Dermatology Practical & Conceptual

Spaghetti Technique Versus Wide Local Excision for Lentigo Maligna Affecting the Head and Neck Regions: Surgical Outcome and Descriptive Analysis of 79 Cases from a Single Practice Cohort

Manel Martinez-Molina[1], Nina Richarz[1], Ane Jaka[1], Juli Bassas-Vila[1], Verónica Mora-Fernández[1], Ariadna Quer Pi-Sunyer [2], Sebastian Podlipnik[3], José Manuel Carrascosa[1], Aram Boada[1]

1 Department of Dermatology, Hospital University Germans Trias i Pujol, Badalona. Autonomous University of Barcelona, Barcelona, Spain
2 Department of Pathology, Hospital University Germans Trias i Pujol, Badalona, Barcelona, Spain
3 Department of Dermatology, Melanoma Unit, Hospital Clinic of Barcelona, IDIBAPS, University of Barcelona, Barcelona, Spain

Key words: Lentigo maligna, Spaghetti technique, Wide local excision, Melanoma

Citation: Martinez-Molina M, Richarz N, Jaka A, et al. Spaghetti Technique Versus Wide Local Excision for Lentigo Maligna Affecting the Head and Neck Regions: Surgical Outcome and Descriptive Analysis of 79 Cases From a Single Practice Cohort. *Dermatol Pract Concept.* 2023;13(3):e2023193. DOI: https://doi.org/10.5826/dpc.1303a193

Accepted: March 2, 2023; **Published:** July 2023

Funding: None.

Competing Interests: None.

Authorship: All authors have contributed significantly to this publication.

Corresponding Author: Manel Martinez Molina, Department of Dermatology, Hospital University Germans Trias i Pujol, Badalona. Autonomous University of Barcelona, Carretera de Canyet, w/n, PC: 08916, Badalona, Barcelona, Spain.
Email: manel.martmol@gmail.com

ABSTRACT

Introduction: Lentigo maligna is a subtype of melanoma in situ that typically affects the head and neck region with an increasing incidence. Margin-controlled techniques, such as spaghetti technique (ST), have gained popularity over wide local excision (WLE) with a margin of 5 mm.

Objectives: To evaluate the outcomes of lentigo maligna cases in the head and neck area treated by either WLE or ST in a tertiary referral hospital. The secondary goal was to describe the demographic and clinical characteristics of our series.

Methods: Cohort study of patients diagnosed with lentigo maligna on the head and neck region between January 2014 and February 2022 in a tertiary hospital.

Results: In total, 79 lentigo maligna were studied, corresponding to 77 patients. Fifty-three lesions (67%) were treated with WLE and 26 (33%) with ST. The mean age of the patients was 73 years and 58% were men. Most of the tumors were located on the cheek (50%) and mean lesion diameter was 2.2 cm for the ST group and 1.2 cm for the WLE group. Mean duration follow-up was 44 months. There were two local recurrences in the WLE group (2/53; 3.7%) and none in the ST group.

Conclusions: Both WLE and ST are appropriate surgical approaches for lentigo maligna. ST offers an efficient alternative to Mohs surgery for treating lentigo maligna in the head and neck area, especially when guided by reflectance confocal microscopy.

Introduction

Lentigo maligna (LM) is a subtype of melanoma in situ that typically appears on the sun-damaged skin of elderly patients [1]. The estimated risk of progression of LM to LM melanoma (LMM) is 3.5 % per year [2]. In recent years, the incidence of LM/LMM has increased in comparison to other melanoma subtypes [3,4]. A study of 8626 melanoma cases in Catalonia (Spain), showed a rise in the incidence of LMM, from 13.9% in 2008 to 22.6% in 2017 [5]. A 25-year study in the Netherlands mirrored this trend, with a rise in the incidence rate from 0.72 LM/100.000 person years in 1989 to 3.84 LM/100.000 patient years [6]. The estimated annual incidence in another recent study was 12 LM/100.000 persons. Surgical excision remains the treatment of choice for LM. Wide local excision (WLE) with 5-mm to 10-mm margins is the standard surgical management [8,9]. However, 5-mm margins may be inadequate in some cases, with recurrence ranging from 6% to 20% [10,11], owing to subclinical peripheral spread and poor histological margin assessment. LM primarily affects the head and neck region and these margins are more difficult to achieve in areas with aesthetic and functional implications, such as the face. Margin-controlled techniques like Mohs micrographic surgery (MMS) evaluate 100% of the surgical margin, reducing the risk of recurrence, while preserving tissue in cosmetically sensitive sites. Owing to the difficulty of assessing atypical melanocytes in frozen sections in MMS, even with immunohistochemical staining, variations of MMS, such as slow Mohs (SM) and staged excision (SE) have gained popularity among surgeons [12]. SM and SE rely on permanent sections and deferred histological examination. SM uses the same horizontal sectioning technique as MMS, but relies on formalin-fixed paraffin-embedded sections, instead of frozen sections. Following the intervention, the patient returns home. A few days later, depending on whether the margins are positive or not, an additional resection or a defect reconstruction is performed. In SE, narrow margins are examined in formalin-fixed permanent sections, without tumour debulking in the first stage. Debulking is performed in the final stage when all margins are clear. Among staged excisions, in both square technique and perimeter technique, a preoperative geometric-shaped excision is outlined adding safety margins to the clinically identified limits of the tumor, to check the periphery of this geometric figure before resection [13,14]. In contrast, in the spaghetti technique (ST), a variation of SE first described by Gaudy-Marqueste et al, the intention is to define, step by step, as closely as possible the real - pathologically identified - shape of the LM, that will enable later its resection and reconstruction [15] (Table 1).

