EXPERT REVIEWS

Effectiveness of staged excisions for treating lentiginous melanoma *in situ*

Expert. Rev. Dermatol. 3(5), 549–555 (2008)

Mark Abdelmalek†, Liana Abramova, Mark A Hurt and George Hruza

†*Author for correspondence*
Department of Dermatology, Drexel University College of Medicine, 219 N. Broad Street – 4th Floor, Philadelphia, PA 19107, USA
Tel.: +1 215 762 5550
Fax: +1 215 762 5570
mark.abdelmalek@drexelmed.edu

Lentiginous melanoma *in situ* (lentigo maligna) is the most common pattern of melanoma *in situ*. Surgical treatment remains the standard of care, with a variety of options available, including routine excision, staged excision and Mohs micrographic surgery. Staged excisions are a safe, effective and relatively simple way to achieve tumor clearance for lentiginous melanoma *in situ*.

KEYWORDS: • lentigo maligna • margin • melanoma • melanoma *in situ* • staged excision

Lentiginous melanoma *in situ* is also known as lentigo maligna; however, lentiginous melanoma implies that there is a dermal component to the melanoma. Utilizing the term lentiginous melanoma *in situ* can be useful for therapeutic purposes as lentiginous lesions with ill-defined borders are ideal candidates for surgical removal with a staged-excision technique. When compared with routine surgical removal for melanoma, the staged-excision technique provides the patient with the benefits of comprehensive and meticulous peripheral margin control, while bypassing the inherent frozen-section issues observed with Mohs micrographic surgery. Staged excisions, with comprehensive margin examination, offer a cure rate for lentiginous melanoma *in situ* that is higher than routine excisions and approaches the published persistence (true local recurrence) rates of Mohs micrographic surgery [1].

Epidemiology & statistics

In 2007, the American Cancer Society and the National Cancer Institute predicted, for the first time, a slight decline in the number of new melanomas and melanoma-related deaths. However, in 2008, this small downward trend has been reversed and the American Cancer Society predicts 116,500 new cases of melanoma for this year, 46% of which will be melanoma *in situ*. Currently, the lifelong likelihood of developing melanoma is one in 41 for males and one in 61 for females [2]. Data from the 1990–2000 National Surveillance, Epidemiology, and End Results (SEER) Cancer Registry showed that lentigo maligna is the most common form of melanoma *in situ* and accounts for 79% of all diagnosed melanoma *in situ* in the USA [3].

Lentiginous melanoma *in situ* clinical picture

The clinical condition known commonly today as lentigo maligna was described and first reported by Hutchinson in the 1890s [4–6]. Lentigo maligna occurs most commonly on chronically sun-damaged skin and in middle-aged or elderly patients [7]. Clinically, lentigo maligna is irregular, hyperpigmented and often with ill-defined margins peripherally. Lentigo maligna can become quite large during its radial growth phase, with facial lesions as large as 13 cm being reported [8].

Lentigo maligna is a form of melanoma *in situ* that is the predecessor of lentiginous melanoma (lentigo maligna melanoma), those containing an epidermal as well as a dermal component of melanoma [9,10]. The exact percentage of those melanomas *in situ* that will eventually involve the dermis is unknown because of a variety of factors, not least of which is that melanomas *in situ* are excised after diagnosis and their natural history is aborted. Host factors also play a role in the development of dermal components of melanoma, but these are poorly understood. It has been reported objectively that patients with lentigo maligna have a 5% lifetime risk of developing lentigo maligna melanoma [11]. Several studies from the 1960s speculated greater rates of melanoma in the dermis in the setting of lentigo maligna based on anecdotal or personal experience

 10.1586/17469872.3.5.549 ISSN 1746-9872

ranging anywhere from 33 to 100% [12,13], with some authors simply reporting a 'high' risk of developing dermal components [14]. Additionally, the time to progression from lentigo maligna to lentigo maligna melanoma in susceptible lesions is unclear and can vary from weeks to months, years or even decades [9].

Surgical options for melanoma

Surgical treatment remains the stardard of care of lentiginous melanoma *in situ* or lentigo maligna melanoma. Several published reports are available for many surgical treatment modalities for treating the early stages of melanoma, including cryosurgery, electrodessication and curettage, laser surgery, routine excision, staged excision and Mohs micrographic surgery. Cryosurgery has been reported to be effective, but persistence (true local recurrence) rates from 2 to 34% have been published within the last 15 years [15–18]. A large study of 1350 melanoma *in situ* lesions revealed persistence (true local recurrence) rates of 43% for laser therapy and 13% for radiotherapy [18]. In addition, another major risk of nonexcisional treatment modalities is a failure to diagnose unsuspected melanoma within the dermis. Medical treatment with imiquimod for lentigo maligna has been studied but, currently, most experts do not feel imiquimod replaces surgery, but rather, can be considered in nonsurgical candidates or preoperatively [19]. Thus, nonsurgical options are not recommended as monotherapy at this time given the high persistence (true local recurrence) rates and lack of multiple studies.

