Depilation By Pulsed Ruby Laser - A Review
M Clement, M Kiernan, P Bjerring

Abstract
This paper is intended to outline the current thinking regarding the process involved in depilation by pulsed ruby laser. Key laser parameters will be discussed together with their impact on the outcome of the procedure. A parallel series of clinical trials have been carried out in a number of centres. A summary of the results of these trials is included. These show that there is an ever increasing body of evidence emerging in support of the technology.

1. Introduction
The aim of this report is to review the progress of the extensive activity carried out within a network of collaborating establishments in the laser depilation field. A number of highly skilled and qualified clinicians and scientists have been involved in the program at the following organisations:

- R.A.F.T. (The Restoration of Appearance and Function Trust), UK.
- The Birmingham Children's Hospital, Birmingham, UK.
- Swansea Institute, Swansea, UK.
- The University Hospital, Aarhus, Denmark.
- The Molholm Clinic, Vejle, Denmark.

The programs have been diverse in nature including studies into treatment optimization, efficacy, laser parameter optimization, histology and microbiology. This review does not contain the sum total of the current knowledge amassed, several scientific manuscripts are in various stages of preparation. Submissions to major international journals are underway. The journals in question forbid public disclosure of these recent scientific advancements prior to publication.

Work started in earnest in this field in early 1992 at locations in Europe and the USA. Arguments will rage regarding which group was first to prove the technique but these issues are not the subject of this review.

What is indisputable is the fact that the long-term suppression of hair growth is potentially an application of laser technology that may surpass in magnitude all other market sectors hitherto developed in this field. The need for long-term hair removal can be divided into two distinct areas, those where there is an identified clinical need and secondly those where there is a cosmetic requirement.

There is confusion regarding terminology in the field, the following is a standard definition for depilation and epilation.

- **Depilation**: the removal of unwanted hair by destroying the part of the hair shaft that projects from the skin surface.
- **Epilation**: the process of the destruction of the hair root resulting in the permanent removal of an unwanted hair.

Throughout this paper the term laser depilation will be used to describe the long-term suppression of hair growth via the application of laser light to tissue.

1.1 The Clinical Need
Hair growth in humans is often thought of as a cosmetic issue. Hair however has key sensory, frictional and protective roles. Patients who experience abnormal hair loss or unwanted hair growth can suffer psychologically and often seek medical advice.
In many clinical situations, excessive hair growth, or hirsutism, can be a side effect of an underlying medical condition or in some cases the result of drug therapy. Both situations can have a major detrimental impact on the individual’s well being.

A common problem encountered is the hormonal imbalance induced when suffering from polycystic ovaries. Here the hair growth on the body and face is dramatically increased, in some reported cases, the sufferer has to shave the facial area twice a day."

Other conditions such as pilonidal sinuses are caused by in-growing hair at the base of the spine.

In plastic and reconstructive surgery procedures, the presence of hair at the donor site is often undesirable. Examples of this include cases where forearm tissue is used for intra-oral lining or where the scalp skin is used for ear reconstruction. (Figures 1 a and 1 b)

1.2 The Cosmetic Need

In addition to cases of medical need, there is a substantial call for hair removal for cosmetic reasons. The requirement may be driven by fashion or cultural issues. However the impact on the individual can be significant, leading to a substantial demand for easy, painless, low-risk long-term hair removal. The worldwide market for cosmetic hair removal is estimated to be in the order of $14 billion annually. This covers the traditional techniques such as shaving, waxing, electrolysis and depilatory creams.

Electrolysis has been employed as a technique for the removal of unwanted hair for 120 years," In electrolysis low levels of DC current are passed through the tissue between two electrodes. This results in tissue damage and the destruction of hair follicles by the creation of a chemical reaction occurring at the tip of one of the electrodes. Thermolysis on the other hand is performed using high frequency AC at low voltage and current, to thermally destroy hair follicles." The techniques require the insertion of a needle into the follicular infundibulum parallel to the hair shaft and advanced slowly until the base of the follicle is reached, usually at a depth of 3 to 4mm. Both techniques when applied skillfully can be relatively effective, however they are associated with pain and substantial risk of scarring and infection. The process is also extremely time consuming. Of the two, thermolysis (or high frequency) has a somewhat greater risk of scarring and pain."
1.3 Laser-based Depilation

An observation was made by one of the authors of this review that accidental exposure of skin to laser light during a scientific experiment led to long term suppression of hair growth. This discovery was followed by substantial theoretical and experimental studies leading to the prediction of laser parameters that should achieve depilation.