Although MMS has been controversial for melanoma, because of concerns about the accuracy of detecting atypical

Table 1. Staged excisions techniques: differences and similitudes.

	Square technique	Perimeter technique	Spaghetti technique	Collarette technique
Differences	Excision of a 2-mm strip of skin in a square pattern.	A variation of the square technique. Excision of a 2-mm strip of skin in a variety of geometric shapes (triangles, rectangles, or pentagons) to facilitate posterior reconstruction.	Curved lines and rounded edges are used instead of straight lines, in order to define as closely as possible, the real pathologically shape of the tumor.	It is identical to spaghetti technique. The only difference with ST is the use of dermoscopy to delineate tumor edges, in its original description by Kassi et al [37].
Similitudes	• A double-bladed scalpel is used to remove a 2–4-mm strip surrounding the lesion. • The resulting linear defect is sutured. • The specimen is paraffin embedded and en face vertical sections containing 100 % of the peripheral margins are assessed. • If positive margins are identified, a procedure is repeated 5 mm beyond the corresponding involved segment and again sutured, until a tumor-free perimeter is achieved. • Resection of the central tumor and reconstruction is performed.			

melanocytes on frozen sections, a recent study showed a high diagnostic accuracy on frozen sections compared with permanent sections [16]. Another limitation of MMS is that immunohistochemical staining is time-consuming for histotechnicians and can impair the flow of a Mohs practice [17]. In contrast, an advantage of ST over MMS is that it does not require specially trained MMS technicians, thus making it more accessible.

Objectives

The primary goal of the present study was to retrospectively evaluate the outcomes of LM cases in the head and neck area treated by either WLE or ST in a tertiary referral hospital. The secondary goal was to describe the demographic and clinical characteristics of our series.

Methods

This retrospective study included data from all the patients diagnosed with LM on the head or neck between January 2014 and February 2022 at a tertiary hospital in Spain (Germans Trias i Pujol Universitary Hospital in Badalona, Barcelona). The database included age at diagnosis, gender, phototype (I-II, III-IV, V-VI), tumor site (cheek, nose, periocular, perioral, scalp, forehead, ear, neck), clinical tumor greatest diameter (< or ≥ 2 cm), type of surgery (WLE or ST), number of stages required in ST (2 or ≥ 3) and in WLE (1 or 2), local and distant recurrence, and follow-up duration (months). We included patients with recurrent LM. These included LM that had reappeared after a prior curative therapy, whether surgical or non-surgical (cryosurgery, laser therapy), performed in our hospital or elsewhere. Patients with invasive melanoma (LMM) were excluded from the study. We also excluded cases in which the management chosen was therapeutic abstention.

Histological diagnosis of LM was obtained by incisional biopsy prior to treatment. The surgical technique was chosen according to current guidelines, with ST being the preferred option in most LM cases in the recent years. When WLE was used, the margin of excision around the clinically apparent tumor was 5 mm. In the case of ST, a 2-mm strip of skin was resected, 2 mm to 3 mm beyond the clinically and dermoscopically defined outline of the lesion. The linear defect was sutured, and the patients discharged pending the results of histology. The narrow strip of resected skin was divided into appropriately sized segments, which were then pinned in a circular pattern reflecting their anatomic orientation. The number of segments varied depending on the size and morphology of the resected specimen (Figure 1). Each segment was fixed in formol and analyzed in vertical in-face sections by dermatopathologists. If a segment was positive for