The appropriate surgical margins utilizing routine excision techniques for melanoma has been debated in the medical literature for over 100 years. Samson Handley, the first to publish on the topic of melanoma margins, recommended a 2-inch surgical margin around the lesion, down to and including the underlying muscular fascia [20]. Since then, a multitude of articles have been published, including five randomized, controlled clinical trials examining wide versus narrow margins in the treatment of melanoma [21–25]. The overall conclusion from the available clinical trials shows no statistically significant difference in disease-free period or survival, with narrow versus wide margins for intermediate-thickness melanoma, defined as melanomas more than 1 mm, but less than 4 mm, deep [21–25].

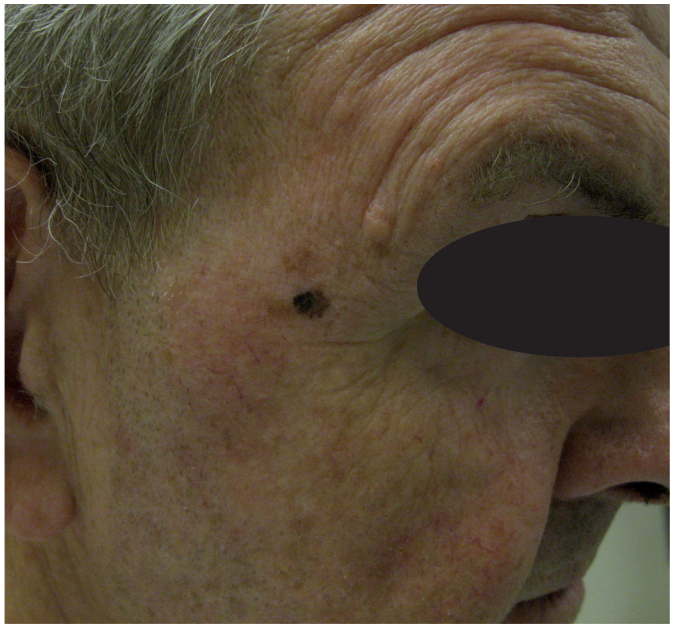

Figure 1. Clinical presentation of lentigo maligna as an irregular black–light brown macule.

While the appropriate surgical margin for intermediate-thickness melanomas has been studied scientifically, the same is not true for melanoma *in situ*, the most common presentation clinically of melanoma. The clinical trials available thus far have all been based on intermediate-thickness melanomas. However, there are no randomized clinical trials for melanoma *in situ*, or even for melanomas greater than 4 mm deep. The current, widely accepted surgical margin recommended for melanoma *in situ* excision is 5 mm; however, this margin recommendation is not based on a randomized, controlled trial, but rather, is a result of a 1992 National Institute of Health (NIH) consensus development conference [26]. Persistence (true local recurrence) rates for lentigo maligna and lentigo maligna melanoma with routine surgical excision have been reported to be as high as 9–20% [27–29].

Several studies have examined the use of Mohs micrographic surgery for lentigo maligna and lentigo maligna melanoma [30–32]. Published persistence (true local recurrence) rates for lentigo maligna and lentigo maligna melanoma treated with Mohs micrographic surgery are as low as 0–3% and as high as 33% [30–32]. While Mohs touts an attractively low persistence (true local recurrence) rate, the process has multiple limitations. Mohs surgery for melanoma may not be readily available, requires specific slide-interpretation expertise and, sometimes, requires specialized Mohs laboratories with immunohistochemistry staining capabilities. With frozen-section processing, normal keratinocytes may appear vacuolated and can, therefore, be mistaken for melanocytes. Melanocytes themselves may be altered on frozen section. Paradoxically, Mohs may even lead to wider excisions as ambiguity on frozen sections may cause the surgeon to unnecessarily remove surrounding additional tissue solely because melanocytes may be relatively closely packed or may vary in size, thus mimicking authentic melanoma *in situ* [9].

Owing to problems with conventional excision methods, the Mohs technique and nonsurgical treatments, staged excision was introduced in 1990 as a reliable alternative [33].

Staged-excision technique

The first step in the staged-excision technique is appropriate lesion selection. Lesions most suitable for a staged-excision technique include melanomas *in situ* of any histological pattern, but especially those with poorly defined clinical borders (Figure 1). Additionally, melanomas that superficially involve the dermis are also acceptable for this type of procedure. Moreover, persistent melanomas are excellent candidates for staged excisions because they have been shown to require more than 5-mm margins for clearance in many cases [34].

