Congenital melanocytic nevi: Where are we now?

Part II. Treatment options and approach to treatment

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After completing this learning activity, participants should be able to identify treatments available for congenital melanocytic nevi; discuss the evidence available for their efficacy or lack thereof; and formulate a rational treatment approach.

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Treatment of congenital melanocytic nevi (CMN) is generally undertaken for 2 reasons: (1) to reduce the chances of cutaneous malignant melanoma and (2) for cosmetic reasons. Over the past century, a large number of treatments for CMN have been described in the literature. These include excision, dermabrasion, curettage, chemical peels, radiation therapy, cryotherapy, electrosurgery, and lasers. Only low-level evidence supporting these approaches is available, and large randomized controlled trials have not been published. This article explores therapeutic controversies and makes recommendations based on the best available evidence. (J Am Acad Dermatol 2012;67:515.e1-13.)

CAPSULE SUMMARY

- Excision has been recommended as the first-line treatment for congenital nevi in which treatment is indicated.
- Data regarding the purported benefits and risks of these procedures are explored.
- Excision may result in high satisfaction, but its efficacy at reducing the incidence of malignant melanoma is unproven.
- Fears regarding the use of lasers for treatment are unsubstantiated, but treatment effectiveness with lasers has been variable.

The treatment of congenital melanocytic nevi (CMN) before the development of malignancy is considered for 2 reasons: (1) to reduce the chances of cutaneous malignant melanoma (MM) and (2) for cosmetic reasons. The treatment of giant CMN (GCMN) is technically difficult, and complete removal of these lesions is often impossible. Approaches to removal can broadly be classified into 2 groups: full- and partial-thickness removal procedures (Table I). Full-thickness procedures remove the entire dermis and epidermis and varying amounts of subcutaneous tissue. They are likely to remove more nevus cells than partial-thickness procedures, but the effectiveness of either method for preventing future malignancy remains a topic of debate. It is important to stress that lifelong surveillance is warranted regardless of if partial- or full-thickness treatments are undertaken.

FULL-THICKNESS PROCEDURES

Complete excision

Key points

- **Although excision more completely removes nevus cells within CMN than partial-thickness treatment approaches, there is no solid evidence that this reduces the risk of malignant melanoma more effectively**
- **High rates of satisfaction have been reported for excision when CMN are <20 cm in size, especially for those on the head and neck**

Excision can be performed either for cosmetic reasons or to attempt to reduce the risk of development of MM. Given that CMN may penetrate deeply, excision to the level of the fascia is advocated in order to assure removal of as much of the lesion as possible and to avoid recurrence. However, the excision of CMN to reduce the chance of malignancy is controversial. Proponents claim that the removal of these nevi reduce the risk of associated MM.[1] Although the absolute risk of MM in many studies appears to be low, it is still considerably higher than the general population.[1] In addition, the true lifetime risk of MM may be underestimated given the skewing towards a younger average age of patients in many studies. In the case of GCMN, most MMs develop deep within the nevi (data supporting this assertion is sparse), where detection from routine observation is likely to be delayed until the development of advanced disease.[1] Finally, the incidence of cutaneous MM is noted to be lower in patients who have undergone excision than in those who choose observation.[1]

In contrast, several arguments against routine surgical excision of CMN have been advanced,

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Abbreviations used:

CMN:	congenital melanocytic nevi
Er:YAG:	erbium:yttrium-aluminum-garnet
GCMN:	giant congenital melanocytic nevi
MM:	malignant melanoma
Nd:YAG:	neodymium-doped yttrium aluminum garnet
NMRL:	normal-mode ruby laser
PAS:	projected adult size
QSRL:	Q-switched ruby laser

including that: (1) the absolute incidence of MM is low in patients with CMN, while surgery has associated risks, including sepsis, scarring, recurrence, and restrictions to joint mobility; (2) excision of cutaneous MM would not reduce the risk of extracutaneous melanoma, which accounts for a significant proportion of melanomas in these patients; and (3) excision of CMN may mask the development of MM,[2] presumably by hiding it beneath scar, grafts, or skin flaps. Contrary to the claim that MM in the setting of GCMN may be understated, some claim it may be overstated.[3] It is noted that differentiating between proliferative nodules and MM is difficult both histologically and clinically, and errors may result in the overdiagnosis of MM in patients with GCMN and proliferative nodules. In addition, the risk of MM is highest in those with the largest CMN, which, confoundingly, are typically too large to be completely excised.[4] Therefore, the risks of MM may erroneously appear to be higher in those who have not undergone excision because this group of patients has intrinsically higher risks of MM than those with smaller GCMN that are more easily excised. Randomized, controlled data on this topic are not yet available.[4]

