Mohs Micrographic Surgery for Digital Melanoma and Nonmelanoma Skin Cancers

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PRACTICE **POINTS**

- Melanoma and nonmelanoma skin cancers of the digits traditionally have been treated with wide local surgical excision and even amputation.
- Conservative tissue sparing techniques such as Mohs micrographic surgery can be used to treat digital skin cancers with high cure rates and improved functional and cosmetic results.

Treatment of digital skin cancers is challenging due to various functional and cosmetic implications. Traditionally, routine treatment includes radical amputation, but digital skin cancers are increasingly being treated with more conservative, tissue-sparing methods such as Mohs micrographic surgery (MMS), which provides excellent tissue conservation and margin control when used to treat melanoma and nonmelanoma skin cancers (NMSCs). In this study, we conducted a retrospective chart review to evaluate clinical outcomes following MMS for treatment of digital melanoma and NMSCs.

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Mohs micrographic surgery (MMS) is a specialized surgical technique for the treatment of melanoma and nonmelanoma skin cancers (NMSCs).[1-3] The procedure involves surgical excision, histopathologic examination, precise mapping of malignant tissue, and wound management. Indications for MMS in skin cancer patients include recurring lesions, lesions in high-risk anatomic locations, aggressive histologic subtypes (ie, morpheaform, micronodular, infiltrative, high-grade, poorly differentiated), perineural invasion, large lesion size (>2 cm in diameter), poorly defined lateral or vertical clinical borders, rapid growth of the lesion, immunocompromised status, and sites of positive margins on prior excision. The therapeutic advantages of MMS include tissue conservation and optimal margin control in cosmetically or functionally sensitive areas, such as acral sites (eg, hands, feet, digits).[1,3]

The intricacies of the nail apparatus complicate diagnostic biopsy and precise delineation of peripheral margins in digital skin cancers; thus, early diagnosis and intraoperative histologic examination of the margins are essential. Traditionally, the surgical approach to subungual cutaneous tumors such as melanoma has included digital amputation[4]; however, a study of the treatment of subungual melanoma revealed no difference in survival based on the level of amputation, therefore advocating for less radical treatment.[4]

Interestingly, MMS for cutaneous tumors localized to the digits is not frequently reviewed in the dermatologic literature. We present a retrospective case series evaluating the clinical outcomes of digital melanoma and NMSCs treated with MMS.

Methods

A retrospective chart review was performed at a private dermatology practice to identify patients who underwent MMS for melanoma or NMSC localized to the digits from January 2009 to December 2014. All patients were treated in the office by 1 Mohs surgeon (A.H.) and were evaluated before and after MMS. Data were collected from the

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electronic medical record of the practice, including patient demographics, histopathologic diagnosis, tumor status (primary or recurrent lesion), anatomic site of the tumor, preoperative and postoperative size of the lesion, number of MMS stages, surgical repair technique, postoperative complications, and follow-up period.

Results

Twenty-seven patients (13 male, 14 female) with a total of 28 lesions (malignant melanoma or NMSC) localized to the digits were identified (Table). The mean age at the time of MMS was 64.07 years. Twelve (42.86%) patients were 70 years of age or older, 11 (39.29%) were between 50 and 69 years, and 5 (17.85%) were younger than 50 years. Fifteen (53.57%) of the lesions were localized to the fingers, and 13 (46.43%) were localized to the toes; 18 (64.3%) of the lesions were distal and 10 (35.7%) were proximal to the distal interphalangeal joint. The most common pathologic diagnosis was squamous cell carcinoma (SCC) in situ (12/28 [42.86%]), followed by melanoma in situ (6/28 [21.42%]), severely dysplastic nevus (4/28 [14.29%]), SCC (4/28 [14.29%]), acrospiroma (1/28 [3.57%]), and melanoma (1/28 [3.57%]).

