Article Type: Original Article

Title: Systematic Review and Meta-Analysis of Local Recurrence Rates of Head and Neck Cutaneous Melanomas after Wide Local Excision, Mohs Micrographic Surgery, or Staged Excision

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Abstract

**Background:** Prospective trials have not compared local recurrence rates for different excision techniques for cutaneous melanomas on the head and neck.

**Objective:** To determine local recurrence rates of cutaneous head and neck melanoma after wide local excision (WLE), Mohs micrographic surgery (MMS), or staged excision.

**Methods:** A systematic review of PubMed, EMBASE, and Web of Science identified all English case series, cohort studies and randomized controlled trials that reported local recurrence rates after surgery of cutaneous head and neck melanoma. A meta-analysis utilizing a random effects model calculated weighted local recurrence rates and confidence intervals (CI) for each surgical technique and for subgroups of MMS and staged excision.

**Results:** Among one-hundred manuscripts with 13,998 head and neck cutaneous melanomas, 51.0% (7138) of melanomas were treated by WLE; 34.5% (4,826) by MMS; and 14.5% (2,034) by staged excision. Local recurrence rates were lowest for MMS (0.61%; 95%CI, 0.1%-1.4%); followed by staged excision (1.8%; 95%CI, 0.1%-2.9%) and WLE (7.8%; 95%CI, 6.4%-9.3%).

**Limitations:** Definitions of local recurrence varied. Surgical techniques included varying proportions of invasive melanomas. Studies had heterogeneity.

**Conclusion:** Systematic review and meta-analysis show lower local recurrence rates for cutaneous head and neck melanoma after treatment with MMS or staged excision compared to WLE.
Capsule summary

- Prospective trials have not compared local recurrence rates for different excision techniques for cutaneous head and neck melanomas.

- Systematic review of retrospective data shows lower local recurrence rates of cutaneous head and neck melanomas after Mohs micrographic surgery or staged excision versus wide local excision.
Introduction

The purpose of melanoma excision is to prevent local recurrence and progression.\textsuperscript{1, 2} Local recurrence may worsen prognosis,\textsuperscript{3, 4} increase surgical costs and complexity,\textsuperscript{5, 6} and heighten patient anxiety.\textsuperscript{7-9} The risk for local recurrence is higher after excision of cutaneous melanomas on the head and neck,\textsuperscript{10-12} where approximately 20\% of melanomas arise.\textsuperscript{13-17}

Although wide local excision (WLE) has been the standard technique for melanoma surgery, Mohs micrographic surgery (MMS)\textsuperscript{18} and staged excision\textsuperscript{19} are increasingly used to treat melanomas at high risk for local recurrence.\textsuperscript{20} MMS and staged excision aim to lower local recurrence rates by using comprehensive microscopic margin assessment to detect and remove subclinical melanoma prior to reconstruction. Subclinical melanoma is more common for both invasive and in-situ melanomas on the head and neck.\textsuperscript{21, 22} In its latest guidelines for cutaneous melanoma, the National Comprehensive Cancer Network indicates that comprehensive histologic assessment of margins with MMS or staged excision should be considered “for large and/or poorly defined” in situ or minimally invasive melanomas (<0.8 mm) associated with high cumulative sun damage.\textsuperscript{23}

Prospective randomized controlled trials have not compared local recurrence rates after WLE versus MMS or staged excision for head and neck melanomas. We hypothesized that local recurrence rates are lower after MMS or staged excision versus WLE. This systematic review and meta-analysis evaluates published local recurrence rates after WLE, MMS, or staged excision of cutaneous head and neck melanoma.
Materials and Methods

Eligibility Criteria

A priori inclusion and exclusion criteria were established to identify studies reporting local recurrence rate after surgery of cutaneous melanoma of the head and neck. (Mendeley Supplemental Table 1)

Inclusion criteria were published English-language case series, cohort studies, or randomized controlled trials that specified surgical technique and reported local recurrence rates for ≥10 cutaneous head and/or neck melanomas. Mucosal melanomas were excluded. Cases were also excluded if adjuvant local treatment such as radiation, electrodessication, or imiquimod was used. No restrictions were placed on tumor depth, systemic treatment use, publication date, or follow-up time. Studies were excluded if data were duplicated in another publication. Reviews, abstracts and unpublished studies were excluded.

The primary outcome was local recurrence rate. Studies were excluded if local recurrence could not be distinguished for melanomas on the head and neck versus other locations.