Concerning outcomes after surgery, Kruk et al[5] found, in their group of 295 patients, that those with nevi <5 cm in diameter could be successfully excised with a single procedure. For patients with larger nevi, multiple procedures were frequently required, such as serial excision or the use of tissue expanders.[5] Gosain et al[6] described their experience with 53 patients with CMN >20 cm in diameter.[6] Serial excision was used most commonly on the extremities, accounting for 50% of reconstructions in these areas, while expanded flaps were used most commonly in head and neck procedures (49% in this area). Most areas required >1 type of reconstructive method.[6] Warner et al,[7] who reported their experience with 40 patients with GCMN, also found the need for multiple surgical procedures.

Kinsler et al[3] followed 305 families with CMN prospectively using questionnaires to evaluate response to therapies. They reported a negative correlation of satisfaction with increasing projected adult size (PAS). A significant proportion of parents felt that surgery had worsened the appearance of their child's CMN when the PAS was >20 cm. When the PAS was <20 cm, almost 90% felt that the procedure was worthwhile, and even more thought so when the lesion was located on the head and neck (95-96%). They also reported the phenomenon of new nevus formation (at the edges of the treated area) in 28% of their study patients who underwent excision. Others have also reported similar findings.[8] This was significant in those with complete excision of their nevi, but not those with partial excision or other treatment methods.[3] The authors hypothesize potential mechanisms for repigmentation, including the activation of nonnevus melanocytes by tissue expanders or the spread of nevus cells from the main nevus in a type of benign regenerative process analogous to recurrent nevus/pseudomelanoma.[3]

Ruiz-Maldonado et al[9] stated that the results of surgery from their 22 patients who underwent excision with various reconstructive methods were more often "fair and poor" than "good." However, others have reached opposite conclusions, although these findings may be biased by the inclusion of mostly small CMN, which would be expected to have better outcomes.[5]

Serial excision

Key point

- **Data regarding serial excision is sparse, but anecdotal reports indicate positive outcomes**

Staged excision has been advocated for large CMNs for more than a century, based on the rationale that smaller procedures give the skin a chance to stretch gradually, thereby increasing the likelihood of a good outcome.[10,11] Fujiwara et al[10] recommend excision between 6 months and 2 years of age. They note that the skin is most elastic early in life and that subcutaneous fat is at its thickest during this time,[10,11] but others have not found better outcomes with early intervention.[3]

Various methods of serial excision have been proposed.[12-14] Data are highly limited regarding any of these techniques, and no comparison studies have been performed. In general, most reports describe results that are good or excellent, but specific outcome measures are lacking. Complications include failure to remove the entire lesion, dehiscence, and scar widening.