Surgical techniques used for repair following MMS included xenograft (10/28 [35.71%]); split-thickness skin graft (7/28 [25.0%]); secondary intention (4/28 [14.29%]); flap (4/28 [14.29%]); full-thickness skin graft (2/28 [7.14%]); and complex closure (1/28 [3.57%]). Clinical preoperative, operative, and postoperative photos from Patient 21 in this series are shown here (Figure). Two patients required bony phalanx resection due to invasion of the tumor into the periosteum: 1 had a malignant melanoma (Breslow depth, 2.52 mm); the other had an SCC. In addition, following removal of a severely dysplastic nevus, debulked tissue revealed melanoma in 1 patient.

Postoperative complications were noted in 4 (14.29%) of 28 MMS procedures, including bacterial wound infection (3.57%), excess granulation tissue that required wound debridement (7.14%), and delay in wound healing (3.57%). Follow-up data were available for 25 of the 28 MMS procedures (mean follow-up, 35.4 months), during which no recurrences were observed.

Comment

Mohs micrographic surgery is a specialized technique used in the treatment of cutaneous tumors, including basal cell carcinoma, SCC, melanoma in situ, atypical fibroxanthoma, dermatofibrosarcoma protuberans, sebaceous carcinoma, microcystic adnexal carcinoma, and Merkel cell carcinoma, among other cutaneous tumors.[1-3] Mohs micrographic surgery provides the advantage of tissue conservation as well as optimal margin control in cosmetically or functionally sensitive areas while providing a higher cure rate than surgical excision. During the procedure, the surgical margin is examined histologically, thus ensuring definitive removal of the tumor but minimal loss of surrounding normal tissue.[1-3] Mohs micrographic surgery is particularly useful for treating lesions on acral sites (eg, hands, feet, and digits).[3-5]

The treatment of digital skin cancers has evolved over the past 50 years with advancements resulting in more precise, tissue-sparing methods, in contrast to previous treatments such as amputation and wide local excision.[6] More specifically, traditional digital amputation for the treatment of subungual melanoma has been reevaluated in multiple studies, which did not demonstrate a statistically significant difference in survival based on the level of amputation, thereby favoring less radical treatment.[4,6] Moehrle et al[7] found no statistical difference in recurrence rate when comparing patients with digital melanomas treated with partial amputation and those treated with digit-sparing surgery with limited excision and histologic evaluation of margins. Additionally, in a study conducted by Lazar et al,[8] no recurrence of 13 subungual malignancies treated with MMS that utilized a full-thickness graft was reported at 4-year follow-up. In a large retrospective series of digital melanomas treated with MMS, Terushkin et al[5] reported that 96.5% (55/57) of patients with primary melanomas that were treated with MMS avoided amputation, and the 5- and 10-year melanoma-specific survival rates for all patients treated with MMS were 95.0% and 82.6%, respectively. Based on a review of PubMed articles indexed for MEDLINE using the search terms *surgical treatment of digital melanoma and nonmelanoma skin cancers*, *Mohs micrographic surgery for melanoma and nonmelanoma skin cancer*, and *surgical treatment of subungual skin cancer*, conservative functional surgical approaches have been found to be cosmetically favorable, whereas local recurrence and survival rates have been shown to be unaffected by the level and degree of amputation.[4,5]

In our study, cutaneous malignancies were located most often on the fingers, and the most common skin cancer identified was SCC in situ. The literature has shown that SCC in situ and SCC are the most common cutaneous neoplasms of the digits and nail unit.[9] The most common specific anatomic site of cutaneous malignancy in our study was the great toe, followed by the fourth finger. A study conducted by Tan et al[9] revealed that the great toe was the most common location of melanoma of the nail bed and subungual region, followed by the thumb. In contrast, primary subungual SCCs occur most frequently on the finger, with rare cases involving the toes.[10]

The etiology of digital SCC may involve extensive sun exposure, chronic trauma and wounds, and viral infection.[9,11] More specifically, the dermatologic literature provides evidence of human papillomavirus (HPV) type 16 involvement in the pathogenesis of digital and periungual SCC. A genital-digital mechanism of spread has been implicated.[11,12] An increased recurrence