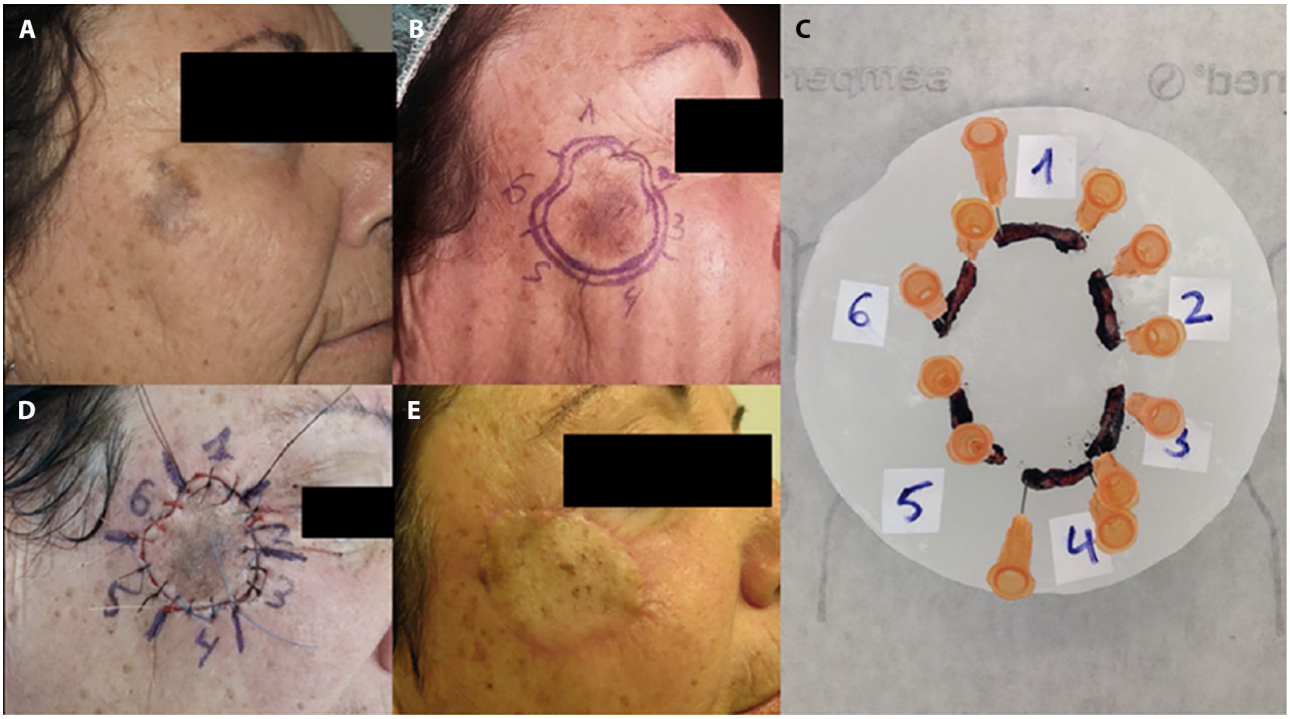

Figure 1. Spaghetti technique. (A) Lentigo maligna on the cheek area. (B) Skin markings prior to the first excision. (C) Resected "spaghetti" strip divided into segments and arranged in a circle before being sent for pathological study. (D) Suture of the resulting linear defect, leaving the tumor on site pending the results of histopathological study. (E) Tumor resection followed by flap reconstruction was performed when all "spaghetti" segments were tumor-free.

malignant cells, an additional strip excision was performed beyond the corresponding area. This step was repeated until all the segments of the 'spaghetti' were tumor free. In the last stage, resection of the tumor and reconstruction of the final defect (skin graft, flap, or primary closure) were performed at the same time. A major disadvantage of the ST is that the central tumor is not excised until the time of closure, so an unsuspected invasive melanoma would not be identified until after closure is complete [18]. This risk could be reduced by correlating the dermoscopy findings with the Breslow index and by performing a punch biopsy of the most suspicious area of depth [19]. From 2019 onwards, reflectance confocal microscopy (RCM) was used to delineate excision margins before surgery in all cases of LM, whether the surgical approach was WLE or ST.

A descriptive analysis was carried out of the demographic and clinical data. We compared the LM characteristics of the two groups (WLE and ST). The Student t test was used to analyze continuous variables and the Mann-Whitney U test when the data were not normally distributed. Comparative variables were analyzed with the Chi^2 test. A P value less than 0.05 was considered statistically significant. Local recurrence-free survival was assessed using Kaplan Meier analysis. For local recurrence-free survival, the time to an event (date of recurrence or last follow-up) was calculated from the date of histological diagnosis. Statistical analysis was performed using SPSS software version 28.0. The study was approved by the local Ethics Committee and patients gave written informed consent.