Table I. Available treatment methods for congenital melanocytic nevi

Method	Advantages (type of evidence)	Disadvantages (type of evidence)
No treatment (observation)	Majority (31/48) of untreated CMNs in 1 prospective study noted to lighten with time (IIB); no risk of complications from treatment (IV)	Risk of melanoma remains unchanged (IV); does not address psychosocial burden (IV)
Excision	Removes more nevus cells than any other treatment (IV); might reduce the incidence of MM (III); improves cosmetic appearance for many small to medium CMN (IIB) and possibly some GCMN (IV)	Repigmentation or new satellite nevi often occur after procedures with larger nevi (IIB); cosmetic appearance may be worsened for large CMN and GCMN (IIB); might mask appearance of MM, especially if resurfaced with skin grafts (IV); unlikely to remove all nevus cells for large CMN or GCMN (IV); larger lesions frequently require serial excision, tissue expansion, or skin grafts (IV); results in scar, sometimes disfiguring (IV); potential for joint contractures (IV)
Dermatome shaving	Removes some CMN cells and therefore might reduce risk of MM (IV); scars and other surgery-related adverse outcomes might be less than with excision (IV); cosmetic outcomes are fair to excellent (III)	Does not remove as many CMN cells as excision (IV); results in scar, sometimes disfiguring (IV); detection of MM might be more difficult (IV)
Curettage	Removes some CMN cells and therefore might reduce the risk of MM (IV); scars and other surgery-related adverse outcomes might be less than with excision (III); improves cosmetic outcome (III); minimal equipment requirement (IV)	Does not remove as many CMN cells as excision (IV); results in scar, sometimes disfiguring (III); detection of MM might be more difficult (IV)
Dermabrasion	Removes some CMN cells and therefore might reduce the risk of MM (IV); scars and other surgery-related adverse outcomes might be less than with excision (III); improves cosmetic outcome (III); minimal equipment requirement (IV)	Does not remove as many CMN cells as excision (IV); results in scar, sometimes disfiguring (III); detection of MM might be more difficult (IV)
Chemical peels	Removes/destroys some CMN cells and therefore might reduce the risk of MM (IV); scars and other surgery-related adverse outcomes might be less than with excision (III); improves cosmetic outcome (III); minimal equipment requirement (IV)	Does not remove as many CMN cells as excision (IV); may result in scar (IV); detection of MM might be more difficult (IV)
Cryotherapy	Removes/destroys some CMN cells and therefore might reduce the risk of MM (IV); scars and other surgery-related adverse outcomes might be less than with excision (III); improves cosmetic outcome (III); minimal equipment requirement (IV)	Does not remove as many CMN cells as excision (IV); may result in scar or hypopigmentation (IV); detection of MM might be more difficult (IV)
Electrosurgery	Destroys some CMN cells and therefore might reduce the risk of MM (IV); scars and other surgery-related adverse outcomes might be less than with excision (IV); improves cosmetic outcome (IV); minimal equipment requirement (IV)	Does not remove as many CMN cells as excision (IV); may result in scar or hypopigmentation (IV); detection of MM might be more difficult (IV); theoretical risk of malignant transformation (IV)
Radiation therapy	None (IV)	Poor efficacy (IV); risk of radiation induced neoplasms (IIB) and radiation dermatitis (IIA)

Continued

Table I. Cont'd

Method	Advantages (type of evidence)	Disadvantages (type of evidence)
Ablative lasers	Can precisely remove tissue to depth of pigmented cells (IV); might reduce the risk of MM (IV); scars and other surgery-related adverse outcomes might be less than with excision (IV); improves cosmetic outcome (III); can be combined with pigment-specific lasers (IV)	Does not remove as many CMN cells as excision (IV); results in scar, sometimes disfiguring (III); detection of MM might be more difficult (IV)
Pigment-specific lasers	Precisely targets melanosomes and melanocytes (IIA); might reduce the risk of MM (IV); scars and other surgery-related adverse outcomes might be less than with excision (III); improves cosmetic outcome (III)	Does not remove as many CMN cells as excision (IV); results in scar, sometimes disfiguring (III); detection of MM might be more difficult (IV); risk of malignant transformation is circumstantial (IV), with small studies showing no malignant transformation (III)

Level IA evidence includes evidence from metaanalysis of randomized controlled trials; level IB evidence includes evidence from at least 1 randomized controlled trial; level IIA evidence includes evidence from at least 1 controlled study without randomization; level IIB evidence includes evidence from at least 1 other type of experimental study; level III evidence includes evidence from nonexperimental descriptive studies, such as comparative studies, correlation studies, and case-control studies; and level IV evidence includes evidence from expert committee reports or opinions or clinical experience of respected authorities, or both.
CMN, Congenital melanocytic nevus; *GCMN*, giant congenital melanocytic nevi; *MM*, malignant melanoma.

PARTIAL-THICKNESS REMOVAL PROCEDURES

Key point

- **Partial-thickness removal procedures may reduce risk of malignant melanoma, but this has never been proven**

Partial-thickness removal procedures will undoubtedly remove a considerable amount of nevus cell burden from the patient, but they are likely to leave some cells present within the reticular dermis or subcutaneous plane. Many patients will therefore find these procedures unsatisfactory as tumor reduction methods, but they might be suitable from an aesthetic improvement perspective. The reduction in nevus cell burden using these methods should in theory reduce the risk of MM developing within the CMN. However, like full-thickness excision, the risk reduction has never been quantified or proven.

Dermatome excision

Key point

- **Fair to excellent results have been reported with dermatome excision**

Cronin[15] was the first to pioneer the superficial removal of GCMN in 1953 using a dermatome.[16] Various methods have been described, some of which suggest saving the excised epidermis and reattaching it after enzymatic debridement of the nevus cells.[17-19] Fair to excellent results have been reported, but in our opinion, the associated photographs of outcomes were unimpressive.