Starting with a basic understanding of the laser-tissue interaction, computer models were constructed to simulate effects on hair and surrounding skin when illuminated with intense pulsed laser radiation. These models allowed the prediction of the laser parameters necessary to achieve depilation whilst minimizing the risk of unwanted side effects. The ultimate goal being a fast and safe procedure which could be carried out on the vast majority of the population.

On completion of the theoretical study, an ethically approved clinical trial was carried out to determine if the computer prediction matched the clinical reality.

2. The Theory of Depilation by Laser

Differing views exist regarding the true mechanism of laser depilation, however the authors believe the following to be a sustainable theory.

Laser depilation is based upon the technique known as "Selective Photothermolysis" This technique was developed in the early 1980's for the treatment of vascular lesions by Pulsed Dye Laser." However it was not identified as a technique for depilation until it became the subject of a patent and later a scientific paper.:"

Photothermolysis is based upon the principle of using laser energy to selectively destroy a target beneath the surface of the skin whilst leaving the healthy surrounding tissue structures intact. The premise is therefore to irradiate the skin surface with a suitable laser source which only deposits its energy in the target, the light passing harmlessly through the other tissue components.

For selective photothermolysis to be achieved, the following criteria have to be taken into consideration:

a) the target must contain a chromophore which can selectively absorb that particular laser wavelength, in some cases the primary target does not contain a suitable chromophore but is in sufficiently close proximity to such a substance to allow selective destruction via a secondary mechanism (this is the case in vascular lesion treatment);

b) the surrounding healthy tissues must have a minimal amount of the target chromophore, allowing light to be transmitted freely through it;

c) the absorption of laser energy in the healthy tissues does not produce any irreversible or long term damage;

d) the laser light incident on the target vessel is sufficient, in both intensity and duration, to induce the desired clinical effect, often this is the heating of the target above a certain threshold and holding it there for a certain minimum period.

An analysis of these requirements leads to a theoretical model which in turn can lead to a set of laser parameters for optimum treatment efficacy. However it is first necessary to understand the mechanism of follicular damage which achieves the suppression of hair growth.

2.1 The Hair Re-growth Mechanism

In humans, hair follicles develop in the foetus during the early stages of its growth. It is therefore hypothesized that by destroying the hair re-growth mechanism with a suitable laser source, permanent removal of unwanted hair can be achieved.v";

It is widely believed that the cells that initiate the growth of hair reside in the region of the follicle between, and include, the bulb and the "bulge" zone (Figure 2).19
During the cyclic phases of hair growth these cells, commonly referred to as “stem” cells, start the growth of new hair after the follicle has been dormant for a period of time. All follicles exist in one of three phases at any moment in time:

- Anagen - growth phase
- Catagen - shedding phase
- Telogen - resting phase

The theory outlined in this review proposes that successful suppression of the growth of hair can only be achieved when the follicle is in the anagen phase. The average period that individual follicles spend in these phases varies significantly from one body location to another. A further variable is the percentage of follicles in one phase or another which also varies considerably from one location to another. Table 1 compiles data on the anagen and telogen cycles, underlining the radical difference observed in different body parts.

Hair densities and growth rates also vary from location to location. This data is recorded in table 2.

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**Figure 2: Physiology of Human Hair**

**Table 2: Typical Human Hair Density and Growth Rates**

<table>
<thead>
<tr>
<th>Body Area</th>
<th>Hair Density</th>
<th>Growth Rate</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>No/mm²</td>
<td>nun/day</td>
</tr>
<tr>
<td>Scalp</td>
<td>13</td>
<td>2.501</td>
</tr>
<tr>
<td>Eyebrow</td>
<td>90</td>
<td>2.401</td>
</tr>
<tr>
<td>Ear</td>
<td>85</td>
<td>2.401</td>
</tr>
<tr>
<td>Cheeks</td>
<td>30-50</td>
<td>8-12.501</td>
</tr>
<tr>
<td>Beard</td>
<td>30</td>
<td>8-12.501</td>
</tr>
<tr>
<td>Ul/Lip</td>
<td>35</td>
<td>4-8.501</td>
</tr>
<tr>
<td>Axilla</td>
<td>70</td>
<td>2.401</td>
</tr>
<tr>
<td>Pubic</td>
<td>70</td>
<td>12.5w</td>
</tr>
<tr>
<td>Arms</td>
<td>80</td>
<td>14-22w</td>
</tr>
<tr>
<td>Leg</td>
<td>80</td>
<td>20-28w</td>
</tr>
<tr>
<td>Thigh</td>
<td>80</td>
<td>20-28w</td>
</tr>
</tbody>
</table>