Results

Between January 2014 and February 2022, 81 lesions diagnosed as LM affecting the head and neck region were identified in 79 patients. Therapeutic abstention was the strategy chosen for two patients due to their advanced age (99 and 100 years-old respectively). In total, 79 LM corresponding to 77 patients were included in the study; 53 lesions were treated with WLE and 26 with ST. The characteristics of the study population are summarized in Table 2. The mean age of the patients was 73 years (range 43 – 95). Forty-two percent were women and 58% men. More than half of the patients had skin phototype III-IV (52/79; 65.8%). Most of the tumors (75/79; 95%) were primary. At the time of diagnosis, three lesions in the ST group and one in the WLE group were recurrent. The most frequent site was the cheek (50%), followed by the forehead (12%), scalp (10%) and nose (10%). In the ST group, 54% of the lesions measured ≥ 2 cm. In contrast, only 17% of the LM treated with WLE measured ≥ 2 cm. Mean lesion size was 2.2 cm for the ST group and 1.2 cm for the WLE group. These differences were statistically significant (P <0.05). The interval since first onset of the lesion as reported by the patient ranged from 2 months to 25 years, and only 8 patients claimed a history of more than 10 years. Mean follow-up duration was 44 months (range 2 – 90 months). Local recurrence was diagnosed in 2 of 53 cases treated with WLE, at 12 and 39 months, respectively, (a mean interval of 25 months). Both cases were subsequently treated with ST. No local recurrences were observed in the ST group. Local recurrence-free survival at 30 and 60 months after diagnosis was 98% and 95%, respectively, for the WLE group and 100% for lesions treated with ST (Figure 2). The difference in local recurrence-free survival between WLE and ST groups was not significant (P = 0.33). Progression to LMM, distant metastases or death attributable to melanoma were not observed in any group. Ten patients died from other causes during the follow-up period.

Conclusions

In this study, we present a cohort of patients with LM on the head and neck treated with either WLE or ST, contributing the experience of one hospital to the literature on LM management. We found no significant difference in the frequency of local recurrence between WLE and ST. Two non-randomized studies have compared long-term outcomes for different surgical treatment modalities in LM, like the present study. Walling et al reported a higher recurrence rate for MMS (36%) than for SE (8%) [20]. Walling et al attributed this significant local recurrence rate to the long follow-up period (mean almost 10 years), arguing that most recurrences occur 3 to 5 years after treatment. Another possible explanation for the high recurrence rate in that study may be the small number (N = 14) of lesions treated with MMS. Hou et al reported a lower risk of recurrence with MMS (1.9%) than with WLE (5.9%), although the difference was not statistically significant [12].

Notably, in our series the recurrence rate for both surgical techniques was lower than that previously reported in the literature [10-12, 20-29]. Other studies have reported recurrence rates for WLE of between 6% and 20%, with a follow-up period of 36 to 90 months. Recurrence rates reported for MMS range from 0% to 6% with a follow-up period of 38 to 95 months, excluding the outlier of 36% in the study mentioned above. In the case of SE, recurrence rates were 2% to 10% with follow-up periods of between 32 and 95 months (Table 3). However, comparison with previous studies may be inaccurate because, the follow-up methods were not described in some cases and in others follow up was performed by general practitioners or was based on telephone reports by family members [30]. In our study, follow-up consisted of a physical examination carried out by one of the authors and local recurrence was confirmed by skin biopsy.

Even though the recurrence rate was lower in the ST group than the WLE group, the difference was not statistically

Table 2. Demographic and clinical characteristics of patients with lentigo maligna in the head and neck region by surgery type.