Study Selection

A literature search was conducted on November 5, 2018 of PubMed, EMBASE, and Web of Science databases using search terms detailed in Mendeley Supplemental Table 2. Two investigators (PGB, JMB) independently reviewed all search results for inclusion and exclusion criteria. If investigators disagreed on article inclusion, they convened to reach consensus. Included studies were reviewed for references that were not captured in the search. Cohen’s Kappa was calculated to provide level of inter-reviewer agreement.

Data Extraction
Two investigators (PGB, JMB) independently extracted data from included studies. Data were recorded on Microsoft Excel (Microsoft Corp., Redmond, WA). If reviewers disagreed on data, they convened to reach consensus. A third investigator (CJM) independently verified the final references and data. All three investigators (PGB, JMB, CJM) convened to resolve any disagreements.

**Data Items**

Extracted data included surgical technique (WLE, MMS, or staged excision); number of cutaneous head and neck melanomas; local recurrence rate; follow-up time; anatomic location; invasion status; and year(s) of surgery. Cases without follow-up information were excluded from analysis.

WLE was defined as conventional excision with microscopic margin assessment on a separate day by a dermatopathologist using formalin-fixed paraffin-embedded breadloafed sections.

MMS was defined as excision with same-day complete circumferential peripheral and deep frozen section microscopic margin assessment by the surgeon prior to reconstruction.

Subcategories were: (1) MMS with immunohistochemical stains (IHC); (2) MMS without IHC; and (3) MMS with and without IHC (for series that did not segregate local recurrence for patients who were treated with versus without IHC).

Staged excision was defined as excision with microscopic margin assessment by the surgeon or dermatopathologist using formalin-fixed paraffin-embedded sections prior to reconstruction. Variations of staged excision (collarette, contour, perimeter, polygon, spaghetti, square, slow-Mohs, and mapped serial excision) were grouped into two subcategories: (1) complete peripheral microscopic margin evaluation, defined by *en face* microscopic margin
assessment of 100% of the peripheral margin; and (2) partial peripheral microscopic margin
evaluation, defined by breadloafed sectioning to examine a portion of the peripheral margin. The
central tumor’s deep margin was typically evaluated with breadloafed vertical sections.

Invasion status, if specified, was classified as melanoma in situ (MIS) or invasive
(extend ing deep to the epidermis). Invasive melanomas could not be stratified further due to
inconsistent reporting of tumor depth and evolving staging criteria over time.

**Data Synthesis**

**Statistical Analysis**

The primary outcome was overall (including both MIS and invasive melanoma) local
recurrence rate after WLE, MMS, or staged excision of cutaneous head and neck melanoma
using a DerSimonion Laird random effects model. Subgroup analysis assessed local recurrence
rates after WLE, MMS, or staged excision of MIS versus invasive melanoma. For studies
reporting local recurrence rates for multiple techniques, populations for each technique were
analyzed separately.

Pre-planned secondary analyses assessed local recurrence rates for subcategories of (1)
MMS (with IHC; without IHC; or with and without IHC), and (2) staged excision (complete or
partial peripheral microscopic margin evaluation).

Freeman-Tukey double arcsine transformation was used since some studies had local
recurrence rates at or near zero.\(^{24}\) Heterogeneity of local recurrence rates across studies was
evaluated using Cochran’s Q statistic and \(I^2\) index. A p-value of <0.05 was considered
statistically significant heterogeneity. Forest plots and calculations were generated with Open
Meta.

**Risk of Bias Assessment**
Risk of bias in comparative studies was assessed using the ROBINS-I tool (Risk of Bias in Non-randomized Studies of Interventions). This tool assesses studies across seven domains of potential bias: confounding, selection of participants, classification of interventions, deviations from intended interventions, missing data, measurement of outcomes, and selection of the reported result. In each domain, assessment focused on whether results were adjusted to account for each potential source of bias. Single-arm studies were considered at high risk of bias.
Results

Overview details

Figure 1 details the screening and selection process. Of 2197 abstracts, 100 manuscripts with 13998 head and neck cutaneous melanomas published between 1972 and 2018 were included.\textsuperscript{18, 19, 26-123} Cohen’s kappa was 0.62. According to the ROBINS-I tool, all studies (5 comparative\textsuperscript{39, 42, 54, 85, 92} and 95 single-arm) had high-risk for bias. All included studies were either case series or cohort studies; no randomized controlled trials met inclusion criteria. Details of each manuscript are included in Mendeley Supplemental Table 3. Table 1 summarizes the data for these manuscripts.