Abrasive removal methods

Key points

- **Results after curettage range from poor to good**
- **Dermabrasion successfully reduces pigmentation in most cases when performed in the newborn period**

Both curettage and dermabrasion rely on a "cleavage plane" that is present within the dermis between the nevus and underlying tissue during the first few weeks of life.[20] The nevi are said to have increasing adherence with time, making their removal much more difficult after 6 months of age.[21] Only anecdotal reports are available to substantiate this claim.

Curettage. Curettage for GCMN was first reported by Moss[21] in 1987. He advocated for treatment during the first few weeks of life. The advantages of this technique are reported to be its simplicity, minimal instrument requirements, low blood loss, and fast healing time. Some worry that MM maybe more difficult to detect after this procedure, but others claim the opposite.[22] Data regarding this technique are limited to 26 patients, some of whom had small CMN.[21,22] Results ranged from poor to good. Complications included hypertrophic scarring and some patients with infections that required systemic antibiotics.[22]

Dermabrasion. Variable outcomes (from poor to excellent) have been reported after dermabrasion for CMN.[10,24,25] The largest study on this topic was performed by Rompel et al,[23] who found in their retrospective review of 215 patients that there were no serious long-term complications. Hypertrophic scarring was present in portions of the treatment area in 14.6% of patients, but results were still deemed satisfactory, even in these patients. A reduction in pigment from 0% to 20% of the initial color was achieved in nearly all patients as long as they were treated within the newborn period.

Chemical peels

Key point

- **Only small numbers of patients have been reported to have treatment with chemical peels**

Chemical peels were being performed on CMN at least as early as 1912.[24] Like dermabrasion, the reported results vary. In general, only small numbers of patients have been treated with this technique.[25-29] Reported complications include infection, recurrence of pigmentation, and scarring.

Cryotherapy

Key point

- **Information on cryotherapy is limited and has not been reproduced in recent years**

In 1907, Pusey[30] described the use of CO_2 snow for the treatment of a GCMN on the face. He noted that a "hideous deformity" was replaced by a slight scar. The photographic images showed a dramatic improvement. Similarly, in 1912, Fox[24] noted some improvement in a single patient with a garment-type CMN after treatment with a combination of nitric acid, phenol, and carbonic acid snow (cryotherapy). "Before" and "after" images were not published, and no specifics as to how the lesion improved were provided.

Muti[31] published a case series of 4 patients with medium-sized CMN that were treated with nitrogen protoxide—cooled cryoprobes. No outcome measures were described, but associated photos revealed good clearance of the lesion with some resulting scarring.

Electrosurgery

Key point

- **Information regarding the use of electrosurgery is limited**

Little information is available regarding electrosurgery for CMN. Analogous to the theoretical problems with laser ablative surgery, electrosurgical treatment of nevi could theoretically lead to transformation to MM. In 1957[32] and 1963,[33] Walton et al published results from a study in which 355 biopsy specimens of nevi were treated with electrodessication and later excised. After follow-up ranging from 1 to 7 years, no malignant degeneration was observed. Nevi were not specified as either congenital or acquired. Stratton[34] reported a single patient with a large facial CMN treated with 5 sessions of electrocoagulation and curettage. Treatment of the lesion resulted in a soft, pliable scar.

Radiation

Key point

- **Only anecdotal information exists on the use of radiotherapy**

Literature regarding the use of radiotherapy for CMN is sparse. In 1921, MacKee[35] wrote that although others had succeeded in removing pigmented nevi with both radiographs and beta rays of radium, he was unable to obtain notable improvement in these lesions without the induction of significant skin reactions. He recommended that nevi not be removed using these methods. Like nearly all other treatment methods, melanoma has been reported after radiotherapy.[36]

Laser

Concerns regarding laser treatment

Key points

- **Primarily in vitro data suggests a theoretical increased risk of melanoma after laser treatment of CMN**
- **Laser treatment does not result in complete eradication of all nevus cells**

Laser therapy for congenital nevi can be categorized as nonspecific or specific. CO_2 and erbium:yttrium-aluminum-garnet (Er:YAG) lasers, which ablate tissue based upon water content, have efficacy and adverse event profiles similar to other nonspecific destructive methods, such as dermabrasion. The use of pigment-specific lasers, such as the ruby, alexandrite, and neodymium-doped yttrium aluminum garnet (Nd:YAG), are highly enticing from a theoretical standpoint. These lasers effectively target pigmented cells and minimize damage to the surrounding tissue. The use of these lasers in a Q-switched mode causes the death of nevus cells via selective photothermolysis of melanosomes.[37-40] The use of lasers with millisecond pulse durations also leads to the death of melanocytes with the potential for localized collateral heating, which may destroy non—melanin-containing melanocytes and other cells. Despite these theoretical advantages, there is debate about the long-term safety and efficacy of laser therapy for congenital nevi.[6,41-45]

