Original article

The Performance of Microdermabrasion Machine Based on Vacuum Pressure Drop

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Abstract

Microdermabrasion in cosmetic field is a mild process in relation to treatment of human facial skin by removing any dead and damage cells, fat spots or impurities adhered to human face. A sudden malfunction of working operation of microdermabrasion machine has been found as significant problem, which is expected due to motor blockage in the machine affected the machine performance that in turn causing shorter machine lifetime. The motor blockage in the machine has been investigated that is usually caused by accumulation of fats or impurities hindering the motor operation. Before using an air filter in its vacuum system it is reported that the efficiency of machine lifetime is only about two months based on five times usage daily, however, after applying the air filter installed in the machine the lifetime getting increased to six months with same frequency of daily use. This investigation is emphasized on the role of air filter in the vacuum system applied to microdermabrasion machine in order to prolong the machine lifetime.

Keywords: Air filter; lifetime; machine; microdermabrasion; vacuum pressure

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Introduction

Microdermabrasion is an act of mechanical exfoliation used for aesthetical purposes corresponding with removal of superficial epidermal layer Fak, M. et al, (2018); Savardekar, P. (2007). In cosmetic field, the microdermabrasion machine is used to remove acne scars, stretch marks and overcome photoaging and hyperpigmentation related to facial treatment. According to Samantha et al., (2011) the application of microdermabrasion is effective for skin therapy and also aiding skin treatment due to scars and keloids Mariane, F., et al. (2014). In addition, microdermabrasion technology has become increasingly popular for skin rejuvenation and exfoliation Sadick, N. & S., Finn, N. A. (2002).

Microdermabrasion machine was first introduced for skin therapy in 1985 Domyati, M. et al, (2016). According to Samuel and Robert Samuel, J. B. & Robert, W. B. (2000), the patient skin has to be cleaned, dried and freed from all make-up and any oil before starting the facial treatment. The technique of microdermabrasion machine has several methods using mechanical abrasion made of jets of zinc oxide or aluminum oxide crystals, fine organic particles, or a roughened surface. Recent microdermabrasion machines are provided for more than one method. More than 100 types of microdermabrasion machine are available in market Mahony, M. (2014).

So far, many articles of microdermabrasion issues have only reported from the viewpoint of cosmetic importance referred to the application of the device. Up to date, investigation on microdermabrasion machine performance especially referred to technical obstacles has not been reported yet and therefore, this preliminary study attempts to present the drawback of microdermabrasion machine from the standpoint of technical matter.

This study uses microdermabrasion, a portable machine namely *Athena Exfoliator* to investigate the technical matter with respect to machine operation regarding machine lifetime and part of component application. The investigation emphasizes on the effect of air filter installed in vacuum channel of this machine and then correlated with machine lifetime. The type of machine applied in this study does not use any abrasive crystal and therefore, this is the benefit of this machine type resulting as preference for many users. In addition, it does not use any disposal product in relation to reduction of economic expense.

Experimental

The experiment was implemented on the portable microdermabrasion machine that consisted of several steps as follows: (i) preparation of instrumentation, (ii) measurement of vacuum pressure with a vacuum gauge, (iii) disassembly of microdermabrasion machine, (iv) cleaning machine motor and vacuum channel, (v) installing and connecting air filter with vacuum channel, (vi) re-measurement vacuum pressure with a vacuum gauge using air filter installed to the machine, and (viii) data collection and analysis.

Operation of microdermabrasion machine

In order to operate the microdermabrasion machine, the hand piece part provided with a tip pasted directly to surface of facial skin. The machine tip is installed at the edge of hand piece that integrated to the machine by a connecting pipe.

Table 1. Characteristics of microdermabrasion machine *"Athena Exfoliator"* .

Parameter	Characteristic
Voltage (AC)	220-230 V
Frequency	60/50 Hz
Current	1 x 5 Amp
Vacuum pressure	*Mild* (< - 26 cm Hg) *Strong* (> - 41 cm Hg)
Size	255mm x 238mm x 135mm
Weight	5 kg
Length of connector pipe	125 cm

The tip has rough surface to abrade skin dead/damage cells. There is a hole in the middle part of the tip to absorb all fats and dead/damage cells from human facial skin. The tip has to be sterile to assure the skin safety of user.

The specification of microdermabrasion machine "Athena Exfoliator" used in this study corresponding with its voltage, frequency, electrical current, vacuum pressure, size and weight of machine, as well as length of connecting pipe, which is shown in Table 1.