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**Table 1: The Telogen and Anagen Phases of Human Hair Cycle**

<table>
<thead>
<tr>
<th>Body Area</th>
<th>%</th>
<th>Period</th>
<th>Period</th>
</tr>
</thead>
<tbody>
<tr>
<td>% Telogen</td>
<td>% Anagen</td>
<td>Telogen</td>
<td>Anagen</td>
</tr>
<tr>
<td>Scalp</td>
<td>13</td>
<td>2.501</td>
<td>2.6y</td>
</tr>
<tr>
<td>Eyebrow</td>
<td>90</td>
<td>2.401</td>
<td>3.9w</td>
</tr>
<tr>
<td>Ear</td>
<td>85</td>
<td>2.401</td>
<td>3.9w</td>
</tr>
<tr>
<td>Cheeks</td>
<td>30-50</td>
<td>12-16w</td>
<td>12-1501</td>
</tr>
<tr>
<td>Beard</td>
<td>30</td>
<td>8-12w</td>
<td>9-15m</td>
</tr>
<tr>
<td>Ul/Lip</td>
<td>35</td>
<td>4-8w</td>
<td>14-18w</td>
</tr>
<tr>
<td>Axilla</td>
<td>70</td>
<td>2.401</td>
<td>3.5w</td>
</tr>
<tr>
<td>Pubic</td>
<td>70</td>
<td>12w</td>
<td>1+01</td>
</tr>
<tr>
<td>Arms</td>
<td>80</td>
<td>14-22w</td>
<td>11-16w</td>
</tr>
<tr>
<td>Leg</td>
<td>80</td>
<td>20-28w</td>
<td>15-19w</td>
</tr>
<tr>
<td>Thigh</td>
<td>80</td>
<td>20-28w</td>
<td>15-19w</td>
</tr>
</tbody>
</table>

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**Depilation by Ruby Laser: A Review**

If, by using a laser with suitable output parameters, these stem cells could be eliminated in a controlled manner, the follicle would not be able to produce new hair shafts, hence inducing long term suppression of hair growth.

Obviously there is a very large range of laser types available with widely varying output parameters. However, by close analysis of the key aspects of selective photothermalys outlined earlier, it is possible to narrow the field of applicable lasers substantially.
2.2 Selection of Suitable Laser Parameters

The key laser parameters that are applicable to selective photothermolysis are:

a) Wavelength;
b) Pulse Duration;
c) Energy Density;

Other factors that influence the clinical outcome are the size and spatial profile of the laser spot.

As in the case of the application of lasers to the treatment of vascular lesions, laser depilation is a secondary effect. This complication is due to the fact that the targets, i.e. the stem cells, do not contain a natural chromophore that can be selectively targeted by the laser source. For this reason a suitable absorbing chromophore near to the stem cell region has to be utilized as the energy absorber leading to the destruction of the stem cells by a secondary heating mechanism.

a) Wavelength Selection

By looking at the physical structure of the skin and hair follicle, the nearest suitable chromophores for absorption of the laser energy are the melanins within the hair shaft. The laser light has to pass through the upper skin surface to be absorbed in the hair shaft at a depth corresponding to the location of the stem cells.

In general, the region of the follicle which contains the stem cells is located in the dermal region of the skin. Therefore the laser light has to pass through the epidermis and upper dermis before interacting with the hair shaft. Since the light has to pass through various skin layers prior to interacting with the hair shaft, other chromophores within the skin influence the choice of wavelength.

For the light to penetrate into the skin to the desired depth, the visible and near infrared region of the spectrum is clearly the most suitable. Outside this optical range, the water content of the skin absorbs the incident light very heavily. In the red and near infrared region, the major chromophores within the skin are the melanins and oxyhaemoglobins, the absorption spectra of these being shown on figure 3.

