

# Treatment and cosmetic outcome of superpulsed CO<sub>2</sub> laser for basal cell carcinoma

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## Abstract

**Introduction:** There are many different treatments for basal cell carcinoma, but the most common is surgical excision. CO<sub>2</sub> laser could be an alternative treatment for many situations in which other treatments are not possible or available.

**Methods:** This follow-up study was performed on 74 (40 female and 34 male) patients with a total of 113 basal cell carcinoma lesions that were pathologically documented. First, the tumor mass was debulked by curettage and later 2 to 5 mm of marginal skin and the debulked area were subjected to 2 to 4 passes of pulsed CO<sub>2</sub> laser.

**Results:** Out of 113 lesions, the nodular type accounted for 67 (59.3%) lesions, and 40 (35.4%) lesions were seen in the nasal area as the most common clinical subtype and site of involvement. One hundred six lesions (93.7%) of basal cell carcinoma showed a cure after one session. Good to excellent cosmetic outcomes were seen in 97 (85.8%) cases.

**Conclusion:** This method appears to be an appropriate alternative treatment for basal cell carcinoma lesions that are smaller than 2 cm, superficial, and pigmented, and have a nodular clinical subtype without an aggressive pathologic pattern. This method should be used with caution in the nasal area with lesions larger than 2 cm.

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## Introduction

Basal cell carcinoma (BCC) is the most common neoplasm and its incidence has been rapidly increasing worldwide during recent decades. This malignancy is a major public health problem that results in disability and deformity (1, 2). The aim of treatment for BCC is eradication of the tumor to prevent local recurrence, minimal complications, and a good aesthetic outcome (1).

A number of physical modalities for treating BCC are available, including radiation therapy (3, 4), electrodesiccation and curettage (5), cryosurgery (6), photodynamic therapy (7, 8) and laser treatment, especially use of a CO<sub>2</sub> laser (9–14). A CO<sub>2</sub> laser emits an infrared wavelength (10,600 nm) that utilizes water as its target chromophore. In addition, the use of the superpulse mode of this laser results in precise ablation of the lesion with minimal thermal diffusion to surrounding tissue, therefore causing minimal damage and scar formation (15, 16). During CO<sub>2</sub> laser therapy, the estimate of the level of skin reached is very important. Observation of pinkness, smoothness, and plane similar to strawberry flesh indicates papillary dermis and observation of large collagen fibers similar to “waterlogged cotton threads” indicates reticular dermis (12, 17). Nevertheless, traditional surgical excision is the most popular and Mohs micrographic surgery (MMS) is the most accurate treatment for BCC (1, 18, 19). This study was carried out to assess the efficacy and cosmetic outcome of the new version of superpulsed CO<sub>2</sub> laser for treatment of different clinical subtypes of BCC on the head and neck.

## Methods

This follow-up study was performed over a period of 40 months from 2006 to 2010 on 74 patients at the Hajdaie Dermatology Clinic of Kermanshah University of Medical Sciences in Iran. A biopsy was performed for patients clinically suspected of having BCC and thus candidates for this method of treatment. Usually the bi-

opsy was taken from well-developed lesions with an appropriate depth that included a portion of the margin and center of lesion. After documentation of BCC, they were given information about this procedure and asked for their consent; the patients were then enrolled in our study. Exclusion criteria included lesions with a diameter larger than 3 cm, penetration of malignant cells deeper than mid-dermis, pregnancy, patients younger than 30, recurrence after excision, comorbidity such as immunodeficiency, and genetic susceptibility for BCC such as xeroderma pigmentosum and keloid formation.

We determined the apparent clinical margin and demarcated 2 to 5 mm of normal marginal skin around the tumor lesion. The extent of the safe margin depended on low- and high-risk BCC lesions. The high-risk BCC lesions (20) include giant lesions. Morpheiform clinical type, infiltrative and micronodular histological subtype, and high-risk location were considered in order to determine the maximum safe margin. After demarcation of a safe margin, the lesion was anesthetized with an injection of 2% lidocaine with epinephrine 1:100,000, or without if there was any contraindication of epinephrine. The tumor mass was debulked by curette until all abnormal or fragile tissue had been removed. Because a more accurate clinical tumor margin was achieved through curettage (21), if the border of the induced defect extended beyond the estimated clinical margin after the debulking procedure, the safe margin was expanded. The safe marginal skin and debulked area were subjected to two to four passes of superpulsed CO<sub>2</sub> laser at 8 to 12 watts and 600 to 800 microsecond pulse duration. The remaining debris tissue between laser passes was wiped with saline-soaked gauze (Fig. 1).