2.2 Main components of microdermabrasion machine

The main parts of microdermabrasion machine include:

1. Vacuum Motor
2. Main Board
3. Pressure regulator valve (solenoid valve)
4. Electric switch

The function of each component is as followed: (i) Vacuum Motor – This component consists of coil emitting electromagnetic wave in order to rotate the rod. The two ends of its rod are wheels to change direction of rotation to alternate movement; (ii) Main Board – This control panel is to manage function of all components of the microdermabrasion machine such as to control the function of vacuum motor and pressure regulator valve; (iii) Pressure regulator valve (Solenoid valve) – The function of pressure regulator valve is to arrange the vacuum pressure that classified into two criteria, i.e. *mild* (< - 26 cm Hg) and *strong* (> - 41 cm Hg) pressures; and (iv) Electric switch – The electric switch uses electromagnetic wave to manage low electrical current related to low power that can produce moderate electrical voltage.

Results and Discussion

Data collection are recorded and obtained from vacuum pressures on the basis of every 4 weeks, which the vacuum pressures were continually weakened during 12-week observation both for *mild* and *strong* criteria. The capability of vacuum motor in microdermabrasion machine was both reduced by 11 pressure unit (cm Hg) for *mild* criteria (from 26 to 15 cm Hg) and 22 pressure unit for *strong* criteria (from 50 to 28 cm Hg) in 12-week observation (data not shown here).

The significant reduction of vacuum pressure gives conclusion that there is any troublesome with the vacuum motor assumed to be corresponding with any blockage in the vacuum channel probably caused by accumulation of dead/damage

cells from human facial skin and impurities in the vacuum cavity.

Furthermore, it seems that the reduction of vacuum pressure in *strong* category is about doubled that one of *mild* category during weeks of observation. It is probably in relation to larger vacuum pressure in *strong* category yielded stronger suction effect on drawing fat impurities and dead skin cells from human facial skin yielding more accumulation in vacuum cavity.

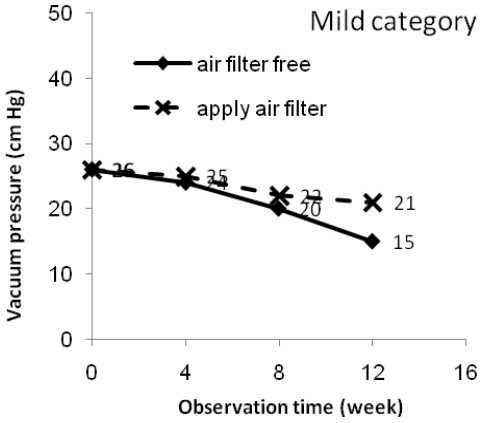

Fig 1. Microdermabrasion machine for *mild* category (< - 26 cm Hg).

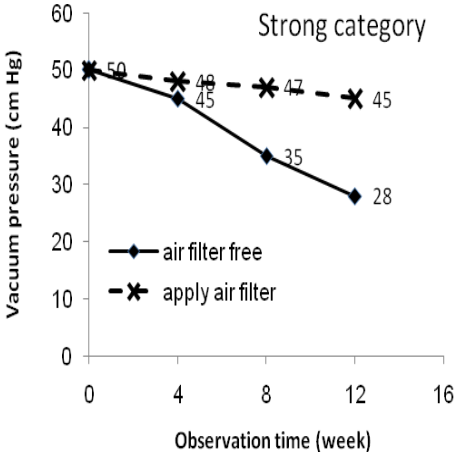

Fig 2. Microdermabrasion machine for *strong* category (> - 41 cm Hg).

In order to overcome this obstacle the machine and vacuum cavity need to be cleaned regularly and this machine becomes more sustainable. This problem generates an idea to diminish the accumulation effect of impurities by providing an air filter in the vacuum channel. It is assumed that the air filter can resist any fat impurities and dead cells entering the vacuum cavity. In this experiment, a piece of air filter made of certain type of polymer installed in the vacuum channel.

Table 2. Average data of vacuum pressures of microdermabrasion machine applying air filter polymer in the vacuum channel (Three replications)

Observation (Weekly)	Vacuum pressures (cm Hg)	
	Mild < - 26	*Strong* > - 41
0	-26	-50
4	-25	-48
8	-22	-47
12	-21	-45

Moreover, the results of vacuum pressure using air filter polymer installed in the microdermabrasion machine are presented in Fig. 1 and Fig. 2. The reduction of vacuum pressures from starting point until at the end of observation, i.e. at the end of the 12th week is found to be 5 pressure unit (cm Hg), either for *mild* category or *strong* category applying air filter polymer (Table 2).

It was found that there is remarkable difference of vacuum pressure data yielding from microdermabrasion machine applying air filter installed in vacuum channel and the machine without air filter for both *mild* and *strong* category (Fig. 1 and Fig. 2). Fig. 1 shows the vacuum pressure data of *mild* category compared between applying air filter installed in vacuum channel and without air filter. Fig. 2 shows the vacuum

pressures of *strong* category compared between machine using air filter and air filter free. It seems that the reduction of vacuum pressures is consistent with lifetime of microdermabrasion machine both for *mild* and *strong* category using air filter or air filter free. The providing of air filter polymer in portable microdermabrasion machine shows better performance of the machine in terms of much more stable results of vacuum pressures obtained during 12 weeks of observation.