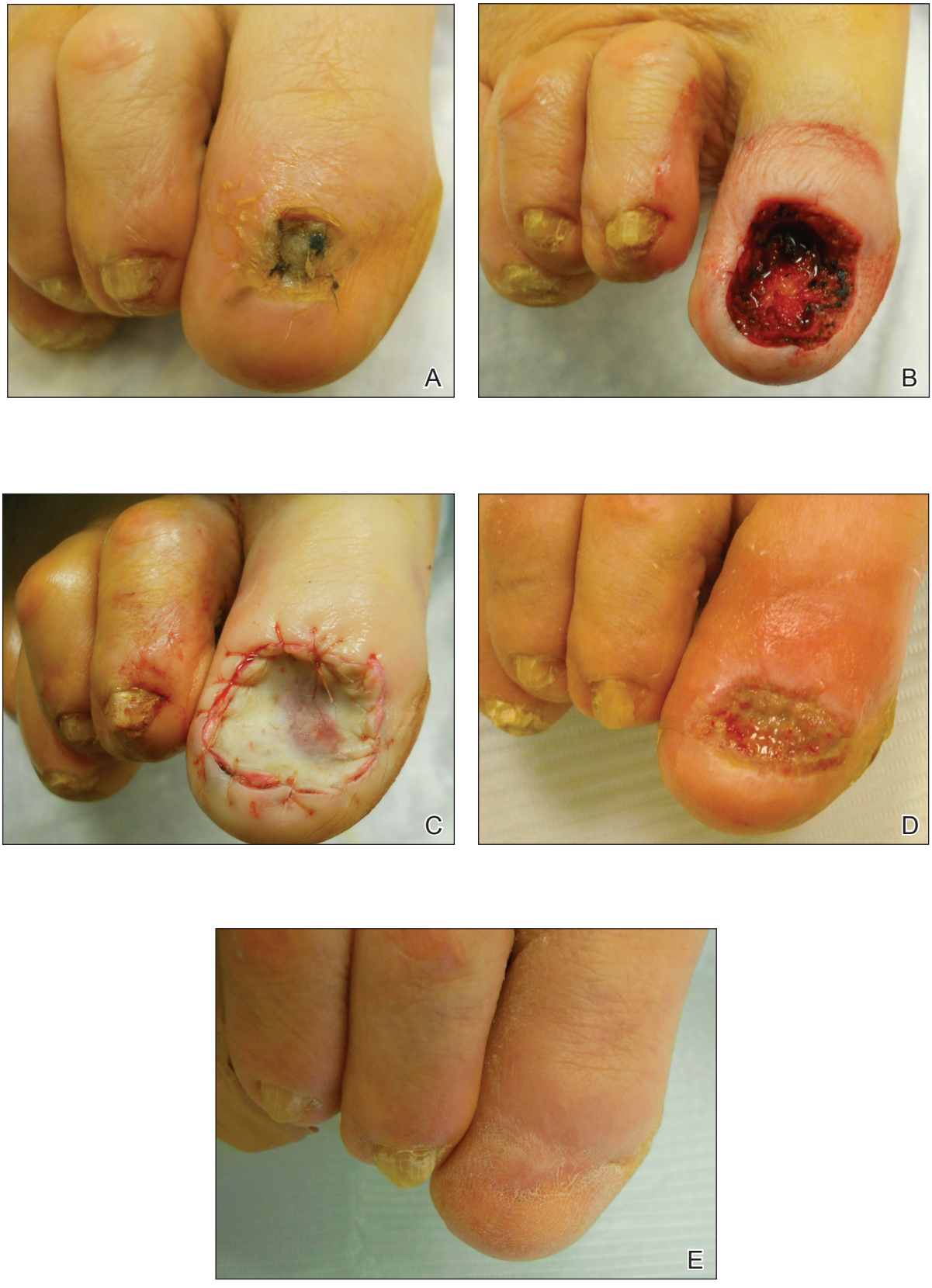
Clinical Data from Retrospective Review of Mohs Micrographic Surgery for Digital Melanoma and Nonmelanoma Skin Cancers