Variable	Spaghetti Technique	Wide Lesion Excision	Overall, N (%)	P value
No. of cases	26 (33%)	53 (67%)	79 (100%)	
Sex				P>0.05
Female	12 (36.4%)	21 (63.6%)	33 (41.8%)	
Male	14 (30.4%)	32 (69.6%)	46 (58.2%)	
Average age	72.2	73.6	73	P>0.05
<70 years	9 (32.1%)	19 (67.9%)	28 (35.4%)	P>0.05
≥70 years	17 (33.3%)	34 (66.7%)	51 (64.5%)	P>0.05
Skin phototype				P>0.05
I-II	10 (40%)	15 (60%)	25 (31.6%)	
III-IV	15 (28.8%)	37 (71.2%)	52 (65.8%)	
V-VI	1 (50%)	1 (50%)	2 (2.5%)	
Site				P>0.05
Centrofacial				
Cheek	16 (40%)	24 (60%)	40 (50.6%)	
Nose	3 (37.5%)	5 (62.5%)	8 (10.1%)	
Periocular	1 (50%)	1 (50%)	2 (2.5%)	
Perioral	1 (100%)	0	1 (1.3%)	
Peripheral				
Scalp	3 (37.5%)	5 (62.5%)	8 (10.1%)	
Forehead	2 (20%)	8 (80%)	10 (12.7%)	
Ear	0 (0%)	9 (100%)	9 (11.4%)	
Neck	0 (0%)	1 (100%)	1 (1.3%)	
Size				P<0.05
<2 cm	12 (21.4%)	44 (78.6%)	56 (70.9%)	
≥2 cm	14 (60.9%)	9 (39.1%)	23 (29.2%)	
Duration				P<0.05
<5 years	15 (38.5%)	24 (61.5%)	39 (49.4%)	
≥5 years	6 (27.3%)	16 (72.7%)	22 (27.8%)	
Unknown	5 (27.8%)	13 (72.2%)	18 (22.8%)	
Primary vs recurrent				P<0.05
Primary	23 (30.7%)	52 (69.3%)	75 (94.9%)	
Recurrent	3 (75%)	1 (25%)	4 (5.1%)	
No. of stages	ST	WLE		P<0.05
1	0 (0%)	51 (96%)	51 (65%)	
2	21 (81%)	2 (4%)	23 (29%)	
≥3	5 (19%)	0 (0%)	5 (6%)	

significant. Since the outcomes of both surgical techniques were similar in our study, we believe that additional factors should be considered before choosing the surgical approach, such as patient preference, tumor size, reconstruction options and the accessibility of margin-controlled techniques. In our hospital, collaboration with experienced dermatopathologists with experience in ST and the use of paraffin-embedded sections has proved to be a fruitful strategy.

Some authors have shown that the standard 5-mm margins are often not sufficiently wide to ensure clear margins [31]. However, wide excisions margins (10 mm) are not always acceptable because they can lead to morbidity in functional and cosmetically sensitive areas. Consequently, the site of the lesion, patient age and comorbidities must also be taken into account. The lower local recurrence rate observed in our WLE patients may be explained by the introduction

Table 3. Summary of studies reporting surgically treated lentigo maligna, by surgery type[a].

Treatment	Study	Recurrence rate (%)	Mean follow-up (months)	Mean time to recurrence (months)
Wide local excision	Pittman (1979)	9% (2/22)	38	-
	Tsang (1994)	6% (1/18)	36	-
	Osborne (2002)	20% (16/81)	43	-
	Hou (2015)	6% (16/269)	95	-
Mohs micrographic surgery	Robinson (1994)	6% (1/16)	60	96
	Cohen (1998)	0% (0/26)	57	-
	Bhardwaj (2006)	1% (1/158)	38	-
	Walling (2007)	36% (5/14)	117	50
	Bene (2008)	1% (1/116)	63	48
	Gambichler (2014)	2% (3/124)	55	-
	Hou (2015)	2% (3/154)	95	-
Staged excision	Bub (2004)	4% (2/55)	57	54
	Walling (2007)	8% (3/36)	95	24
	Lee (2008)	10% (3/31)	42	48
	Abdelmalek (2012)	2% (4/225)	32	15
	De Vries (2016)	4% (4/100)	60	62

[a]Lentigo maligna melanoma cases were excluded

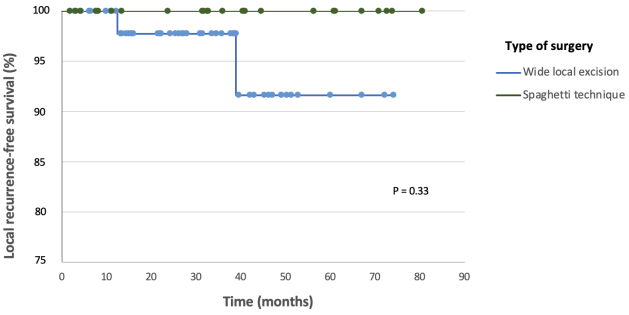

Figure 2. Local recurrence-free survival after wide local excision vs spaghetti technique.

of RCM in our hospital, which allowed preoperative identification of surgical margins in vivo. Moreover, RCM guidance contributed to the low number of stages ('spaghetti') needed to achieve clearance in the ST group (2 stages in 21 patients vs >3 stages in 5 patients). Advantages of RCM guided ST for LM, especially in functional and aesthetic areas, has also been reported by Couty et al [32]. A major drawback of RCM is that is limited to few centers. In addition, RCM adds further cost (device, maintenance, specific training) in the diagnostic performance of melanoma. It is also a time-consuming procedure.