Close inspection of the defect between laser passes was carried out looking for tumor residues, which were subjected to the spot-ting superpulsed CO<sub>2</sub> laser. Tumor residues have a partially different texture and color than the normal surrounding tissue, which is a whitish-yellow color with slight friability during scrubbing (9). There was also observation of the contracting chamois surface

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with the striation surface of normal dermis, which indicates complete tumor ablation (14). The number of laser passes, and the power and pulse of the laser also depended on the size, high-risk location, clinical and pathologic subtype of BCC, and close inspection between laser passes. For large, high-risk location, pathological and clinical subtypes, more passes and greater power and pulse duration of the laser was selected, whereas for small, superficial, pigmented lesions fewer passes and lower power and pulse duration of the laser was selected. Postoperative care included washing with Rivanol 1:1,000 and dressing with silver sulfadiazine cream for 7 to 10 days.

According to tissue alteration induced at the treatment site by the CO<sub>2</sub> laser, histopathological evaluation at the treatment site was not accurate. However, a biopsy was performed during the follow-up period in the presence of any clinical suspicion of recurrence. The cosmetic outcome was classified as: 1) good to excellent, minimal or without scarring, erythema, and pigmentation changes; 2) moderate to good, with moderate scarring and/or erythema and/or pigmentation changes; or 3) poor with prominent atrophic or hypertrophic scarring and hypopigmentation or hyperpigmentation and persistent erythema.

The study was approved by the Ethics Committee of Kermanshah University of Medical Sciences and registered in the IRCT database. Analysis of data was carried out using SPSS software version 16. Data analysis was done using a chi-square test and Fisher's exact test to determine the association between cosmetic results and recurrence by gender, age, and lesion size groups. Levene's test and an independent sample t-test were also used to compare variance and the means of age and lesion size between two groups such as gender and recurrence.