Patient	Age, y/ Sex	Histopathologic Diagnosis (Tumor Status)	Lesion Location	Pretreatment Lesion Size, cm	No. of MMS Stages	Type of Repair	Posttreatment Lesion Size, cm	Postoperative Complications	Tumor Recurrence	Follow-up Period, mo
1	70/M	SCC in situ (primary)	Left distal great toe	2.0×0.8	7	XG	2.2×2.7	None	No	53.5
2	85/M	SCC in situ (recurrent)	Left distal third fingernail	1.8×1.5	3	FTSG	2.5×1.3	None	No	34.2
3	55/F	SCC in situ (primary)	Right proximal fourth finger	0.7	1	Flap	0.7×0.7	None	NA	NA
4	67/M	SCC in situ (primary)	Right proximal first finger	0.8	2	Flap	5.0×3.0	None	No	22.2
5	72/F	SCC in situ (primary)	Right proximal fourth finger	0.9	2	STSG	1.7×1.0	None	No	6.0
6	61/M	SCC in situ (primary)	Left proximal third finger	0.8	1	Secondary intention	0.9×0.7	None	No	22.1
7	84/F	SCC in situ (primary)	Right proximal fourth toe	1.0×0.7	3	STSG	2.5×3.3	None	No	9.1
8	43F	SCC in situ (recurrent)	Left proximal second finger	1.0×0.7	2	STSG	1.5×1.8	None	No	23.8
9[a]	83/F	SCC (NA)	Left distal first finger	2.5	3	XG	2.2×3.5	None	No	45.0
	84/F	SCC in situ (NA)	Left distal fifth finger	NA	3	XG	1.2×1.4	None	No	45.8
10	81/M	SCC in situ (primary)	Left distal first finger	1.6×2.3	2	STSG	2.8×2.3	Excess wound granulation	No	5.4
11	59/M	SCC in situ (primary)	Right distal fourth finger	NA	3	XG	2.3×1.6	None	No	60.6
12	78/F	SCC in situ (primary)	Left distal second toe	0.6	2	XG	1.1×0.7	None	No	9.0
13	66/M	SCC (recurrent)	Left proximal first finger	2.0×1.5	2	STSG	2.0×2.5	None	No	43.4
14	55/M	SCC (primary)	Right distal first fingernail	NA	2	Secondary intention	1.9×1.7	None	No	53.6

Patient	Age, y/ Sex	Histopathologic Diagnosis (Tumor Status)	Lesion Location	Pretreatment Lesion Size, cm	No. of MMS Stages	Type of Repair	Posttreatment Lesion Size, cm	Postoperative Complications	Tumor Recurrence	Follow-up Period, mo
15	92/F	SCC (recurrent)	Left proximal second finger	0.7	2	Complex closure	1.0×0.8	None	No	9.3
16	34/F	Melanoma in situ (primary)	Left distal great toe	0.6	1	XG	1.0×1.2	None	NA	NA
17	33/F	Melanoma in situ (primary)	Right proximal fifth toe	0.5	1	Flap	4.2×2.6	None	NA	NA
18	57/F	Melanoma in situ (primary)	Left distal great toe	0.6	1	XG	1.1×1.3	None	No	61.9
19	51/M	Melanoma in situ (primary)	Right proximal fourth finger	NA	1	Flap	2.3×1.2	None	No	51.6
20	46/M	Melanoma in situ (primary)	Right distal third fingernail	NA	2	STSG	2.5×2.7	None	No	9.2
21	80/M	Melanoma (primary)	Right distal great toe	NA (Breslow depth, 2.52 mm)	2	FTSG	1.7×2.4	Excess wound granulation	No	44.7
22	65/F	SDN (recurrent)	Left distal third toe	NA	3	XG	2.1×1.4	Bacterial wound infection	No	60.8
23	54/F	SDN (primary)	Right distal second toe	0.5	1	STSG	1.1×1.4	Delay in wound healing via secondary intention	No	77.9
24	24/F	SDN (primary)	Right distal great toe	0.3	1	Secondary intention	0.8×1.0	None	No	63.1
25	64/M	SDN (primary)	Left distal fifth toe	0.3	1	XG	1.5×1.1	None	No	50.2
26	75/F	Melanoma in situ (recurrent)	Right distal fifth toe	2.2×2.0	2	Secondary intention	3.4×3.6	None	No	5.0
27	76/M	Acrospiroma (primary)	Right great toe	2.1	1	XG	2.5×1.1	None	No	18.0

Abbreviations: MMS, Mohs micrographic surgery; M, male; SCC, squamous cell carcinoma; XG, xenograft; FTSG, full-thickness skin graft; F, female; NA, not available; STSG, split-thickness skin graft; SDN, severely dysplastic nevus.