Finally, our low recurrence rate could also be attributable to the short mean follow-up duration (44 months), since some authors have suggested that recurrence occurs later in LM than other melanoma subtypes [33,34].

A major limitation of this study is its retrospective and non-randomized design, which means that the comparison between the WLE and ST groups cannot be precise. We nonetheless consider it to be of interest to report the outcomes for these 2 surgical techniques to reflect a real-world practice scenario.

In terms of descriptive findings, our cohort is in line with those previously reported [32,35]. A predominance of male patients (58%) was observed in our registry, as previously widely described [34]. Interestingly, mean tumor size was 16 mm, which is not especially large for slow-growing and ill-defined lesions. The clinical findings and tumor characteristics did not differ significantly between the two groups. It is noteworthy that the tumors treated by ST were larger in diameter than those treated with WLE and that this difference was statistically significant. ST was the preferred treatment for recurrent LM. Both larger diameter tumours and recurrent tumours were considered high risk by Hou et al [12], and MMS was the surgical approach chosen for those LM. Even though treatment was individualized in our study group in accordance with current guidelines and patient preference, larger and recurrent LM were more likely to be treated by ST.

The results of this study provide real-world insight into the surgical treatment of LM in the head and neck area, comparing WLE and ST. While some authors have concluded that margin-controlled techniques are the preferred treatment for LM, to our knowledge, none of them have compared the outcomes of WLE and ST. To date, in the absence of data from randomized clinical trials and comparative studies on the preferred surgical approach in different cases of LM, this

data from a consecutive cohort treated at a tertiary referral hospital guarantees consistency in the reported outcomes.

This study shows that both WLE and ST are appropriate surgical approaches for LM on the head and neck region. The optimum treatment should, therefore, decide on a case-by-case basis. Based on our experience, ST is an efficient alternative to MMS for the treatment of LM on the head and neck. ST guided by RCM may be of special interest for large, recurrent, and ill-defined lesions. Careful long-term follow-up after treatment is mandatory as recurrence appears later in LM than in other melanoma subtypes.