![Figure 3: Absorption Spectra of the Two Major Skin Chromophores](image)

As indicated earlier, the ideal wavelength should have high absorption in the target structure with minimal absorption in the surrounding tissue. Therefore from the absorption spectra in figure 3, the point where the light interaction is high in the target melanin and low in the surrounding vasculature is in the range 640-760nm. This ensures minimum interaction with the oxyhaemoglobin thereby limiting the amount of potential damage to the capillary network of the skin.

By selecting a wavelength in this domain, there are two distinct benefits. Firstly the laser light penetrates the skin to a maximum depth due to the fact that there is no competing chromophore for the incident light. Secondly, because there is little interaction with the vasculature, the risk of bruising after treatment due to damage to the vessels is low, therefore ensuring the patient is not left with unsightly discoloration of the skin after treatment.

Thus the wavelength range developed from the analysis of the skin and follicle structure is in the 640-760nm region. Currently technology offers two laser types that operate in this wavelength domain, the Ruby laser (694nm) and the Alexandrite laser (755nm).

Depilation by Ruby Laser: A Review
Some workers have reported the use of Neodymium-YAG (Nd:YAG) lasers for depilation. Since the Nd:YAG laser operating at
1064nm is not specifically absorbed in the target chromophore, coupled with the fact that the wavelength has a higher water absorption, it would seem logical that this laser is not appropriate for depilation. This would explain why Nd:YAG can only be used in conjunction with the application of opaque substances to the surface of the skin. Even then the mechanism of depilation is difficult to justify and sustain logically."

b) Selection of Pulse Duration

The intention of this theory of depilation is to induce a thermal necrosis in the stem cells. Heat is generated in the cells via a secondary effect which involves the absorption of the incident light energy in the hair shaft. Diffusion of this thermal energy outward to the surrounding tissues eventually reaches the stem cells which are in close proximity to the hair shaft.

The laser-tissue interaction is a photothermal process as distinct from a photochemical or photomechanical interaction.

A photothermal interaction requires a pulse duration of the order of magnitude of thermal relaxation time of the tissues involved. Pulses of less than 1 usec induce in general a photomechanical disruption of the tissue. Laser pulses in this regime are typically produced by Q-switch lasers with durations in the order of 20-40nsec and are primarily used for tattoo and pigmented lesion removal."

The upper pulse duration limit can be determined by the threshold of tissue necrosis, i.e. when irreversible damage is caused by the generation of heat. It is known that when cells are raised to approximately 70°C and held for a time in the order of 1 msec, vital proteins are denatured and cell necrosis sets in. Although it is necessary to induce this necrosis in the stem cells controlling the hair growth, producing non-specific necrosis in the surrounding tissue will lead to scar formation and an unacceptable cosmetic result."

Theoretical calculations can predict the desired pulse duration by using the physical properties of the target structure. By calculating the "Thermal Relaxation" time of the target, the pulse duration necessary for maximum heating can be defined." The thermal relaxation time is that time taken for a body to cool to 50% of its maximum temperature, this is given by:

\[ \tau = \frac{d^2}{16 \chi} \]

where: \( \tau \) is the thermal relaxation time, 
\( d \) is the structure diameter, 
\( \chi \) is the tissue diffusivity.

Two different methodologies have been suggested. The first assumes that the target structure is the entire follicle and therefore the calculation for the thermal relaxation time should be carried out using the physical parameters of the follicle. This produces a theoretical pulse duration of between 30-50msec depending upon the follicle size."

The second, and the model adopted by the authors, uses the hair shaft as the target. This has been the choice since it is clear that the melanin is contained only in the shaft and not the entire follicle. Using the above equation, the pulse duration obtained using the physical properties of the hair shaft predicts a pulse duration in the order of 300-1000nsec.

c) Selection of Energy Density

Clearly the greater the energy density, the greater the thermal energy deposited in the shaft and subsequently the stem cells. The challenge, remembering the existence of some melanin, the target chromophore in the basal layer and epidermis, is to deposit sufficient energy in the shaft without damaging the surface of the skin.

The required energy density to induce stem cell necrosis, whilst maintaining the integrity of the skin structures, can be predicted by theoretical modelling followed by clinical experimentation.
Whilst an accurate prediction of energy density can be made, factors such as body location and skin type (Fitzpatrick I - VI) will determine how the skin reacts to the lazer energy. In general, energy densities, in the order of 1-25J/cm$^2$ are applicable.