28% (28/100) of manuscripts provided a definition for local recurrence. Definitions varied from recurrence ‘in the scar’ (n=1);\textsuperscript{18} ‘within or adjacent to scar’ (n=3);\textsuperscript{96, 97, 101} within ‘2 cm’ (n=7),\textsuperscript{39, 49, 63, 69, 99, 104, 112} 3 cm’ (n=1),\textsuperscript{71} or ‘5 cm’ (n=4) of the scar;\textsuperscript{28, 38, 64, 102} ‘at the primary/original site’ (n=8);\textsuperscript{40, 41, 46, 48, 59, 66, 73, 89} or, ‘recurrence that was not nodal/regional or distal’ (n=4).\textsuperscript{58, 61, 65, 67} Details for local recurrence definitions by surgical technique are available in Mendeley Supplemental Table 4.

Comparison of population characteristics

The most common technique was WLE (60 references, 51.0% [7138/13998] of cases),\textsuperscript{26-85} followed by MMS (22 references, 34.5% [4826/13998] of cases),\textsuperscript{18, 39, 42, 54, 85-102} and staged excision (23 references, 14.5% [2034/13998] of cases).\textsuperscript{19, 92, 103-123} The proportion of invasive melanomas was higher in the WLE group (96% [5734/5955]) compared to MMS (30% [926/3080]) or SE (27% [416/1539]). The weighted mean follow-up time was longest for staged excision (66.5 months), followed by WLE (52.8 months) and MMS (46.9 months).
Subcategories of MMS and staged excision

Studies for MMS varied in their use of IHC. 50.0% (2411/4826) of reported patients were treated with IHC; 15.2% (732/4826) without IHC; and 34.9% (1683/4826) with or without IHC. Among cases treated with staged excision, 87.8% (1786/2034) were evaluated with complete and 12.2% (248/2034) with partial peripheral microscopic margins.

Overall Local Recurrence Rates

Overall local recurrence rate was lowest for MMS (0.61% [95%CI, 0.1-1.4%]), followed by staged excision (1.8% [95%CI, 0.1-2.9%]) and WLE (7.8% [95%CI, 6.4-9.3%]). (see Table 1 for summary data and Figures 2-4 for forest plots)

Within MMS subcategories, local recurrence rate was 0.49% for MMS with IHC (95%CI, 0.18-0.91%); 0.20% for MMS with and without IHC (95%CI, 0.0-1.18%); and 3.37% for MMS without IHC (95%CI, 0.54-7.72%). (Table 1 and Mendeley Supplemental Figures 1-3) Within staged excision subcategories, local recurrence rate was 1.7% (95%CI, 0.79-2.8%) for complete peripheral margin assessment versus 3.1% (95%CI, 3.2-7.8%) for partial peripheral margin assessment. (Table 1 and Mendeley Supplemental Figures 4-5)

For overall local recurrence rates, heterogeneity was significant for studies with WLE (I²=72.1%, p<0.0001) and MMS [all subgroups combined] (I²=68.9%, p<0.0001) and non-significant for staged excision (I²=20.0%, p=0.1933). For MMS subgroups, heterogeneity was significant for MMS without IHC (I²=74.8%, p=0.0004) and MMS with and without IHC (I²=64.0%, p=0.025) but was not significant for MMS with IHC (I²=6.96%, p=0.37).

Local Recurrence Rates by Invasion Status
Invasion status was available for 75.5% (10574/13998) of melanomas, of which 66.9% (7076/10574) were invasive. It was not possible to distinguish local recurrence rates between MIS and invasive melanomas in some studies with mixed populations. However, local recurrence rates were determinable for 96.9% (3392/3498) of MIS and for 78.9% (5583/7076) of invasive melanomas.

For invasive melanomas, local recurrence rates were determinable for 4255 cases treated with WLE; 926 with MMS; and 402 for staged excision. For these invasive melanomas, local recurrence rate was lowest for MMS (0.61% [95%CI, 0-1.85%]) followed by staged excision (1.08% [95%CI, 0-4.04%]) and WLE (7.65% [95%CI, 5.83-9.65%]) (see Table 1 for summary data and Mendeley Supplemental Figures 6-8 for forest plots).