References

1. Iznardo H, Garcia-Melendo C, Yélamos O. Lentigo Maligna: Clinical Presentation and Appropriate Management. *Clin Cosmet Investig Dermatol.* 2020;13:837-855. DOI: 10.2147/CCID.S224738. PMID: 33223843. PMCID: PMC7671473.
2. Menzies SW, Liyanarachchi S, Coates E, et al. Estimated risk of progression of lentigo maligna to lentigo maligna melanoma. *Melanoma Res.* 2020;30(2):193–197. DOI: 10.1097/CMR.0000000000000619. PMID: 31095041.
3. Swetter SM, Boldrick JC, Jung SY, Egbert BM, Harvell JD. Increasing incidence of lentigo maligna melanoma subtypes: northern California and national trends 1990–2000. *J Invest Dermatol.* 2005;125(4):685–691. DOI:10.1111/j.0022-202X.2005.23852.x9. PMID: 16185266.
4. Mirzoyev SA, Knudson RM, Reed KB, et al. Incidence of Lentigo Maligna in Olmsted County, Minnesota, 1970–2007. *J Am Acad Dermatol.* 2014;70(3):443–448. DOI: 10.1016/j.jaad.2013.11.008. PMID: 24373777. PMCID: PMC4527652.
5. Podlipnik S, Carrera C, Boada A, et al. Incidence of Melanoma in Catalonia, Spain, Is Rapidly Increasing in the Elderly Population. A Multicentric Cohort Study. *J Clin Med*. 2020;9(11):3396. DOI:10.3390/jcm9113396. PMID: 33113930. PMCID: PMC7690683.
6. Greveling K, Wakkee M, Nijsten T, et al. Epidemiology of Lentigo Maligna and Lentigo Maligna Melanoma in the Netherlands, 1989–2013. *J Invest Dermatol*. 2016;136(10):1955–1960. DOI: 10.1016/j.jid.2016.06.014. PMID: 27349862.
7. Guitera P, Collgros H, Madronio CM, et al. The steadily growing problem of lentigo maligna and lentigo maligna melanoma in Australia: Population-based data on diagnosis and management. *Australas J Dermatol.* 2019;60(2):118-125. DOI:10.1111/ajd.12928
8. Robinson M, Primiero C, Guitera P, et al. Evidence-Based Clinical Practice Guidelines for the Management of Patients with Lentigo Maligna. *Dermatology.* 2020;236(2):111-116. DOI: 10.1159/000502470. PMID: 30302753.
9. Garbe C, Amaral T, Peris K, et al. European consensus-based interdisciplinary guideline for melanoma. Part 2: Treatment - Update 2022. Eur J Cancer. 2022;170:256-284. doi:10.1016/j.ejca.2022.04.018. PMID: 35623961.
10. 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.* 2002;55(8):611-615. DOI:10.1054/bjps.2002.3967. PMID: 12550112.
11. Tsang RW, Liu FF, Wells W, Payne DG. Lentigo maligna of the head and neck. Results of treatment by radiotherapy. *Arch Dermatol.* 1994;130(8):1008-1102. PMID: 8053696.
12. Hou JL, Reed KB, Knudson RM, et al. Five-year outcomes of wide excision and Mohs micrographic surgery for primary lentigo maligna in an academic practice cohort. *Dermatol Surg.* 2015;41(2):211-218. DOI: 10.1097/DSS.0000000000000248. PMID: 25590473.
13. Johnson TM, Headington JT, Baker SR, Lowe L. Usefulness of the staged excision for lentigo maligna and lentigo maligna melanoma: the "square" procedure. *J Am Acad Dermatol*. 1997;37(5 Pt 1):758-764. DOI:10.1016/s0190-9622(97)70114-2. PMID: 9366823.
14. Mahoney MH, Joseph M, Temple CL. The perimeter technique for lentigo maligna: an alternative to Mohs micrographic surgery. *J Surg Oncol*. 2005;91(2):120-125. DOI:10.1002/jso.20284. PMID: 16028282.
15. Gaudy-Marqueste C, Perchenet AS, Taséi AM, et al. The "spaghetti technique": an alternative to Mohs surgery or staged surgery for problematic lentiginous melanoma (lentigo maligna and acral lentiginous melanoma). *J Am Acad Dermatol.* 2011;64(1):113-118. DOI:10.1016/j.jaad.2010.03.014. PMID: 21167406.
16. Bhatt MD, Perz AM, Moioli E, et al. The accuracy of detecting melanoma on frozen section melanoma antigen recognized by T cells 1 (MART-1) stains and on permanent sections of previously frozen tissue: A prospective cohort study. *J Am Acad Dermatol*. 2021;84(6):1764-1766. DOI:10.1016/j.jaad.2020.12.055. PMID: 33453343
17. Sarlin, SK, Beroukhim, K, Tarantino, I, Goldberg, LH, Kimyai-Asadi, A. Implementation of immunohistochemical staining among Mohs micrographic surgeons. *JEADV Clin Pract*. 2022;1:126–128. DOI:10.1002/jvc2.21.
18. Bouzari N, Fisher EJ, Maccormack MA, Olbricht S. Limitations of the "spaghetti technique". *J Am Acad Dermatol.* 2012;66(2):323-324. DOI:10.1016/j.jaad.2011.03.033 PMID: 22243724.
19. Barragán-Estudillo ZF, Brito J, Chavez-Bourgeois M, et al. Dermoscopy and Reflectance Confocal Microscopy to Estimate Breslow Index and Mitotic Rate in Primary Melanoma. *Dermatol Pract Concept*. 2022;12(4):e2022174. DOI:10.5826/dpc.1204a174. PMID: 36534562. PMCID: PMC9681198.
20. Walling HW, Scupham RK, Bean AK, Ceilley RI. Staged excision versus Mohs micrographic surgery for lentigo maligna and lentigo maligna melanoma. *J Am Acad Dermatol.* 2007;57:659-664. DOI: 10.1016/j.jaad.2007.02.011. PMID: 17870430.
21. Pitman GH, Kopf AW, Bart RS, Casson PR. Treatment of lentigo maligna and lentigo maligna melanoma. *J Dermatol Surg Oncol.* 1979;5(9):727-737. DOI:10.1111/j.1524-4725.1979.tb00016.x. PMID: 489814.
22. Robinson JK. Margin control for lentigo maligna. *J Am Acad Dermatol.* 1994;31(1):79-85. DOI: 10.1016/s0190-9622(94)70140-7. PMID: 8021377.
23. Cohen LM, McCall MW, Zax RH. Mohs micrographic surgery for lentigo maligna and lentigo maligna melanoma. A follow-up study. *Dermatol Surg.* 1998;24(6):673-677.DOI: 10.1111/j.1524-4725.1998.tb04226.x. PMID: 9648576.
24. Bhardwaj SS, Tope WD, Lee PK. Mohs micrographic surgery for lentigo maligna and lentigo maligna melanoma using Mel-5 immunostaining: University of Minnesota experience. *Dermatol Surg*. 2006;32(5):690-696. DOI: 10.1111/j.1524-4725.2006.32142.x. PMID: 16706765.