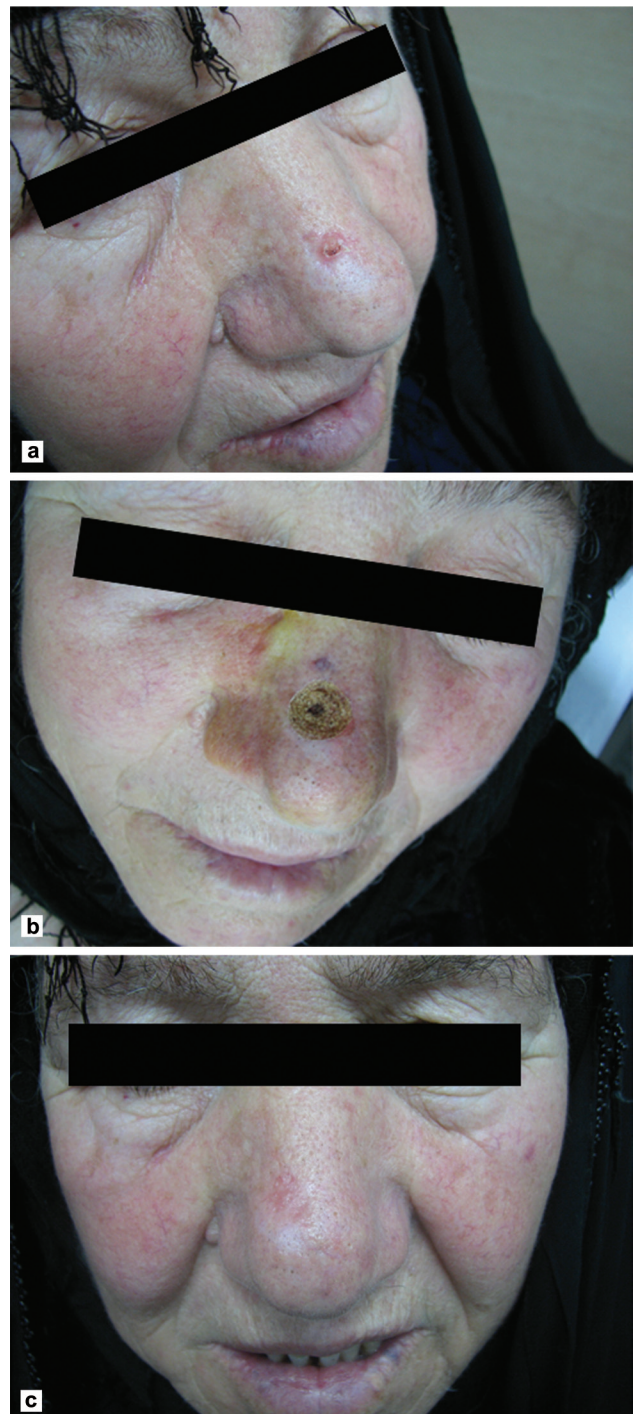
## Results

This study included 113 BCCs in 74 patients that were followed up for 15 to 40 months (mean 28.1 months), with the number of lesions ranging between 1 and 7 (mean = 1.5). The sex distribution was 34 men (45.9%) and 40 women (54.1%), and the lesion diameter varied between 3 and 30 mm (mean = 9.7 mm). The mean age was 61.3 years (range: 30–85), with the most common age being above 70 (31.8%). There were 67 (59.3%) BCC lesions manifested clinically as nodular (the most common form), 35 (31%) pigmented BCCs, 7 (6.5%) superficial BCCs, and 4 (3.5%) morphoeic type (Table 1).

The nasal area was the most common site of treatment 40 (35.4%), and the cheek 26 (23%) and scalp 18 (15.9%) were other common areas. Out of 113 lesions, 106 lesions (93.7%) showed a cure in one session, and only seven lesions (6.2%) showed a recurrence (Tables 2, 3). In recrudescence lesions, relapse was often seen after 4 to 6 months and usually in a marginal region of the site treated. All recurrent lesions showed a complete cure after the second session with CO<sub>2</sub> laser therapy with the same protocol (Fig. 2). Out of seven recurrent lesions, four (57.1%) were seen in the nasal area and six (85.7%) cases of recurrence occurred as a nodular type; these were the most common site and clinical subtype of recurrence (Table 2). Recurrence in males was more common than among females ( $p = 0.043$ ) and out of five lesions larger than 2 cm relapse occurred in two (40%) lesions ( $p = 0.467$ ) but recurrence was not more common in any particular age group ( $p = 1$ ). In histopathological evaluation, the nodular type ( $n = 68$ , 60.2%) and nodulocystic type ( $n = 22$ , 19.5%) are the most common histopathological types (Table 1). The most common recurrence rates based on histopathological subtype were seen in infiltrative ( $n =$

4, 57.1%), micronodular ( $n = 2$ , 28.6%), and nodular ( $n = 1$ , 14.2%) types, respectively (Table 2).

In relation to the cosmetic outcome, 97 (85.8%) lesions showed a good to excellent outcome, 14 (12.4%) a moderate to good outcome, and 2 (1.6%) a poor cosmetic outcome. In the nasal area good to excellent, moderate to good, and poor cosmetic outcomes were seen in 32 (80%), seven (17.5%), and one (2.5%) case, respectively (Table 3). Only one patient with a significant scar in the nasal area needed further treatment and underwent surgical repair. In the nodular type there were 54 (80.6%) good to excellent results, 12 (17.9%) moderate to good results, and one (1.5%) poor cosmetic outcome (Table 3). The cosmetic outcome was better in females with lesions smaller than 1 cm and between 40 to 70 years old ( $p = 0.179$ ).



**Figure 1** | a) Patient with nodular BCC in nasal area, b) Tumor mass of BCC and safe margin treated with curettage and CO<sub>2</sub> laser, c) Post-treatment site with good cosmetic outcome.