For MIS, local recurrence rates were determinable for 141 cases treated with WLE; 2154 with MMS; and, 1097 with staged excision. For these MIS, local recurrence rate was lowest for MMS (0.74% [95%CI, 0.25-1.42%]) followed by staged excision (1.30% [95%CI, 0.27-2.83%]) and WLE (3.28% [95%CI, 0-10.17%]) (see Table 1 for summary data and Mendeley Supplemental Figure 9-11 for forest plots).

In subgroup analyses of MIS or invasive melanoma, heterogeneity was not significant for any surgical technique, except for WLE of invasive melanomas ($I^2=70.2$, $p<0.0001$). (Table 1)

Local Recurrence in Comparative Studies

Five studies compared two techniques. Secondary analysis of the four articles (n=341) that compared local recurrence rates after WLE versus MMS (3 articles without IHC and 1 article with and without IHC) showed that the local recurrence rate was lower for MMS with a pooled odds ratio of 0.70 (95%CI, 0.20-2.49) and heterogeneity was nonsignificant ($I^2=50.15\%$, $p=0.11$). (Mendeley Supplemental Figure 12) However, the difference in local
recurrence rates for these comparative studies was not statistically significant (p=0.5801). Three of these four articles reported lower local recurrence rates after MMS; one reported higher local recurrence rate after MMS, but this article exclusively evaluated ear melanomas, and only 10 were treated with MMS (without IHC). Analysis of MMS versus SE could not be performed, as only one study compared these techniques.
Discussion

This systematic review and meta-analysis compiles the largest dataset for head and neck melanomas treated with WLE, MMS, and staged excision. These retrospective data show lower overall local recurrence rates with non-overlapping confidence intervals after treatment of cutaneous head and neck melanoma with MMS or staged excision compared to WLE. Subgroup analyses for MIS and invasive melanoma also show lower local recurrence rates after MMS or staged excision versus WLE. These retrospective data are important because current guidelines for WLE of melanoma are based on six randomized controlled trials (n=4231 randomized cases) that included only 27 (<1%) head and neck melanomas. Until prospective data are available, meta-analysis of available data provides the best method to make rational, evidence-based treatment decisions.

This study has limitations, and results should be interpreted with caution. One limitation is that the WLE cohort had a higher percentage of invasive melanomas compared to MMS or staged excision, and it was not possible to determine tumor stage or Breslow depth for all of the invasive melanomas. The WLE cohort may have had deeper melanomas that could have contributed to more local recurrences. However, the impact of tumor stage on local recurrence is uncertain. Whereas some studies show that higher stage melanomas have increased risk for true local and local satellite/in-transit recurrence, others show no correlation between tumor stage and local recurrence. In this analysis, local recurrence rate was lower after MMS or staged excision versus WLE for head and neck melanomas whether evaluating MIS or invasive melanomas together or in subgroups. (Table 1)

Another limitation was missing or non-uniform definitions for local recurrence. The majority of studies did not specify criteria for local recurrence, and among the 28% (28/100) of
manuscripts that did specify criteria, definitions for local recurrence varied. Some definitions of
local recurrence could include both true local recurrences and local satellite/in-transit
recurrences. However, local satellite/in-transit recurrences would be unlikely to account for
meaningful differences in local recurrence rates because localized intralymphatic metastasis
occur with a low overall rate of 16%\textsuperscript{131} and with an even lower rate of 2%-11% as the site of first
recurrence.\textsuperscript{131-134} In addition, local satellite/in-transit recurrences are less common for
melanomas arising on the head and neck versus the extremities.\textsuperscript{131,134}

Another limitation was study heterogeneity, but our random effects model and sub-group
analyses help minimize the effect of heterogeneity on the results. While the overall analysis
showed significant heterogeneity for MMS and WLE, sub-group analysis for MIS and invasive
melanomas showed non-significant heterogeneity for all techniques except WLE of invasive
melanomas ($I^2=70.2\%$, $p<0.0001$). Overall local recurrence rates were inconsistent after WLE,
ranging from 0 to 46%, and exceeded 5% in two-thirds (40/60) of WLE studies. (Figure 2)
Staged excision and MMS, particularly when performed with IHC, have lower heterogeneity and
less variable local recurrence rates, possibly because microscopic-margin directed excisions are
less dependent on clinical judgment.