Unlike ultraviolet light, pigment-specific lasers have wavelengths that do not appear to directly damage DNA. Therefore, any mutagenic effect would have to result from heat. The association of squamous cell carcinomas within burn scars is often used to support concerns regarding the use of lasers to treat nevi.[46-48] In fact, several case reports exist where melanomas have been diagnosed after laser therapy.[43,49-52] However, many of these lesions were likely misdiagnosed malignant lesions before therapy. In addition, another concern regarding the possibility for malignancy is the regrowth of some nevi after laser irradiation.[53] This behavior may indicate a proliferative response to laser injury or resulting changes in the cellular matrix.[48] In fact, the recurrences of nevi after excision or CO_2 laser resurfacing closely mimics melanoma both clinically and histologically.[54,55] This phenotypic finding has been coined "pseudomelanoma." It is, however, considered a benign process.

Finally, some argue that ablation of the pigmented portion of a nevus might mask the occurrence of tumors within the treated area.[44] Others argue the opposite, and data are lacking to support either contention.

Laboratory studies examining malignant changes after laser irradiation have been performed.[56-59] Results have varied, with some giving cause for concern and others not. The relevance of these in vitro studies to actual real world human risk remains to be determined, because these studies used malignant cells instead of nevus cells.

Regarding in vivo studies, Grevelink et al[48] looked at the effect of Q-switched laser irradiation on congenital nevi in 5 patients. They studied the histologic effects of both Q-switched Nd:YAG and ruby lasers compared to no treatment. They found no malignant degeneration, but noted that nevus cells persisted in all lesions, especially in the deeper portions of the dermis. Imayama et al[59] performed a long-term clinical and histologic study of CMN treated with normal mode ruby laser (NMRL) in 10 patients.[59] Malignant changes were absent from all studied nevi, but nevus cells remained, even in the nevi with good cosmetic results.

Ruby laser

Key points

- **Outcomes after ruby laser treatment have been variable**
- **Early treatment has been hypothesized to have better results**

Q-switched ruby lasers (QSRLs) have been popular in the past for treatment of congenital nevi because of their wavelength (694 nm), which is selectively absorbed by melanin, and because of their nanosecond pulse durations that closely match the thermal relaxation time of melanosomes.[39,60]

Initial reports of QSRLs featured responses ranging from poor to excellent.[48,53,61-67] All histologic analyses showed residual nevus cells after treatment, leaving open the possibility of future malignant degeneration.[59] Multiple treatments were almost always necessary.[53,66] Study durations were typically just a few months, and therefore the persistence of efficacy is largely unknown. Treatment failures with QSRL are thought to result from their short pulse durations and limited depth of penetration (1 mm).[53,68,69]

Ueda et al[70] suggested that long-pulsed lasers might allow more heat dispersion to surrounding cells, allowing for more effective targeting of nevus nests, including nonpigmented melanocytes rather than individual nevus cells.[70] Studies using NMRLs have shown efficacy at nevus clearance of small to giant sized CMN in Japanese patients.[59,70-72] Like QSRLs, the clinical results have been variable, and most follow-up periods for published reports are too short to make generalized statements regarding the persistence of improvements.

Because NMRLs closely match the thermal relaxation time of the epidermis, Kono et al[68] theorized that treatment first with a NMRL, which causes epidermal separation at the dermoepidermal junction, would allow for increased depth of penetration with subsequent QSRL treatments. At least 4 studies have been reported on the use of combined NMRL and QSRL.[66,68,73,74] The first 4 studies reported positive results. The largest one, by Kono et al,[68] studied 34 patients and demonstrated >70% lightening with all histologic types, but greater efficacy was correlated with more superficial intradermal CMN types.[73] Overall, 31 of 34 patients were judged as having excellent and good responses, 3 with fair results, and none with poor clinical results.

Kono et al's[68] favorable outcomes were not replicated by Helsing et al's[74] 2006 study of 14 children with medium-sized facial CMN. Twelve children were treated with combined QSRL and NMRL and 2 with NMRL only. After a median of 3 treatments, no outcomes were satisfactory as judged by photography.