After the clinically visible border of the lesion is marked, the lesion is examined under a Wood's lamp to further delineate its border. A geometric shape with at least three sides is then drawn

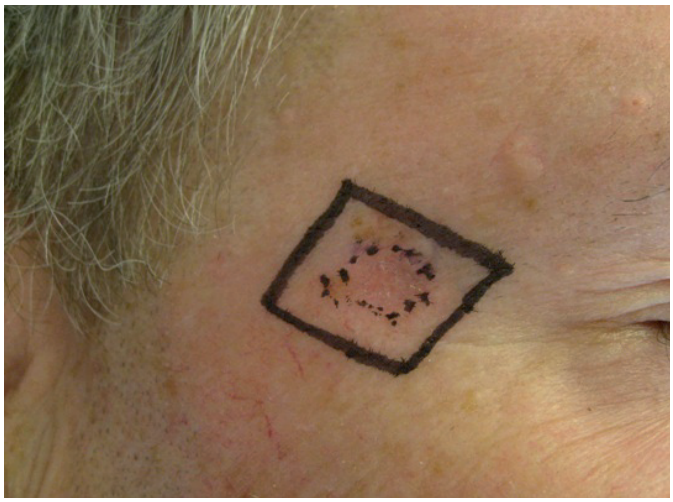

Figure 2. Lentigo maligna clinical border (dotted line) and four-sided geometric shape encompassing a 5-mm margin around lesion (solid line).

around the lesion encompassing a 3–5-mm margin (Figure 2). Alternatively, some experts advocate the use of excising lesions with rounded edges with notches placed for mapping purposes. The lesion is excised with vertical incisions into the subcutaneous fat (Figure 3). The specimen is then mapped, divided, inked and sent for rush permanent section evaluation. The patient is bandaged and sent home with dermatopathology interpretation expected within 24–48 h. Occasionally, margin assessment results may be delayed for immunohistochemical analyses of submitted specimens, which requires 48 h. A dermatopathologist then interprets the slides by examining 100% of the peripheral margin and sampling the deep margin to determine the depth of the melanoma's dermal component, if any. The patient returns for subsequent stages as needed, until tumor control is achieved (Figure 4). Patients return after the final stage for repair of suitable defects (Figure 5).

Dermatopathology review

The dermatopathologist inspects the specimen on its arrival in the laboratory and compares the surgeon's diagram to the specimens received. As a rule, the surgeon has applied ink to the specimens so that they correspond to the drawing received. In most cases, there are four specimens, which are the periphery, but the range is three-to-six specimens for the periphery, depending on the size of the procedure. Often, the center field, either a debulk (not a true deep margin) or center section with a true deep margin, is submitted in addition to the peripheral margins.

The peripheral margins are then examined, measured and a small application of ink is applied to the most clockwise area of the epidermis. The effect is that when the epidermis is up, with the epidermal ink toward the examiner, the true margin is always to the right. Each of these specimens is placed in cassettes for processing to paraffin. The center section, whether a true debulk or a center section with a true margin, is inked in the deeper aspect and divided as is practical. These sections are also placed into a cassette for processing to paraffin.

The following day, the specimens, which are now fully paraffinized, are re-examined by the dermatopathologist at the embedding bench. With the assistance of a histotechnologist, each of the peripheral margins is oriented so that the inked epidermal surface is toward the dermatopathologist, the true margin on the right. The specimens are then rotated 90° so that the true margin is down, *en face*, and the inked epidermis is scored superficially with a sharp blade so that the score mark can be identified under the microscope. The center sections are embedded on edge so that any residual melanoma can be measured.

In recent years, it has been valuable to apply Melan-A (clone A103) to evaluate the true peripheral margins and to compare those margins to a control, if available [Hurt M, Pers. Comm.]. One way this is achieved in a practical way is to order Melan-A on sections one and five from each peripheral margin, with hematoxylin and eosin for sections two, three and four. The central sections initially require two hematoxylin and eosin stains, the third section being stained with Melan-A. These stains and extra sections are ordered at the time the specimens are embedded to standardize the process for 36–48-h turnaround.

Finally, every effort is made to obtain the original melanoma so that it can be used as a control to evaluate the original in relation to the residual melanoma in the center and to any residual in the peripheral margins.

As a rule, confluence of melanocytes at the dermoepidermal junction is the minimal criterion for a positive peripheral margin. If theques are identified, these are additional evidence of a positive peripheral margin. Pitfalls include closely spaced melanocytes, often in a 1:1 ratio with keratocytes. Even if the ratio is relatively high but the melanocytes are periodically spaced, one cannot consider the margin positive. A second pitfall is that of the so-called pseudotheque, which occurs when collections of lymphocytes or keratocytes mimic theques of melanocytes. Melan-A or recut sections (or both) often helps in differentiating these mimics. A third pitfall consists of incidental lentiginous melanocytic nevi that