In the absence of prospective comparative studies, meta-analysis of case series is the best
available evidence to compare surgical techniques\textsuperscript{135-137} and to guide current practice. While
retrospective data have limitations, this systematic review and meta-analysis demonstrates lower
local recurrence rates for cutaneous head and neck melanoma after treatment with MMS or
staged excision compared to WLE.
Figure Legend

Figure 1. PRISMA Diagram of Search Process

Figure 2. Forest plots of studies of wide local excision (WLE)

Figure 3. Forest plots of studies of Mohs micrographic surgery (MMS), including studies with, without, and with and without IHC

Figure 4. Forest plots of studies of staged excision (SE), including studies with complete and partial peripheral margin assessment

Mendeley Supplemental Figure Legend

Supplemental Figure 1. Forest plot of studies of Mohs Micrographic Surgery with IHC (MMS + IHC)

Supplemental Figure 2. Forest plot of studies of Mohs Micrographic Surgery without IHC (MMS – IHC)

Supplemental Figure 3. Forest plot of studies of Mohs Micrographic Surgery with and without IHC (MMS +/- IHC)

Supplemental Figure 4. Forest plot of studies of staged excision with complete peripheral margin assessment (SE Complete)
Supplemental Figure 5. Forest plot of studies of staged excision with partial peripheral margin assessment (SE Partial)

Supplemental Figure 6. Forest plot of studies of invasive melanoma treated by wide local excision (WLE)

Supplemental Figure 7. Forest plot of studies of invasive melanoma treated by Mohs micrographic surgery (MMS), including studies with, without, and with and without IHC

Supplemental Figure 8. Forest plot of studies of invasive melanoma treated by staged excision (SE), including studies with complete and partial peripheral margin assessment

Supplemental Figure 9. Forest plot of studies of melanoma in-situ (MIS) treated by wide local excision (WLE)

Supplemental Figure 10. Forest plot of studies of melanoma in-situ (MIS) treated by Mohs micrographic surgery (MMS), including studies with, without, and with and without IHC

Supplemental Figure 11. Forest plot of studies of melanoma in-situ (MIS) treated by staged excision (SE), including studies with complete and partial peripheral margin assessment

Supplemental Figure 12. Forest plot of studies comparing Mohs micrographic surgery (MMS) to wide local excision (WLE).
Table 1. Summary data and local recurrence rates by technique and invasion status, results of meta-analysis

<table>
<thead>
<tr>
<th>Technique</th>
<th>Articles, n</th>
<th>Mean F/U, mo.(^\wedge)</th>
<th>Overall</th>
<th>MIS</th>
<th>Invasive</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td>n</td>
<td>LR, % (CI)</td>
<td>(\text{I}^2, %)</td>
</tr>
<tr>
<td>WLE</td>
<td>60</td>
<td>52.8</td>
<td>7138</td>
<td>7.81 (6.4-9.3)</td>
<td>72.1*</td>
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<tr>
<td>MMS</td>
<td>22</td>
<td>46.9</td>
<td>4826</td>
<td>0.61 (0.1-1.4)</td>
<td>68.9*</td>
</tr>
<tr>
<td>without IHC</td>
<td>10</td>
<td>41.3</td>
<td>732</td>
<td>3.37 (0.5-7.7)</td>
<td>74.8*</td>
</tr>
<tr>
<td>with IHC</td>
<td>7</td>
<td>38.2</td>
<td>2411</td>
<td>0.49 (0.2-0.9)</td>
<td>7.0</td>
</tr>
<tr>
<td>with and without IHC</td>
<td>5</td>
<td>60.5</td>
<td>1683</td>
<td>0.20 (0.0-1.2)</td>
<td>64.0*</td>
</tr>
<tr>
<td>Staged Excision</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Complete</td>
<td>23</td>
<td>66.5</td>
<td>2034</td>
<td>1.84 (0.1-2.9)</td>
<td>20.0</td>
</tr>
<tr>
<td>Partial</td>
<td>3</td>
<td>40.8</td>
<td>248</td>
<td>3.09 (0.3-7.8)</td>
<td>48.5</td>
</tr>
<tr>
<td>Total</td>
<td>100(^\dagger)</td>
<td></td>
<td>13998</td>
<td>---</td>
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</tr>
</tbody>
</table>

WLE – Wide local excision; MMS – Mohs micrographic surgery; IHC – Immunohistochemistry; LR – Local recurrence rate; CI – 95% Confidence Interval; F/U – Follow-up; MIS – Melanoma in-situ; Complete – Complete peripheral microscopic assessment of margins; Partial – Partial peripheral microscopic assessment of margins