The most recent study on the use of ruby lasers for CMN was published in 2009 by Kishi, et al.[75] They treated 9 Japanese patients from 1 month of age with serial 2- to 4-week QSRL treatments with escalating

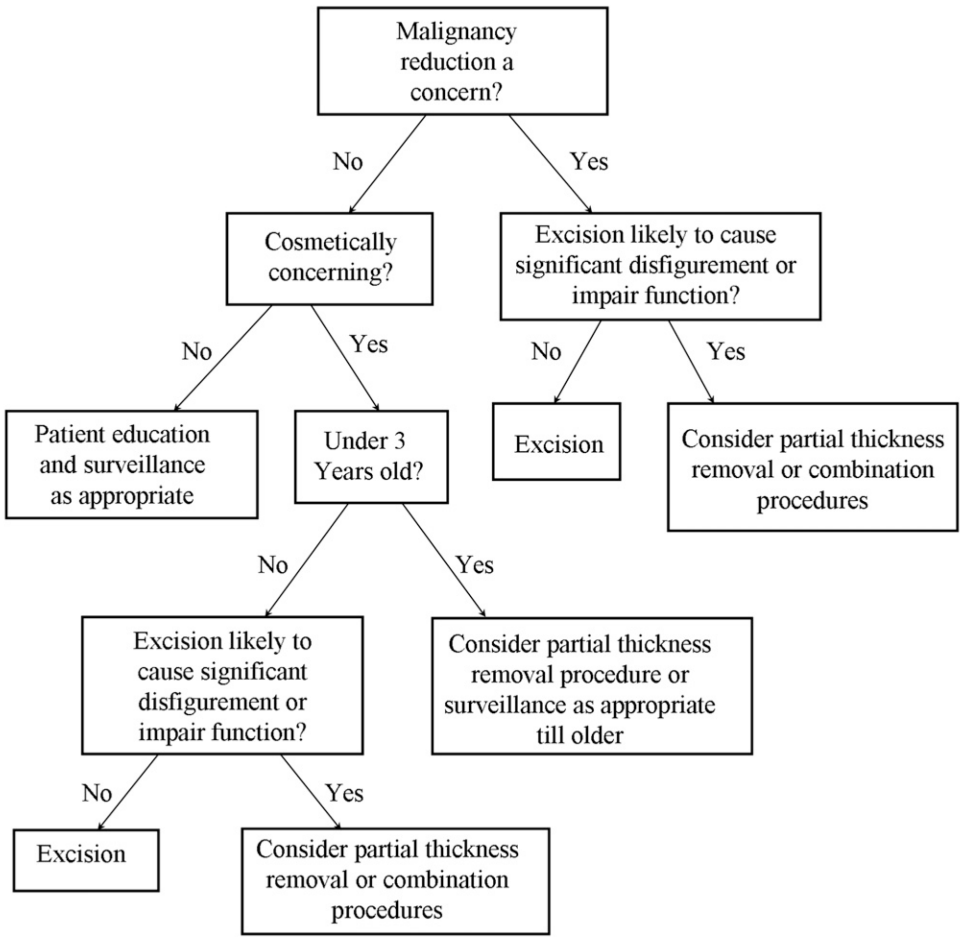

Fig 1. Treatment algorithm. Given the paucity of evidence, treatment recommendations are largely conjectural in nature. Concerning the use of surgery to reduce the risks of cutaneous malignant melanoma, we recommend avoiding its use where significant disfigurement or compromised function is likely to result, because evidence regarding its efficacy is limited and chances of malignancy are low.

fluences. The mean follow-up was 29 months. After a mean of 9.6 treatments, color was reduced to 0% to 20% of baseline in all patients. Eight patients experienced mild repigmentation. All were retreated with 1 to 2 more sessions, which resulted in relightening that persisted for at least 1 year. The last patient experienced repigmentation of his lesion to a level close to baseline within 2 weeks of his last treatment. The authors speculated the success of their therapy might be caused by the more transparent nature of infant skin.

Alexandrite laser
Key point

- **Response to alexandrite laser treatment appears good, but complications and repigmentation are frequent**

Kim[76] treated 53 patients with CMN with a Q-switched alexandrite laser (QSAL). Sixteen of these patients also received CO_2 laser therapy in between QSAL treatment sessions. An average of 72% improvement was noted with QSAL alone, and even higher rates were noted with combined treatment. Complications included skin textural changes (67.3%), hypopigmentation (30%), hyperpigmentation (28%), depressed scarring (3.8%), and hypertrophic changes (7.5%). Repigmentation was seen in most patients (83%) after an average of 5.45 months. The degree of repigmentation was not specified. The authors concluded that treatment with QSAL provided cosmetic benefit with low complications. How long standing the results of QSAL therapy are is currently unknown.