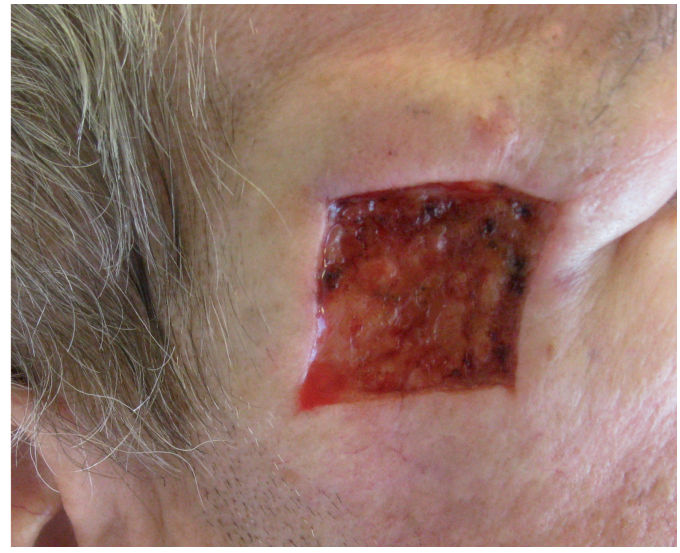

Figure 3. Specimen excised with vertical incisions into the subcutaneous fat.

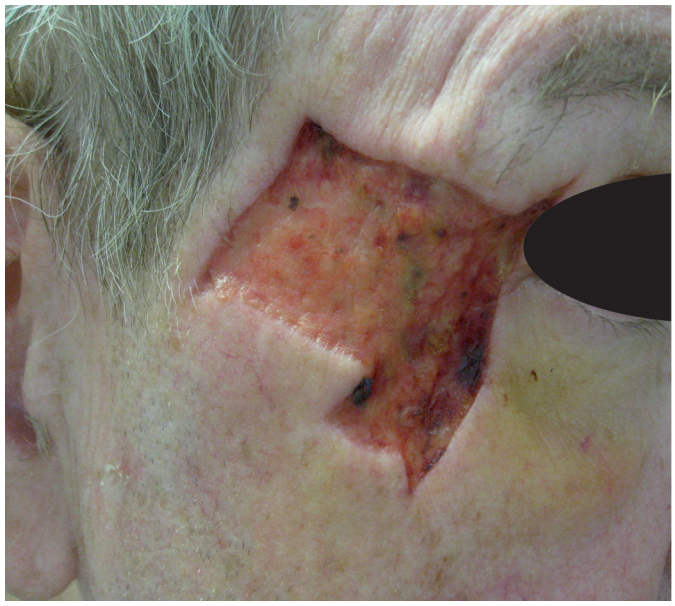

Figure 4. Final defect after 5 stages of surgery with final excision margin of 2.4 cm.

mimic melanomas *in situ*. As a rule, these are much more uniform in pattern than the melanoma *in situ* and they usually diminish in deeper sections. Finally, 'stray' Melan-A-positive cells are often identified in the dermis of the peripheral margins; these should not be considered part of any melanoma because they can be identified in control skin, especially in solar elastotic skin [35].

Is it melanoma *in situ* or melanoma with a dermal component?

Several studies have shown that careful microscopic analysis of lesions biopsied and initially interpreted as superficial lentigo maligna or melanoma *in situ* sometimes reveals a dermal component at the time of complete excision [36,37]. Agarwal *et al.* recently examined 92 cases of biopsy-proven lentigo maligna, treated utilizing a geographic staged-excision technique. In addition to examining 100% of the excised peripheral margin for tumor presence, the center portions of the excised lesions were re-examined to assess for the presence of a dermal component of the melanoma. In this series, 16% of the lesions previously thought to be lentigo maligna (melanoma *in situ*) revealed a dermal component of the melanoma [36]. Similarly, in a study of 61 lentigo maligna and lentigo maligna melanoma patients, 43% of lentigo maligna melanoma lesions were thought to be *in situ* only pre-operatively [37]. Older studies show similar findings, with one series reporting that more than 50% of lesions initially thought to be lentigo maligna were actually lentigo maligna melanoma [38].

The discrepancies in regards to the presence or absence of a dermal component of melanoma between the original biopsies and the subsequent excised specimens are important, as final excision margins are determined based on maximal lesion depth. Therefore, melanoma *in situ* lesions excised with routine excision and 5-mm margins, at times may be lesions that were actually present within the dermis and, thus, would have required a 1-cm margin. When these lesions are processed as routine excisions with standard bread-loafing of the excisional specimen, only a very small portion of the specimen is actually microscopically examined and, therefore, whether or not there is a dermal component remains unknown. If, instead, appropriate melanoma *in situ* lesions are treated with a staged-excision technique, a 5-mm margin would still be utilized, but rather than random sampling of the margin for involvement, 100% of the peripheral margin would be examined and the deep portion of the lesion would be evaluated for the presence of a dermal component.