* statistically significant for p<0.05
\(^\wedge\) The mean follow-up was weighted by number of cases in each article reporting a mean follow-up time
# Only contained 1 study, so confidence interval could not be calculated
\(^\dagger\) 5 articles reported cases treated with techniques from more than one category
- The population sizes for MIS and invasive melanoma do not add up to the overall population size because it was not possible to distinguish local recurrence rates between MIS and invasive melanomas in some studies with mixed populations.
Abbreviations

CI – Confidence Interval
IHC – Immunohistochemistry
MMS – Mohs Micrographic Surgery
WLE – Wide Local Excision
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96. Newman J, Beal M, Schram SE, Lee PK. Mohs micrographic surgery for lentigo maligna and lentigo maligna melanoma using Mel-5 immunostaining: an update from the University of


135. Chambers D, Rodgers M, Woolacott N. Not only randomized controlled trials, but also case series should be considered in systematic reviews of rapidly developing technologies. J Clin Epidemiol 2009;62:1253-60.e4.


Records identified through database searching of:
- PubMed (n=1399)
- Embase (n=190)
- Web of Science (n=731)
  (total n = 2320)

Additional records identified through reference review (n = 15)

Records after duplicates removed (n = 2197)

Records screened (n = 2197)

Records excluded (n = 1706)

Full-text articles excluded, with reasons (total n = 391)
- Outcome Reporting (Unable to determine Local Recurrence): n=149
- Study Type (Case Report; Sys Rev; NOT n>10 Case Series, Cohort, RCT): n=121
- Intervention type (Not surgery, Use of adjuvant local therapy, or Intervention type unknown): n=59
- Lesion (Not Melanoma): n=13
- Melanoma Location (Not Head/Neck; Mucosal): n=21
- Cannot Extricate Outcomes for Head/Neck Melanoma: n=27
- Data accounted for in another study: n=1

Studies included in qualitative synthesis (n = 100)

Studies included in quantitative synthesis (meta-analysis) (n = 100)
Figure 2
Forest plots of studies of wide local excision (WLE) 1-60


8. Bogle M, Kelly P, Shenaq J, Friedman J, Evans GRD. The role of soft tissue
reconstruction after melanoma resection in the head and neck. *Head Neck-J Sci Spec


E15.


12. Carlson JA, Dickersin GR, Sober AJ, Barnhill RL. DESMOPLASTIC NEUROTROPIC
MELANOMA - A CLINICOPATHOLOGICAL ANALYSIS OF 28 CASES. *Cancer.*


14. Chin-Lenn L, Murynka T, McKinnon JG, Arlette JP. Comparison of outcomes for
malignant melanoma of the face treated using Mohs micrographic surgery and wide local
excision. *Dermatologic surgery : official publication for American Society for


39. McKenna DB, Lee RJ, Prescott RJ, Doherty VR. A retrospective observational study of primary cutaneous malignant melanoma patients treated with excision only compared