Fig 2. Multiple treatments with different laser systems may be necessary to achieve cosmetic improvement of congenital nevi. **A**, Nevus on the left upper lip of a 7-year-old girl. **B**, Appearance after 4 monthly Q-switched ruby laser treatments. **C**, Six months later, the lesion began to recur. **D**, The final appearance 10 years later, after an additional 3 separate Q-switched alexandrite laser treatments and additional treatment with a 5-millisecond long-pulsed alexandrite laser. (Photograph courtesy of Mitchel P. Goldman, MD. Reproduced with permission from: Treatment of Benign Pigmented Lesions, in, Cutaneous and Cosmetic Laser Surgery, Mitchel P. Goldman (Ed.). 2006 Elsevier, London. © 2012 Mitchel P. Goldman, MD.)

CO_2 laser

Key points

- **CO_2 laser has been used both as monotreatment and in combination with other Q-switched devices**
- **Multiple treatments are necessary**
- **Data on outcomes are limited**

Similar to Kono et al's[68] concept of combined QSRL and NMRL therapy, Choi et al[77] recommended the use of CO_2 laser followed immediately by QSRL. They theorized that ablative resurfacing would allow for the deeper penetration of QSRL energy, allowing for more pigment removal. Their study included 15 patients who received between 4 and 7 treatment sessions. Thirty-three percent had responses rated as excellent, 47% were rated as good, and 20% as poor.

Chong et al[78] also investigated dual laser therapy for CMN. They used an ablative CO_2 laser followed by QSAL. All patients noted significant improvement of their nevi after 2 to 9 treatments. Three of the 11 patients developed hypertrophic scars, and 1 developed postinflammatory hyperpigmentation. Reynolds[79] described 7 patients with giant CMN treated with CO_2 laser. Follow-up ranged from 1.5 to 6 years. Four patients required repeat treatments. Formal outcome measures were not reported. The authors stated that the results were encouraging, but the included photographs showed significant recurrence or persistence of the lesions after treatment.

Erbium:yttrium-aluminum-garnet laser

Key point

- **Similar to CO_2 lasers, limited data suggest that multiple treatments may significantly lighten the nevi, but complications and repigmentation are common**

Lapiere et al[80] appear to be one of the first groups to describe the use of Er:YAG lasers for CMN. Their 2002 report included a single patient who underwent 1 treatment at 9 days of age. The outcome was reported as excellent and no pigmentation was seen after 16 months of follow-up. The authors stated that one of the advantages of Er:YAG lasers is that they ablate tissue in a linear nature with each subsequent

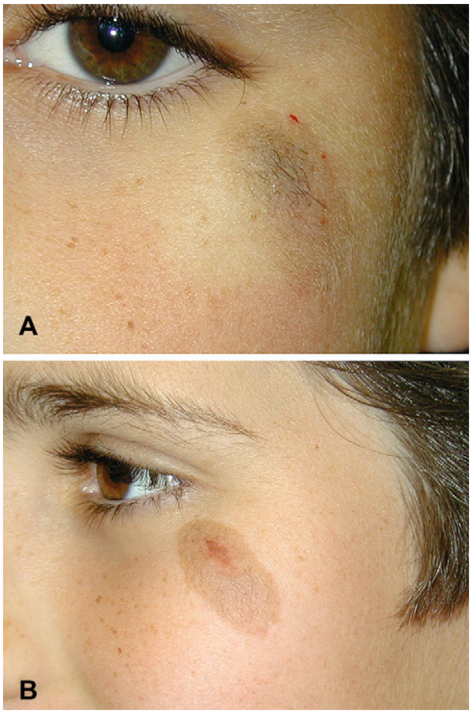

Fig 3. Complete clearance of lesions can be a challenge. **A**, Congenital hairy nevus on the left cheek of a 12-year-old girl. **B**, Clinical appearance after 11 separate laser treatments consisting of 2 Q-switched ruby laser treatments, 1 510-nm, 300-millisecond pigment lesion laser, 1 Q-switched 532-nm neodymium-doped yttrium aluminum garnet treatment, 3 Q-switched alexandrite laser treatments, 3 treatments with a long-pulsed alexandrite laser, and 1 treatment with an intense pulsed light device. Hair density and diameter were reduced, but color remains relatively unchanged, and some scarring is present centrally. (Photograph courtesy of Mitchel P. Goldman, MD. Reproduced with permission from: Treatment of Benign Pigmented Lesions, in, Cutaneous and Cosmetic Laser Surgery, Mitchel P. Goldman (Ed.). 2006 Elsevier, London. © 2012 Mitchel P. Goldman, MD.)

pass. This contrasts with CO_2 lasers, which reach a plateau and also cause more thermal damage to the surrounding tissue. The authors suggest that this allows for the precise ablation of pigmented tissue with lower risks of scarring and pigmentation changes.