Further examination on Fig. 1 the vacuum pressure for *mild* category (< - 26 cm Hg) at the end of observation (12th week) experienced reduction by 6 pressure unit (cm Hg) without using air filter in the machine. However, the reduction of vacuum pressure for *strong* category (> - 41 cm Hg) at the end of observation (12th week) was more dramatic falling by 17 pressure unit (cm Hg) as presented in Fig. 2 that is almost three times larger than that shown by *mild* category (< -26 cm Hg) (Fig. 1).

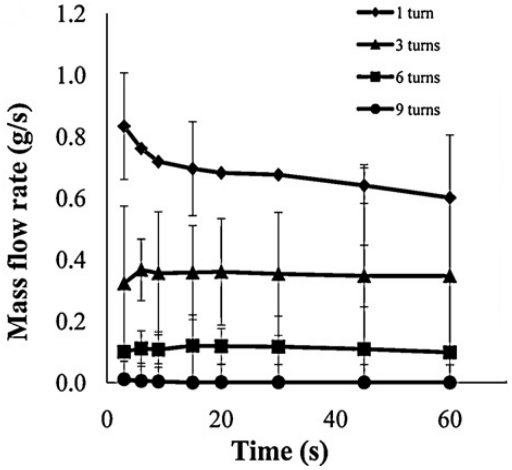

Fig 3. Crystal mass flow rate as a function of time at varied crystal knob turns. Suction pressure – 50 kPa. Alumina crystal (Samantha, N. et al, (2011).

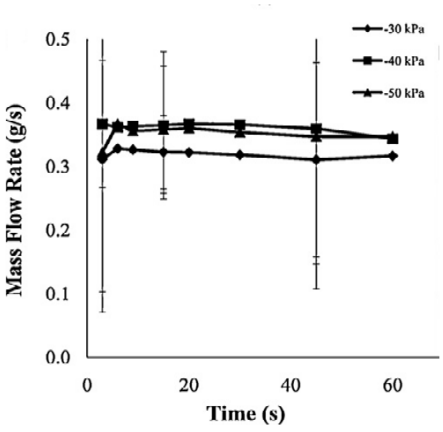

Fig 4. Crystal mass flow rate as a function of time at varied suction pressures. Three knob turns. Alumina crystal (Samantha, N. et al, (2011).

Unfortunately, very much little information has been available related with effect of parameters used in microdermabrasion machine in correlation with machine lifetime. However, Samantha, N. et al, (2011) ever reported the characteristics of dermabrasion machine in terms of suction pressure (vacuum pressure) and crystal flow rate. The *Athena Exfoliator* microdermabrasion machine used in this study does not apply any abrasive crystal for operation, so this is the added value of this

Athena Exfoliator machine

Furthermore, Samantha, N. et al, (2011) studied the relationship between crystal flow rate in terms of mass flow rate (g/s) and time of observation (second) at varied knob turns and suction pressures and the results shown in Fig. 3 and Fig. 4. The crystal mass flow rate expressed in relative unit ranging from 0 (highest flow rate) to 9 (lowest flow rate). The mass flow rate is directly measuring the mass moving through the machine. Moreover, zero knob turns is the maximum valve opening, whereas at nine turns the valve is almost closed. The time of observation is ranging for 3 – 60 s. As shown in Fig. 3 there is a consistency between number of knob turns and mass flow rate at observation time of interest, for example, mass flow rate at one knob turn is much higher than that of six knob turns. This is reasonable, since one knob turn at the position of almost maximum valve opening, whereas at six knob turns the valve opening getting much narrowed.

On the other hand, as shown by Fig. 4 the different suction pressures (-30 kPa, -40kPa, and -50 kPa) at observation time of interest showed less remarkable effect on mass flow rate at medium knob turns (three knob turns). It is apparent that degree of valve opening gives more effect on crystal mass flow rate rather than that of suction pressure effect based on detailed examination of Fig. 3 and Fig.4.

Although this work is still in the level of preliminary study, nevertheless the facts finding obtained from this study can be assumed as a valuable contribution for microdermabrasion machine performance using for human facial skin, which has never been discussed in any detail report previously. It should be noted that previous work as reported by Samantha, N. et al, (2011) was an investigation on porcine skin, while this study is in relation with human facial skin. As mentioned above, the *Athena Exfoliator* machine used in this study does not need any abrasive crystal, so less economic expense required for operating this machine.

Conclusion

The lifetime of microdermabrasion machine can be prolonged by applying air filter polymer installed in vacuum channel to resist any dead/damage skin cells from human facial skin entering the vacuum cavity and therefore, a better performance obtained in this investigation.

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