<table>
<thead>
<tr>
<th>Studies: WLE</th>
<th>Estimate (95% C.I.)</th>
<th>Ev/Ttr</th>
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<tr>
<td>Ames et al. 1976</td>
<td>0.0422 (0.0160, 0.0789)</td>
<td>7/166</td>
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<tr>
<td>Byers et al. 1982</td>
<td>0.0588 (0.0000, 0.2354)</td>
<td>1/17</td>
</tr>
<tr>
<td>Froelker et al. 1982</td>
<td>0.0728 (0.0261, 0.1204)</td>
<td>11/151</td>
</tr>
<tr>
<td>Lang et al. 1984</td>
<td>0.0274 (0.0004, 0.0808)</td>
<td>2/73</td>
</tr>
<tr>
<td>Utist et al. 1984</td>
<td>0.0412 (0.0258, 0.0599)</td>
<td>22/534</td>
</tr>
<tr>
<td>de Langen et al. 1988</td>
<td>0.0427 (0.0000, 0.2339)</td>
<td>0/10</td>
</tr>
<tr>
<td>Fisher et al. 1988</td>
<td>0.2000 (0.0298, 0.4460)</td>
<td>3/15</td>
</tr>
<tr>
<td>Vreeburg et al. 1988</td>
<td>0.0429 (0.0054, 0.1058)</td>
<td>2/70</td>
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<td>Warren et al. 1989</td>
<td>0.1446 (0.0741, 0.2294)</td>
<td>12/83</td>
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<tr>
<td>Beenken et al. 1989</td>
<td>0.4615 (0.1949, 0.7391)</td>
<td>6/13</td>
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<tr>
<td>Loree et al. 1989</td>
<td>0.1696 (0.1283, 0.2151)</td>
<td>49/289</td>
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<tr>
<td>Hudson et al. 1990</td>
<td>0.2500 (0.0393, 0.5392)</td>
<td>3/12</td>
</tr>
<tr>
<td>O'Brien et al. 1991</td>
<td>0.1303 (0.1101, 0.1519)</td>
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<td>Andersson et al. 1992</td>
<td>0.2713 (0.0530, 0.5986)</td>
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<td>Cole et al. 1992</td>
<td>0.0645 (0.0012, 0.1847)</td>
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<td>On et al. 1993</td>
<td>0.1136 (0.0546, 0.1894)</td>
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<td>Plukker et al. 1993</td>
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<td>Ringborg et al. 1993</td>
<td>0.0826 (0.0615, 0.1065)</td>
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<td>Davidsson et al. 1993</td>
<td>0.2857 (0.0741, 0.5544)</td>
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<td>Lent et al. 1994</td>
<td>0.0133 (0.0000, 0.0887)</td>
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<td>Martin et al. 1994</td>
<td>0.0299 (0.0040, 0.0649)</td>
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<td>Carlson et al. 1995</td>
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<tr>
<td>Andersson et al. 1996</td>
<td>0.0270 (0.0058, 0.0606)</td>
<td>4/148</td>
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<tr>
<td>Bono et al. 1997</td>
<td>0.0230 (0.0000, 0.1496)</td>
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<td>Kane et al. 1997</td>
<td>0.0519 (0.0236, 0.0752)</td>
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<td>Papadopoulos et al. 1997</td>
<td>0.2353 (0.1056, 0.3944)</td>
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<td>Hudson et al. 1998</td>
<td>0.0700 (0.0269, 0.1296)</td>
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<td>Bogle et al. 2001</td>
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<td>Giba et al. 2001</td>
<td>0.0655 (0.0234, 0.1085)</td>
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<td>Vaziri et al. 2002</td>
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<td>Esmaili et al. 2003</td>
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<td>Gyori et al. 2003</td>
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<td>Park et al. 2003</td>
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<td>McKenna et al. 2004</td>
<td>0.0638 (0.0385, 0.0946)</td>
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<td>Lin et al. 2005</td>
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<td>Raviv et al. 2006</td>
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<td>Rughani et al. 2007</td>
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<td>Chen et al. 2008</td>
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<td>Soliman et al. 2010</td>
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<td>Jaber et al. 2011</td>
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<td>Buck et al. 2012</td>
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<td>Mohidien et al. 2012</td>
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<td>Sullivan et al. 2012</td>
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<td>Chin-Len et al. 2013</td>
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<td>Harish et al. 2013</td>
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<td>Jones et al. 2013</td>
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<td>McCarty et al. 2013</td>
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<td>Akhtar et al. 2014</td>
<td>0.0482 (0.0105, 0.1069)</td>
<td>4/83</td>
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<td>Parrett et al. 2014</td>
<td>0.0316 (0.0040, 0.0785)</td>
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<td>Dik et al. 2015</td>
<td>0.2400 (0.0895, 0.4295)</td>
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<td>Rawlani et al. 2015</td>
<td>0.0886 (0.0343, 0.1628)</td>
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<tr>
<td>Hafstrom et al. 2016</td>
<td>0.0616 (0.0275, 0.1073)</td>
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<tr>
<td>Picon et al. 2016</td>
<td>0.0139 (0.0000, 0.0587)</td>
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<tr>
<td>Kukar et al. 2017</td>
<td>0.0427 (0.0000, 0.2739)</td>
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Overall (n=272, 0.08%, P<0.04) 0.0781 (0.0640, 0.0934) 609/7138
Figure 3
Forest plots of studies of Mohs micrographic surgery (MMS), including studies with, without, and with and without IHC 1-22


Figure 4:
Forest plots of studies of staged excision (SE), including studies with complete and partial peripheral margin assessment1-23


Capsule summary

- Prospective trials have not compared local recurrence rates for different excision techniques for cutaneous head and neck melanomas.
- Systematic review of retrospective data shows lower local recurrence rates of cutaneous head and neck melanomas after Mohs micrographic surgery or staged excision versus wide local excision.