**d) Spatial Distribution**

Most laser operators take great care to carefully select dosage levels. This often means the appropriate selection of the required energy, spot size and exposure time. Much depends on the skill and experience of the operator since variables such as skin type can play a critical role. A parameter that is very often neglected is that of the spatial profile of the beam. Spatial profile refers to the uniformity of the applied beam in 'space' i.e. if, for example, on applying a 5mm spot to tissue at an energy density of 15 J/cm$^2$, how can one be sure that the dosage is equal at all portions of the 5mm diameter spot.

The importance of energy density has already been discussed. Control of this parameter allows the operator to access that window facilitating efficacy without skin damage.

Figures 4(a) and 4(b) illustrate the spatial profile produced by an articulated arm, the energy distribution being non-uniform. Figures 5(a) and 5(b) illustrate a beam produced by a fibre optic delivery system, the energy distribution being uniform. In both cases the applied energy is identical. However the applied energy density to each portion of skin is quite markedly different.
The profiles illustrated in figures Sa and Sb are often those produced from a laser delivered to tissue via an articulated arm. In addition some fibre delivery systems are not designed with sufficient care and can also produce a highly non-uniform beam.

Let us assume that the beams illustrated on figures 4(a) and 4(b) are applied to a skin type that should safely receive a 15J/cm² dosage. Close scrutiny of the spatial profiles shows that in some areas the skin is receiving less than 10J/cm² (i.e. below the efficacy threshold) whilst in other areas the dosage is greater than 32J/cm² (dangerously above the skin damage threshold).

Operators should make a point of confirming the spatial profile of their system since correct setting of energy levels could still produce resultant skin damage if so-called ‘hot-spots’ are present.

c) Spot Size

Spot size has a significant effect on the processes involved in laser-tissue interaction. In addition the dimension of the spot clearly has a direct impact on the speed of treatment.

In terms of tissue interaction the spot size has a direct influence on the diffusion of the beam in the tissue. The larger the spot size, the more homogenous the spatial distribution of the light beneath the surface of the skin. It is this effect that shows a well documented improvement in treatment efficacy when moving from a spot size of 5mm to 7mm in the treatment of port-wine stains by dye laser. The collaborators involved in this program have also observed similar improvements in depilation efficacy when increasing spot size from 5mm to 7mm. This assumes naturally that spatial profile is still ‘top hat’ at the larger spot size.

It is interesting to note that as the spot sizes increase, the damage threshold of the skin (which is dependent on skin type) decreases. This is because the tissue near the centre of the spot is further from the ‘cold’ tissue and hence the natural heat dissipation processes have to diffuse the heat through a greater volume of temperature increased tissue. Table 3 indicates the recommended energy density value for the two studied spot sizes.

The exact definition of skin type is also difficult, experts of many years may differ on identification of a particular skin on the Fitzpatrick scale. A further complicating factor is that the operator views skin in white light whereas the laser ‘sees’ the skin in 694nm only. In order to address this issue, the authors are working with others to prove a skin melanin density identification instrument called Chromotest. The Chromotest is designed to accurately identify the Fitzpatrick rating of the skin and predict the dosage that should be applied. Clinical studies with the Chromotest are in progress and publications will soon appear in the learned literature.

Table 3: Outline FluenceValues for Laser Depilation with a Long PulseRuby Laser Operating in ‘Top Hat’ Spatial Mode

<table>
<thead>
<tr>
<th>Spot Size</th>
<th>Skin Type</th>
<th>J/cm²</th>
</tr>
</thead>
<tbody>
<tr>
<td>5mm</td>
<td>I</td>
<td>22-25</td>
</tr>
<tr>
<td></td>
<td>II</td>
<td>20-23</td>
</tr>
<tr>
<td></td>
<td>III</td>
<td>18-21</td>
</tr>
<tr>
<td></td>
<td>IV</td>
<td>15-19</td>
</tr>
<tr>
<td>7mm</td>
<td>I</td>
<td>20-23</td>
</tr>
<tr>
<td></td>
<td>II</td>
<td>18-21</td>
</tr>
<tr>
<td></td>
<td>III</td>
<td>15-19</td>
</tr>
<tr>
<td></td>
<td>IV</td>
<td>12-17</td>
</tr>
<tr>
<td></td>
<td>V</td>
<td>10-15</td>
</tr>
<tr>
<td></td>
<td>VI</td>
<td>8-13</td>
</tr>
</tbody>
</table>

f) Laser Selection

From an analysis based on the knowledge of the process of depilation of human skin via a process of selective photothermolysis, the optimal laser parameters are in the following domain:

- Wavelength: 640-760nm
- Pulse Direction: ~800 sec
- Energy Density: 10-25 J/cm²

Spot size and spatial profile also play an important role but these three are the pivotal parameters. Taking these three key parameters into account, the Free Running Ruby laser is...
now accepted by most practitioners as the instrument of choice.