25. Bene NI, Healy C, Coldiron BM. Mohs micrographic surgery is accurate 95.1% of the time for melanoma in situ: a prospective study of 167 cases. *Dermatol Surg.* 2008;34(5):660-664. DOI: 10.1111/j.1524-4725.2007.34124.x. PMID: 18261099.
26. Gambichler T, Kempka J, Kampilafkos P, Bechara FG, Altmeyer P, Stücker M. Clinicopathological characteristics of 270 patients with lentigo maligna and lentigo maligna melanoma: data from a German skin cancer centre. *Br J Dermatol.* 2014;171(6): 1605-7160. DOI: 10.1111/bjd.13204. PMID: 24958545.
27. Bub JL, Berg D, Slee A, Odland PB. Management of lentigo maligna and lentigo maligna melanoma with staged excision: a 5-year follow-up. *Arch Dermatol.* 2004;140(5):552-558. DOI: 10.1001/archderm.140.5.552. PMID: 15148099.
28. Abdelmalek M, Loosemore MP, Hurt MA, Hruza G. Geometric staged excision for the treatment of lentigo maligna and lentigo maligna melanoma: a long-term experience with literature review. *Arch Dermatol.* 2012;148(5):599-604. DOI: 10.1001 /archdermatol.2011.2155. PMID: 22782151.
29. de Vries K, Greveling K, Prens LM, Munte K, Koljenović S, van Doorn MB, Prens EP. Recurrence rate of lentigo maligna after micrographically controlled staged surgical excision. *Br J Dermatol.* 2016;174(3):588-593. DOI: 10.1111/bjd.14325. PMID: 26616840.
30. Lee MR, Ryman WJ. Treatment of lentigo maligna with total circumferential margin control using vertical and horizontal permanent sections: a retrospective study. *Australas J Dermatol.* 2008;49(4):196-201. DOI: 10.1111/j.1440-0960.2008.00468.x. PMID: 18855780.
31. Kunishige JH, Doan L, Brodland DG, Zitelli JA. Comparison of surgical margins for lentigo maligna versus melanoma in situ. *J Am Acad Dermatol*. 2019 ;81(1):204-212. DOI: 10.1016/j .jaad.2019.01.051. PMID: 31014825.
32. Couty E, Tognetti L, Labeille B, et al. In vivo reflectance confocal microscopy combined with the 'spaghetti technique' for the identification of surgical margins of lentigo maligna: experience in 70 patients. *J Eur Acad Dermatol Venereol*. 2018;32(9):e366-e368. DOI: 10.1111/jdv.14947. PMID: 29573292.
33. Connolly KL, Hibler BP, Lee EH, Rossi AM, Busam KJ, Nehal KS. Locally Recurrent Lentigo Maligna and Lentigo Maligna Melanoma: Characteristics and Time to Recurrence After Surgery. *Dermatol Surg*. 2017;43(9):792-797. DOI: 10.1097 /DSS.0000000000001118. PMID: 28296789.
34. Collgros H, Rodriguez-Lomba E, Regio Pereira A, Lo SN, Scolyer RA, Guitera P. Lentiginous melanoma (lentigo maligna and lentigo maligna melanoma) in Australia: clinicopathological characteristics, management and recurrence rates after 10-year follow-up at a tertiary centre. *J Eur Acad Dermatol Venereol.* 2021;35(6):1315-1322. DOI: 10.1111/jdv.17135. PMID: 33502077.
35. Hilari H, Llorca D, Traves V, et al. Conventional surgery compared with slow Mohs micrographic surgery in the treatment of lentigo maligna: a retrospective study of 62 cases. *Actas Dermosifiliogr.* 2012;103(7):614-623. doi: 10.1016/j.ad.2011.12.009. PMID: 22572575.
36. Liu-Smith F, Majid Farhat A, Arce A, et al. Sex differences in the association of cutaneous melanoma incidence rates and geographic ultraviolet light exposure. *J Am Acad Dermatol.* 2017;76(3):499–505. PMID: 28413057. PMCID: PMC5407289.
37. Kassi K, Vanwijck R, Kanga JM. The "collerette" technique for skin excision and biopsy: an efficient method for managing lentigo maligna of the head and neck. *Int J Dermatol*. 2014;53(7):899-903. doi:10.1111/ijd.12430. PMID: 24372370.