**Table 1** | Distribution of BCC lesions and patient characteristics.

Characteristic		Frequency	Percent	
Clinical type	Pigmented	35	31.0	
	Nodular	67	59.3	
	Superficial	7	6.2	
	Morpheaform	4	3.5	
Treatment result	Cure	106	93.8	
	Recurrence	7	6.2	
Cosmetic outcome	Good to excellent	97	85.8	
	Moderate to good	14	12.4	
	Poor	2	1.8	
Treatment location	Chin	3	2.7	
	Nose	40	35.4	
	Neck	2	1.8	
	Cheek	26	23.0	
	Ear	5	4.4	
	Inner canthus	2	1.8	
	Upper lip	1	0.9	
	Upper lid	2	1.8	
	Lower lid	5	4.4	
	Forehead	8	7.1	
	Scalp	18	15.9	
	Temple	1	0.9	
	Size (cm)	< 1	61	54.0
		1–2	45	39.8
> 2		7	6.2	
Age (years)	< 50	13	17.6	
	50–59	20	27.0	
	60–69	18	24.3	
	> 70	23	31.1	
Pathologic subtype	Nodular	68	60.2	
	Nodulocystic	22	19.5	
	Micronodular	5	4.4	
	Infiltrative	7	6.2	
	Superficial	7	6.2	
	Morpheaform	4	3.5	
Total		113	100	

## Discussion

In our study 113 BCC lesions in the head and neck area in 74 patients with different clinical and pathological subtypes were treated with two to four passes of a superpulsed CO<sub>2</sub> laser. The cure rate was 106 (93.8%) and a good to excellent outcome was observed in 97 (85.8%). Adams et al. (22) concluded in 1979 that conservative therapy of 25 superficial BCCs using a single non-overlapping continuous mode of a CO<sub>2</sub> laser is not an adequate treatment due to a 50% recurrence rate.

In another study, which included 52 patients, 370 superficial BCCs on the limbs and the trunk were treated by a combination continuous wave of CO<sub>2</sub> laser and curette. The patients were followed up for a mean period of 19.9 months and no recurrence in the lesions treated was observed, but hypertrophic scarring occurred in 5% of the patients (9). In this study, only superficial types of BCC that were located on the trunk and extremities were selected and, because of the use of continuous mode of the CO<sub>2</sub> laser, there was an increased possibility of complication. Humphreys et al. (11) performed a pulsed mode of a CO<sub>2</sub> laser with a concurrent histopathological study and concluded that 4 mm margins with three passes of ultrapulse with a CO<sub>2</sub> laser (500 mJ, 2–4 W) is the most favorable treatment in superficial BCC. In this study, superficial types of BCC were also subjected to laser therapy.

Compolmi et al. (12) also performed superpulsed CO<sub>2</sub> laser treatment on 140 patients with superficial and nodular BCC coupled with intraoperative histopathological and cytological assessment. This study found a desirable healing outcome without any recurrence after 3 years of follow-up.



**Figure 2** | a) Patient with nodular BCC in nasal area, b) Recurrence in margin of treated site after 4 months, c) Twelfth month after retreatment of recurrent site.

Horlock et al. (13) reported the use of multiple passes of pulsed mode CO<sub>2</sub> laser in the treatment of 21 superficial, 28 nodular, and two infiltrative BCC tumors combined with intraoperative clini-

cal and histopathological examination. They concluded that this method was most effective for superficial BCC and nodular types less than 10 mm.

Mohs micrographic surgery is the choice treatment for BCC (1, 19, 23) but this procedure is time-consuming, requires a skilled surgical and pathological team, requires special equipment, and is not available in most area of world. Although histopathological assessment may be valuable during CO<sub>2</sub> laser therapy, it provides an inaccurate assessment for detection of residual tumor due to the alteration of the tissue during laser therapy.

One major concern of surgeons is the recurrence of BCC due to incomplete excision. In this situation, repair of a BCC defect by simple closure, flap, and graft leads to anatomic distortion, in addition to discontinuous growth and obscuring of malignant cells by induced scars, thus making precise identification of the tumor margin more difficult (24, 25).

The recurrence rate in our protocol was 6.2% and was more common at the margin of the site treated. All recurrent lesions were subjected to the same procedure, which led to a complete cure in all of them. However, there is no concern about the recurrence of BCC following laser therapy because our method does not induce anatomic distortion, which results in early detection of recurrence at the precise location and easy access to the extent of the tumor. Therefore the treatment of recurrence by CO<sub>2</sub> laser is successful and uncomplicated. We found that 57.1% of recurrence occurs in the nasal area, which is consistent with many previous studies (26–28). The reasons include embryologic fusion planes,

insufficient margins because of concern regarding nasal deformity, and a tendency to fan-out and spread but rarely to invade the perichondrium (29, 30).