3. Clinical Studies

Numerous clinical studies have been carried out to ensure the efficacy and safety of Ruby laser depilation. The following is a sample of the results gained by various investigators.

3.1 Evaluation of the free running Ruby laser for Hair Removal - A Retrospective Study.

P. Bjerring, H. Zachariae, H. Lybecker, M. Clement
Acta Derm Venereol (Stockh) 1998;77:48-57

Abstract
The free running ruby laser has recently been introduced for removal of unwanted hair growth. It is assumed that the mode of action of ruby laser depilation is that of selective photothermolysis of the melanin-rich structures. The present data reflects our results of ruby treatment of 133 patients attending a dermatological laser clinic for hair removal. When success of the laser treatment was defined as >50% hair removal, 59% of patients reported successful results after 90 or more days after the last treatment. With success defined as >25% hair removal at 90 days, successful treatment was obtained in 75% of cases.

Also, the patients evaluated the overall result of their treatments. The percentage of patients who were either ‘very satisfied’ or ‘satisfied’ after 90 days was 64.2%. On ly a few side-effects were observed. In general, pain was not a clinical problem. No significant scarring was observed. A temporary hypopigmentation was experienced by approximately 10% but only one patient still had hypopigmentation 90 days after treatment.

Due to variability of hair density as well as anagen and telogen phase durations in different anatomical locations, firm conclusions regarding the long-term effect still cannot be drawn. (This at the time of writing which was March 1997).
Figure 7: Male Transexual Photographed 3 Months After Treatment at 20J/cm².

Figure 8: Female Lower Leg, Photographed 220 Days After One Treatment at 74J/cm².
3.2 Ruby Laser Irradiation Results in Decreased Hair Diameter in Re-growing Hair


Abstract
Thirty-two volunteers with dark coloured hair were treated with the Chromos 694 Depilation Ruby Laser. The lowest power which caused visible hair destruction (i.e. singeing), without excessive skin redness at the time of treatment, was used. Hair diameter was measured pre- and post-treatment under the microscope with the aid of an image analysis system. Hair density pre- and post-treatment was also counted using a magnifying grid. The hair diameter was measured in micrometers. The percentage drop of the hair diameter in each site was calculated.

Results
Thirty-two subjects with thirty-six treatment sites were examined. There were 13 male and 19 female with a mean age of 31. Fitzpatrick skin type of the subjects ranged from 1 to 5. The mean follow-up was 10.92 weeks (range: 8-16). The areas treated included face, neck, chest, abdomen, groin, back, scalp, legs and axilla.

The percentage drop in hair diameter was calculated for each treatment site and one sample Hest was used to analyze the results. The average percentage drop in hair diameter was 9.55%, which was statistically significant (t=23, degree of freedom = 35, P = 0.032).

No correlation was found between the change in diameter and the power density used and between the change in diameter and the follow-up interval.
4. Efficacy Studies

Work carried out in collaboration with numerous groups in Europe treating many hundreds of patients have led to the following conclusions:

- long term mean reduction in hair density was 59%,
- the follow up period was up to 65 weeks, i.e. 455 days,
- average follow-up period was 16.8 weeks i.e. 118 days,
- the mean number of treatments was 2.4,
- the mean reduction in brown and black hair was 61%,
- the mean reduction in fair hair was 56%,
- the average energy density used was 12.94Jcm^{-2}.
- no incidence of scarring were observed,
- pigmentation changes were observed in 3.2% of patients, all were eventually fully resolved.

5. Conclusion

The use of Ruby lasers for the long term suppression of unwanted hair growth is becoming a treatment of choice in the field. The technique has been shown to offer long term depilation in a range of skin types without scarring. It is clear also that the technology can be further improved for example, it remains a time consuming process. The introduction of automated scanning systems will significantly overcome this drawback.

References

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