Case for staged excisions

The case for staged excisions for melanoma *in situ* is supported by several published studies that have shown that the frequently utilized 1992 NIH consensus conference margin recommendation of 5-mm may not be adequate. In 2002, a University of Utah (UT, USA) study utilized a staged-excision technique to determine if the NIH consensus conference recommendation was adequate for the treatment of lentigo maligna. Analysis of 92 cases of lentigo maligna treated with a staged-excision technique revealed that only 42% of lentigo maligna lesions were cleared after one 5-mm stage and that 58% of lesions required more than the recommended 5-mm margin to achieve tumor control [36]. Numerous other studies have shown inadequate tumor control of lentigo maligna and lentigo maligna melanoma lesions with 5-mm margins. A 1999 Australian study showed that 38% of lesions required two or more layers [37]. Only 69% of melanoma lesions would have cleared with the standard 5-mm margins in a study examining periocular lentigo maligna [39]. In total, 50% of head and neck lentigo maligna and lentigo maligna melanoma lesions required more than two stages [40]. Similarly, a

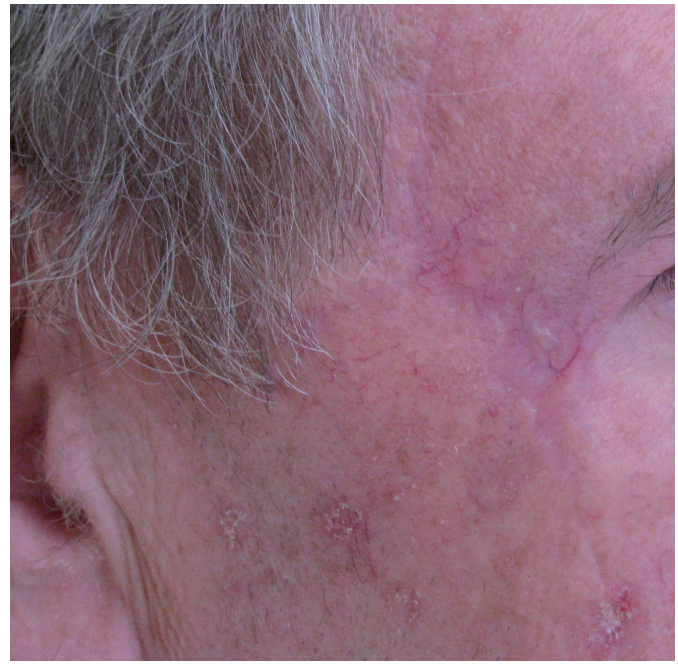

Figure 5. Post-operative photograph 4 months after combination advancement flap and full-thickness Burow's skin graft repair.

2004 Australian study demonstrated that 30% of lentigo maligna lesions required more than one level (>5 mm) for complete excision [41]. Utilizing a staged-excision technique, a separate study showed that only 35% of lentigo maligna/lentigo maligna melanoma lesions had clear surgical margins after the first 5-mm excision [42]. Further highlighting the case for staged excision with complete margin control is a recently published study that surveyed academic and nonacademic US dermatologists regarding their treatment practices. The survey found that half of dermatologists are not following the 1992 NIH consensus conference recommendation and treat melanoma *in situ* with less than the recommended 5-mm margin [43].

Effectiveness of staged excisions

In the first published case utilizing a staged-excision technique, a recurrent (probably a true local recurrence or persistent) cheek lentigo maligna was cleared after 11 sequential excisions over a period of a few weeks resulting in a defect that extended 10 cm beyond the clinically visible boundary [33]. Since the initial report, there have been several papers describing variations on the staged-excision technique, including the use of rounded edges, geometric shapes and a modification called a 'square' procedure, where a peripheral rim of tissue is excised but the central portion of the lesion is left intact and excised after the margins are deemed clear [10].

Despite the slight variations in technique, the effectiveness of the staged-excision technique is well-documented in the medical literature. To date, there are approximately 775 published lesions treated with staged excisions [8,10,33,36,37,39–42,44,45]. With an average follow-up of 41 months, the persistence rates (true local recurrence) for staged excisions of 0–7% are similar to published Mohs persistence (true local recurrence) rates of 0–3% [8,10,32,33,36,37,39–42,44]. While the majority of the literature finds that staged-excision persistence (true local recurrence) rates are comparable to Mohs surgery, a recently published comparison of the two techniques found that staged excisions have a lower persistence (true local recurrence) rate (7%) than that observed with Mohs surgery (33%) [44].

Expert commentary

Currently, the tens of thousands of people afflicted with melanoma *in situ* are most often treated with conventional excision without complete margin examination, putting them at risk for local persistence of tumor and subsequent possible local, regional or distant disease spread. Although time-consuming, staged excisions offer a distinct advantage for the patient in that they ensure adequate and confident margin control. Staged excisions are a safe, effective and simple way to achieve tumor clearance for lentiginous melanoma *in situ*. Studies have shown that blindly taking wider margins for melanoma has not been shown to increase survival. However, the 5-mm margin for melanoma *in situ*, which has become widely accepted after the 1992 NIH consensus conference, has never been studied scientifically and, recently, has been shown to be adequate in less than 50% of cases [36]. While Mohs micrographic surgery may allow for smaller surgical margins with complete margin examination, Mohs for melanoma is not readily available and frozen-section processing can obscure the pattern of the melanocytes.