Our study with a clinical pathological correlation indicated that recurrence most often occurs in the nodular clinical subtype (n = 6, 85.7%). The infiltrative and micronodular histopathological subtype is also the most common type associated with recurrence, and therefore the nodular clinical subtype with infiltrative and micronodular histopathology is not suitable for CO<sub>2</sub> laser therapy.

A good to excellent cosmetic outcome was observed in 97 (85.8%) of the lesions treated. The results showed that the cosmetic outcome was better in females with lesions smaller than 1 cm and 40 to 70 years old (p = 0.179). Better cosmetic results in females may be due to more assiduous wound care. In small lesions (less than 1 cm), the selection of a minimum safe margin and lower laser power and passes may be associated with better cosmetic results.

We found curettage and superpulsed CO<sub>2</sub> laser to be an appropriate alternative treatment for multiple lesions smaller than 2 cm that were superficial, pigmented, and nodular clinical subtypes without the aggressive pathology of BCC lesions with an acceptable cosmetic outcome. This method is not recommended for micronodular, infiltrative pathological subtypes or for morpheaform clinical subtypes larger than 1 cm.

We recommend future studies to obtain accurate information on outcome and performing long-term follow-up.

**Table 2 | Result of treatment in one session based on variables.**

Variables	Result			p value	
	Cure	Recurrence	Total		
Location	Chin	3	0	3	0.242
	Nose	36	4	40	
	Neck	1	1	2	
	Cheek	26	0	26	
	Ear	5	0	5	
	Inner canthus	2	0	2	
	Upper lip	1	0	1	
	Upper lid	0	2	2	
	Lower lid	5	0	5	
	Forehead	8	0	8	
	Scalp	18	0	18	
	Temple	1	0	1	
	Size (cm)	< 1	58	3	
1–2		43	2	45	
> 2		5	2	7	
Clinical subtype	Pigmented	34	1	35	0.231
	Nodular	61	6	67	
	Superficial	7	0	7	
	Morpheic	4	0	4	
Pathologic subtype	Nodular	67	1	68	
	Nodulocystic	22	0	22	
	Micronodular	3	2	5	
	Infiltrative	3	4	7	
	Superficial	7	0	7	
	Morpheaform	4	0	4	
	Total	106	7	113	
Gender	Male	28	6	34	0.043
	Female	39	1	40	
Age (years)	30–39	7	1	8	1.0
	40–49	5	0	5	
	50–59	18	2	20	
	60–69	16	2	18	
	> 70	21	2	23	
Total	67	7	74		

**Table 3** | Cosmetic outcome based on variables.

Variables	Cosmetic outcome			Total	p value	
	Good to excellent	Moderate to good	Poor			
Location	Chin	2	1	0	3	0.187
	Nose	32	7	1	40	
	Neck	2	0	0	2	
	Cheek	23	2	1	26	
	Ear	5	0	0	5	
	Inner canthus	1	1	0	2	
	Upper lip	1	0	0	1	
	Upper lid	2	0	0	2	
	Lower lid	4	1	0	5	
	Forehead	8	0	0	8	
	Scalp	17	1	0	18	
	Temple	0	1	0	1	
<b>Total</b>	<b>97</b>	<b>14</b>	<b>2</b>	<b>113</b>		
Age	30–40	5	2	1	8	0.179
	40–50	4	1	0	5	
	50–60	15	5	0	20	
	60–70	15	3	0	18	
	> 70	20	2	1	23	
<b>Total</b>	<b>59</b>	<b>13</b>	<b>2</b>	<b>74</b>		
Gender	Male	28	4	2	34	0.605
	Female	31	9	0	40	
<b>Total</b>	<b>59</b>	<b>13</b>	<b>2</b>	<b>74</b>		
Size	< 1	54	6	1	61	0.375
	1–2	38	6	1	45	
	> 2	5	2	0	7	
<b>Total</b>	<b>97</b>	<b>14</b>	<b>2</b>	<b>113</b>		
Clinical subtype	Pigmented	34	1	0	35	0.054
	Nodular	54	12	1	67	
	Superficial	5	1	1	7	
	Morpheaform	4	0	0	4	
<b>Total</b>	<b>97</b>	<b>14</b>	<b>2</b>	<b>113</b>		

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