In 2005, Whang et al[81] reported results from a retrospective study comparing treatment with a dual-mode, 2940-nm Er:YAG laser versus curettage. Efficacy in terms of skin lightening appeared to be similar. Lim et al[82] reported results from a retrospective study of 13 patients treated with excision of as much of the lesion as possible followed immediately by treatment with a dual-mode, 2940-nm Er:YAG laser to the remaining nevus. After 6 months of follow-up, 83% of patients were rated as having good to excellent results. Two patients developed repigmentation requiring laser therapy with a Q-switched Nd:YAG laser. The associated images demonstrated good clearance of the pigmentation but the presence of prominent scars.

Ostertag et al[83] described outcomes in 10 treated patients with 1 to 6 treatments beginning in the first few weeks of life. Eight patients were said to have no or minimal pigmentation recurrence during follow-up ranging from 3 to 36 months. Results were rated as good to excellent in all responders. Two patients experienced significant repigmentation within 3 months after treatment. Viral and bacterial infections affected 3 patients.

Most recently, Rajpar et al[84] treated 3 children with 4 to 8 Er:YAG laser sessions. They noted significant lightening in all treated lesions without scarring. Objective outcome measures were not reported, and the included images of a single patient did not show dramatic efficacy.

APPROACH TO TREATMENT

Key points

- **The benefits of early excision have not yet been proven; surveillance is therefore a reasonable option, even for GCMN**
- **Surgery that is likely to result in significant deformity or compromised function should be avoided**
- **Partial-thickness removal strategies, such as dermabrasion or lasers, may be considered when more aggressive surgical procedures are not practical**

Given the paucity of evidence regarding CMN therapies, recommendations regarding treatments will be mostly conjectural (Fig 1). In theory, excision, which removes the most tissue (and therefore the greatest number of nevus cells), should have the best chances of reducing chances of malignant degeneration within CMN. However, no studies have documented the benefit of excision over routine surveillance or compared it to less aggressive partial-thickness removal procedures. In addition, excision will do nothing to reduce the chances of extracutaneous MM or neuromelanosis. Many might find that the small risk of malignant degeneration, even in GCMN, does not warrant the risks of aggressive surgical procedures. Each physician and patient will need to weigh the information together. Given that risks of MM seem to correlate with CMN size, the consideration of treatment for malignancy reduction need only concern nevi of large size.

In addition to malignant considerations, CMN may carry significant psychosocial consequences.

Treatment should certainly be considered for cosmetic reasons in appropriate patients. We feel that any elective treatment involving general anesthesia should be deferred until after 3 years of age, as recommended by other authorities, until the risks are better understood.[85-87] As mentioned in part I of this review, there is concern regarding potential adverse impacts on neurologic, cognitive, and social development in young children who are subjected to general anesthesia. This might make partial-thickness procedures more appealing, many of which can be accomplished with topical or local anesthesia. If the outcomes are poor, the treated area could always be treated with excision in the future.

As to which partial-thickness treatments might be superior, information is limited. Although the risks of laser surgery appear to be low, outcomes are largely inconsistent (Figs 2 and 3). Which option to choose should be based upon local availability of equipment and previous experience. Regarding surgery for incomplete or poor responders, satisfaction appears to be high when the nevi are <20 cm, especially for those located on the head and neck. Given the wide variability in size and locations of CMN, recommendations will need to be individualized. We agree with previous authors that surgery that is likely to result in significant deformity or compromised function should be avoided.

CONCLUSION

Despite the large number of publications concerning the treatment of CMN, our understanding of treatment effectiveness remains elusive. Excision removes the most tissue and therefore the greatest nevus cell burden, and should have the best chances of reducing malignancy. However, given that risk of MM transformation is low, morbidity may not be reduced after any treatment procedure. In terms of cosmetic outcomes, most studies for any treatment have been uncontrolled, have contained few patients, and were of short duration, making decisions on treatment difficult. Decisions on therapy will need to rely on anecdotal experience until better studies are performed, but clinicians should weigh the inherent risks with the potential benefits.

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