The staged-excision procedure is most often described as an effective surgical technique for melanoma *in situ*. However, reports utilizing staged excisions for lentigo maligna melanoma can be found in the medical literature [10,37,39–41,42]. In such circumstances, where the lesion has a dermal component, the staged-excision initial margin of excision is less well-defined, but is often 5 mm. While 5 mm is sometimes adequate, lentigo maligna melanoma can require multiple stages of surgery to achieve margin control. Those cases of lentigo maligna melanoma where tumor control was achieved after a single 5-mm stage is a further testament to the existing trials that have shown that wider margins are not necessarily required for tumor clearance.

For the dermatopathologist, the determination of tumor presence at the margin can be difficult, especially if there is no control to assist in the evaluation of the margins. Often, melanocytes will have ratios with keratocytes of 1:1 in fields of solar elastosis, although unequivocal melanoma *in situ* is not identified. There can be a prominent population of melanocytes at the dermoepidermal junction, including pseudotheques as well as individual melanocytes with relatively large nuclei, which often pose challenging situations for the dermatopathologist. Maximizing the effectiveness and benefits of the staged-excision procedure requires a close working relationship and understanding between the dermatologic surgeon and the dermatopathologist. To better assist the dermatopathologist in distinguishing between the control population of melanocytes in a field of solar elastosis versus melanoma *in situ*, some experts advocate sampling from nonlesional, sun-exposed skin for comparison purposes [46]. Additionally, Florell *et al.* advocate the use of positive and negative controls to aid both inter- and intra-observer concordance in the staged-excision technique [46]. We agree with this approach and practice it routinely.

Five-year view

Although there are almost 800 published lesions in the medical literature treated with the staged-excision technique, there has been only one small study comparing Mohs surgery versus staged-excision outcomes [32]. In the next 5 years, additional staged-excision series and reports will probably continue to be published. Owing to persistence (true local recurrence) rates being important factors to consider when determining the effectiveness of a specific treatment modality, it is important to closely examine the duration of follow-up reported, with longer duration of follow-up encouraged in future publications. In addition, the most helpful reports will be randomized trials with study arms comparing the most widely utilized surgical techniques, including routine excisions, staged excisions and Mohs surgery.

Financial & competing interests disclosure

The authors have no relevant affiliations or financial involvement with any organization or entity with a financial interest in or financial conflict with the subject matter or materials discussed in the manuscript. This includes employment, consultancies, honoraria, stock ownership or options, expert testimony, grants or patents received or pending, or royalties.

No writing assistance was utilized in the production of this manuscript.

Key issues

- Lentiginous melanoma *in situ* is a common pattern of melanoma *in situ*.
- Lentiginous melanoma *in situ* commonly presents on chronically photodamaged skin.
- The current recommended surgical margin of 5 mm for melanoma *in situ* is based on a consensus conference and not on a randomized controlled scientific trial.
- Several studies have shown that 5-mm margins are not adequate for all cases of melanoma *in situ*.
- A staged-excision technique allows for complete tumor control with analysis of the entire peripheral margin and sampling of the excised specimen for an intradermal component of a melanoma.
- Staged excisions for melanoma *in situ* offer a cure rate that is higher than that of routine excisions and approaches the published persistence (true local recurrence) rates of Mohs micrographic surgery.
- The staged-excision technique has been shown to be effective for melanoma *in situ* and further studies with extended durations of follow-up should be encouraged to assess long-term cure rates.

References

Papers of special note have been highlighted as:
• of interest

1 Brown CD, Zitelli JA. The prognosis and treatment of true local cutaneous recurrent malignant melanoma. *Dermatol. Surg.* 21(4), 285–290 (1995).

2 American Cancer Society. Cancer Facts and Figures 1997–2008. New York, NY, USA.

3 Swetter SM, Boldrick JC, Jung SY, Egbert BM, Harvell JD. Increasing incidence of lentigo maligna melanoma subytpes: northern California and national trends 1990–2000. *J. Invest. Dermatol.* 125, 685–691 (2005).

4 Hutchinson J. Senile freckles. *Arch. Surg.* 3, 319–322 (1892).

5 Hutchinson J. Notes on the cancerous process and on new growths in general. *Arch. Surg.* 2, 83–86 (1890).

6 Hutchinson J. Lentigo-melanosis: a further report. *Arch. Surg.* 5, 253–256 (1894).

7 McKenna JK, Florell SR, Goldman GD, Bowen GM. Lentigo maligna/lentigo maligna melanoma: current state of diagnosis and treatment. *Dermatol. Surg.* 32, 493–504 (2006).

8 Mahoney EJ, Dolan RW, Choi EE, Olbricht SM. Surgical reconstruction of lentigo maligna defects. *Arch. Facial Plast. Surg.* 7, 342–346 (2005).

