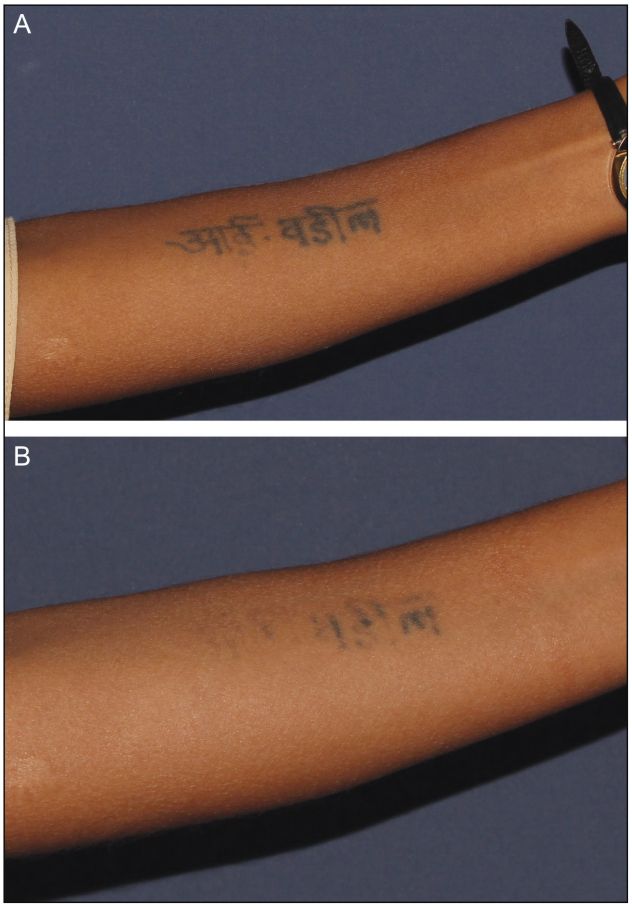

Figure 21: (A) Forearm tattoo. (B) Grade 4 improvement in two R0 sessions

limitations of which the need for many sessions over a prolonged period being the major one. The average number of sessions required with standard QSNY laser ranges for 4–6 sessions for amateur tattoos and 14–16 sessions for professional tattoos in types I–III skin.[5] Jones *et al.*[6] studied tattoo removal in type VI skin and found that only 50% patient showed improvement of 75%–90% at the end of four sessions and another 50% showed 50% improvement. Most of our patients seek quick tattoo removal because of various social, occupational, or personal issues, such as occupational interview or marriage.

The traditional R20 method, described by Kossida *et al.*,[2] requires a long waiting time of at least 1.5–2 h in the clinic. It is impractical for the patient and a busy physician to wait for this long time on a busy day.

The use of PFD along with QSNY laser tattoo removal overcomes this to a large extent. High-energy QSNY laser pulses induce the formation of intracellular steam and microscopic gas bubbles because of cavitation effect.[3,4] This is observed clinically as instantaneous whitening or frosting of the treated tattoo. This whitening is highly optically scattering thereby making the area literally opaque, thus preventing further photons to penetrate deeply. Further passes of laser light are unable to penetrate due to the scattering property of the gas bubbles. PFD is colorless, inert liquid with low surface tension and has unusual ability to absorb gas and helps clear the whitening that follows the initial pass of QSNY laser.[7] Another mechanism by which PFD helps is by optical clearing. As the opaque layer clears, the optical scattering reduces because of the PDF, thereby increasing the permeability of laser light to reach the deeper pigment and thus laser can penetrate deeper.[8]

The additional benefits of using PFD include reduced collateral thermal damage[9] and decreased cutaneous blood flow and edema during the treatment because of tissue compression exerted by PFD.[10]

Reddy *et al.*[3] studied PFD in tattoo removal and reported that R0 method is as effective as the R20 method with a treatment time of 5 min.

Biesman *et al.*[11] in their study evaluated rapid, multi-pass Q-switched alexandrite laser treatment of tattoos through a transparent PFD-infused patch and found that treatment of tattoos with highest tolerated fluence facilitated by a transparent PFD-infused patch clears tattoos more rapidly than conventional methods.

Figure 22: (A) Forehead tattoo. (B) Grade 5 improvement in a single R0 session

In our series, the PFD solution was sprayed immediately following each laser pass on the treated tattoo, which led to the immediate clearing of the frosting (absorption of the gas bubbles), aiding another pass to be given. On an average three passes were made. This allowed faster clearing of the tattoos and significantly cut down the total treatment duration. There were no untoward adverse effects on the use of PFD along with QSNY laser tattoo removal as also reported in the study by Biesman *et al*.[11] Immediate post-procedural side effects, such as erythema, edema, and mild burning sensation, were transient and they subsided in a few hours.

We tried to correlate our results with the KD scale, which predicts the number of sessions required for tattoo removal. Kirby *et al*.[4] found a positive correlation between the actual number of sessions required and predicted the number of sessions by using their scale in 100 patients. A similar study by Gorsic *et al*.[12] showed the average number of treatments required was six (6 ± 2.68). This result correlates with the average KD score of 7.46 with a standard deviation of ±2.03. A good correlation coefficient, $r = 0.743$, was found between the KD score and the number of laser tattoo-removal treatments.[12]

This study got high KD score because of skin color and location of the tattoos. The average predicted treatments were 10.3. By using R0 technique, the number can be reduced to 2–4 sessions safely. Most of our patients (68%) required either one or two sessions. The number of sessions required is significantly lesser than KD scale prediction as the study was conducted on single-colored amateur tattoos.

Conclusion

Tattoo removal with the R0 technique using PFD allows faster clearing of tattoos and significantly cuts down the total treatment duration needed for tattoo removal. The procedure is as safe if not safer than conventional tattoo removal. Most amateur tattoos were cleared in one session with R0 technique. This protocol overcomes the major issue of patient compliance and their desire for rapid tattoo removal.

Study limitation

Split tattoo study comparing single session versus rapid multi-pass R0 method would have yielded better comparison but could not be carried out due to ethical issues.

Declaration of patient consent

The authors certify that they have obtained all appropriate patient consent forms. In the form the patient(s) has/have given his/her/their consent for his/her/their images and other clinical information to be reported in the journal. The patients understand that their names and initials will not be published and due efforts will be made to conceal their identity, but anonymity cannot be guaranteed.

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Nil.

Conflicts of interest

There are no conflicts of interest.

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