9 Cohen LM. Lentigo maligna and lentigo maligna melanoma. *J. Am. Acad. Dermatol.* 33 (6), 923–936 (1995).

10 Johnson TM, Headington JT, Baker SR, Lowe L. Usefullness of the staged excision for lentigo maligna and lentigo maligna melanoma: the 'square' procedure. *J. Am. Acad. Dermatol.* 37(5), 758–764 (1997).

• **Describes a modification of the technique where only the surgical margin is initially excised utilizing a two-bladed knife. Following margin control, the central portion of the lesion is then removed.**

11 Weinstock MA, Sober AJ. The risk of progression of lentigo maligna to lentigo maligna melanoma. *Br. J. Dermatol.* 116, 303–310 (1987).

12 Jackson R, Williamson G, Beattie W. Lentigo maligna and lentigo maligna melanoma. *Can. Med. Assoc. J.* 95, 846–851 (1966).

13 Davis J, Pack GT, Higgins G. Melanotic freckle of Hutchinson. *Am. J. Surg.* 113, 457–463 (1967).

14 Blodi FC, Widner RR. The melanotic freckle (Hutchinson) of the lids. *Surv. Ophthalmol.* 13, 23–30 (1968).

15 Kuflik EG, Gage AA. Cryosurgery for lentigo maligna. *J. Am. Acad. Dermatol.* 31(1), 75–78 (1994).

16 Graham GF. Advances in cryosurgery during the past decade. *Cutis* 52(6), 365–372 (1993).

17 Bohler-Sommeregger K, Schuller-Petrovic S, Neumann R, Muller E. Cryosurgery of lentigo maligna. *Plast. Reconstr. Surg.* 90(3), 436–440 (1992).

18 Zalaudek I, Horn M, Richtig E, Hodl S, Kerl H, Smolle J. Local recurrence in melanoma in situ: influence of sex, age, site of involvement and therapeutic modalities. *Br. J. Dermatol.* 148, 703–708 (2003).

19 Cotter MA, McKenna JK, Bowen GM. Treatment of lentigo maligna with imiquimod before staged excision. *Dermatol. Surg.* 34(2), 147–151 (2008).

20 Handley WS. The pathology of melanotic growths in relation to their operative treatment. *Lancet* 1, 927(33), 996–1003 (1907).

21 Veronesi U, Cascinelli N. Narrow excision (1 cm margin): a safe procedure for thin cutaneous melanoma. *Arch. Surg.* 126, 438–441 (1991).

22 Balch CM, Urist MM, Karakousis CP *et al.* Efficacy of 2-cm surgical margins for intermediate-thickness melanomas (1 to 4 mm): results of a mulit-institutional randomized surgical trial. *Ann. Surg.* 218, 262–269 (1993).

23 Karakousis CP, Balch CM, Urist MM, Ross MM, Smith TJ, Bartolucci AA. Local recurrence in malignant melanoma. *Ann. Surg. Oncol.* 3, 446–452 (1996).

24 Cohn-Cedermark G, Rutqvist LE, Andersson R *et al.* Long-term results of a randomized study by the Swedish Melanoma Study Group on 2-cm versus 5-cm resection margins for patients with cutaneous melanoma with a tumor thickness of 0.8–2.0 mm. *Cancer* 89, 1495–1501 (2000).

25 Khayat D, Rixe O, Martin G. Surgical margins in cutaneous melanoma (2 cm versus 5 cm for lesions measuring less than 2.1 mm thick). *Cancer* 97, 1941–1946 (2003).

26 National Institutes of Health Consensus Conference. Diagnosis and treatment of early melanoma. *JAMA* 268, 1314–1319 (1992).

27 Pitman GH, Kopf AW, Bart RS *et al.* Treatment of lentigo maligna and lentigo maligna melanoma. *J. Dermatol. Surg. Oncol.* 5, 727–737 (1959).

28 Coleman WP, Davis RS, Reed RJ *et al.* Treatment of lentigo maligna and lentigo maligna melanoma. *J. Dermatol. Surg. Oncol.* 6, 476–479 (1980).

29 Osborne JE, Hutchinson PE. A follow-up study to investigate the efficacy of initial treatment of lentigo maligna with surgical excision. *Br. J. Plast. Surg.* 55, 611–615 (2002).

30 Temple CLF, Arlette JP. Mohs micrographic surgery in the treatment of lentigo maligna and melanoma. *J. Surg. Oncol.* 94(4), 287–292 (2006).

31 Ziteli JA, Brown C, Hanusa BH. Mohs micrographic surgery for the treatment of primary cutaneous melanoma. *J. Am. Acad. Dermatol.* 37, 236–245 (1997).

32 Cohen LM, McCall MW, Zax RH. Mohs micrographic surgery for lentigo maligna and lentigo maligna melanoma. *Dermatol. Surg.* 24(6), 673–677 (1998).

- **First direct comparison of Mohs micrographic surgery to the staged-excision technique. The geometric staged-excision technique was found to have a lower recurrence rate than Mohs surgery, albeit in a small cohort.**

33 Dhawan S, Wolf D, Rabinowitz H, Poulos E. Lentigo maligna – the use of rush permanent sections in therapy. *Arch. Dermatol.* 126, 928–930 (1990).

- **Early report of Mohs surgery followed by rush permanent frozen-section sections.**

34 Huilgol S, Selva D, Chen C *et al*. Surgical margins for lentigo maligna and lentigo maligna melanoma- the technique of mapped serial excision. *Arch. Dermatol.* 140, 1087–1092 (2004).

35 Agarwal-Antan N, Bowen GM, Gerwels JW. Histologic evaluation of lentigo maligna with permanent sections: implications regarding current guidelines. *J. Am. Acad. Dermatol.* 47(5), 743–748 (2002).

- **Various polygonal shapes were utilized around the melanocytic neoplasms. Study found that 5-mm margins were not always adequate and that lesions previously felt to be *in situ* were found to have an invasive component.**

36 Hill DC, Gramp AA. Surgical treatment of lentigo maligna and lentigo maligna melanoma. *Aust. J. Dermatol.* 40, 25–30 (1999).

37 Wayte DM, Helwig EB. Melanotic freckle of Hutchinson. *Cancer* 21, 893–911 (1968).

38 Malhotra R, Chen C, Huilgol SC, Hill DC, Selva D. Mapped serial excision for periocular lentigo maligna and lentigo maligna melanoma. *Ophthalmology* 110(10), 2011–2018 (2003).

- **Examines periocular lentigo maligna and lentigo maligna melanoma, a particularly high-risk anatomic location and emphasized that the staged-excision technique may also be useful for recurrent lesions.**

39 Bub JL, Berg D, Slee A, Odland PB. Management of lentigo maligna and lentigo maligna melanoma with staged excision. *Arch. Dermatol.* 140, 552–558 (2004).

40 Huilgol S, Selva D, Chen C *et al.* Surgical margins for lentigo maligna and lentigo maligna melanoma- the technique of mapped serial excision. *Arch. Dermatol.* 140, 1087–1092 (2004).

41 Jejurikar SS, Borschel GH, Johnson TM, Lowe L, Brown DL. Immediate, optimal reconstruction of facial lentigo maligna and melanoma following total peripheral margin control. *Plast. Reconstr. Surg.* 120, 1249–1255 (2007).

42 Charles CA, Yee VS, Dusza SW *et al*. Variation in the diagnosis, treatment, and management of melanoma in situ: a survey of US dermatologists. *Arch. Dermatol.* 141, 723–729 (2005).

- **Survey study among US dermatologists found no consensus on appropriate surgical margins or depth of excision for melanoma *in situ*.**

43 Walling HW, Scupham RK, Bean AK, Ceilley RI *et al.* Staged excision versus Mohs micrographic surgery for lentigo maligna and lentigo maligna melanoma. *J. Am. Acad. Dermatol.* 57, 659–664 (2007).

44 Hazan C, Dusza SW, Delgado R, Busam KJ, Halpern AC, Nehal KS. Staged excision for lentigo maligna and lentigo maligna melanoma: A retrospective analysis of 117 cases. *J. Am. Acad. Dermatol.* 58(1), 142–148 (2008).

45 Florell SR, Boucher KM, Leachman SA *et al.* Histopathologic recognition of involved margins of lentigo maligna excised by staged excision: an interobserver comparison study. *Arch. Dermatol.* 139(5), 595–604 (2003).

46 Hendi A, Brodland DG, Zitelli JA. Melanocytes in long affiliations-standing sun-exposed skin: quantitative analysis using the MART-1 immunostain. *Arch. Dermatol.* 142(7), 871–876 (2006).

Affiliations

- Mark Abdelmalek, MD
Chief, Division of Laser and Dermatologic Surgery, Assistant Professor, Department of Dermatology, Drexel University College of Medicine, 219 N. Broad Street, 4th Floor, Philadelphia, PA 19107, USA
Tel.: +1 215 762 5550
Fax: +1 215 762 5570
mark.abdelmalek@drexelmed.edu
- Liana Abramova, MD
Instructor in Dermatology, Division of Dermatology, Washington University School of Medicine, St Louis, MO, USA
lianaabramova@gmail.com
- Mark A Hurt, MD
Cutaneous Pathology, WCP Laboratories, Inc, 2326 Millpark Dr Maryland Heights MO 63043–3530, USA
Tel: +1 314 991 4470
Fax: +1 314 991 4309
markhurt@aol.com
- George Hruza, MD
Director, Laser and Dermatologic Surgery Center, Clinical Associate Professor of Dermatology and Otolaryngology, St Louis University, St Louis, MO, USA
Tel.: +1 314 878 3839
Fax: +1 314 878 6575
info@lasersurgeryusa.com