[a]Patient presented with 2 lesions on different fingers months apart at different ages. Both lesions were evaluated separately in this study.



Primary subungual melanoma of the right distal great toe in an 80-year-old man at presentation (A); following Mohs micrographic surgery (B) and repair with a full-thickness skin graft (C); and at 6 weeks' (D) and 18 months' (E) postsurgical follow-up.

rate of HPV-associated digital SCCs has been reported following MMS, likely secondary to residual postsurgical HPV infection.[11,12]

Maintaining function and cosmesis of the hands, feet, and digits following MMS can be challenging, sometimes requiring skin grafts and flaps to close the defect. In the 28 MMS procedures evaluated in our study, 19 (67.9%) surgical defects were repaired with a graft (ie, split-thickness skin graft, full-thickness skin graft, xenograft), 4 (14.3%) with a flap (advancement and rotation), 4 (14.3%) by secondary intention, and 1 (3.6%) with primary complex closure.

Surgical grafts can be categorized based on the origin of the graft.[2,13] Autografts, derived from the patient's skin, are the most frequently used dermatologic graft and can be further categorized as full-thickness skin grafts, which include the epidermis and the entire dermis, thus preserving adnexal structures, and split-thickness skin grafts, which include the epidermis and partial dermis.[2,13] Xenografts (eg, porcine grafts) can be used to repair defects involving the mucosa and those with a large wound depth, exposed cartilage, and/or bony defects, as well as wounds with indeterminate tumor margins and in patients with medical comorbidities that might prevent or delay plans for immediate wound reconstruction (eg, diabetes, cardiovascular disease, autoimmune connective tissue disease).[13,14]

A cross-sectional survey of fellowship-trained Mohs surgeons revealed that more than two-thirds of repairs for cutaneous acral cancers were performed using a primary closure technique, and one-fourth of closures were performed using secondary intention.[15] Of the less frequently utilized skin-graft repairs, more were for acral lesions on the legs than on the arms.[14] The type of procedure and graft used is dependent on multiple variables, including the anatomic location of the lesion and final size of the defect following MMS.[2] Similarly, the use of specific types of sutures depends on the anatomic location of the lesion, relative thickness of the skin, degree of tension, and desired cosmetic result.[15] The expertise of a hand surgeon may be required, particularly in cases in which the extensor tendon of the distal interphalangeal joint is compromised, manifested by a droopy fingertip when the hand is held horizontally. Additionally, special attention should be paid to removing the entire nail matrix before skin grafting for subungual tumors to avoid nail growth under the skin graft.

Evaluation of debulked tissue from digital skin cancers proved to be important in our study. In Patient 21, debulked tissue revealed melanoma following removal of a severely dysplastic nevus. This finding emphasizes the importance of complete excision of such lesions, as remaining underlying portions of the lesion can reveal residual tumor of the same or different histopathology.

In a prospective study, MMS was shown to have a low rate (0.91%; 95% confidence interval, 0.38%-1.45%) of surgical site infection in the absence of prophylactic antibiotics.[16] The highest rates of surgical site infection were closely associated with flap closure. In our study, most patients had an uncomplicated and successful postoperative recovery. Only 1 (3.57%) of the 28 MMS procedures (Patient 22) was complicated by a bacterial wound infection postoperatively. The lesion removed in this case was a severely dysplastic melanocytic nevus on the toe. Infection resolved after a course of oral antibiotics, but the underlying cause of the wound infection in the patient was unclear. Other postoperative complications in our study included delayed wound healing and excess granulation tissue requiring wound debridement.

There are limited data in the dermatologic literature regarding outcomes following MMS for the treatment of cutaneous malignancies localized to the digits. In our study, patients treated with MMS were evaluated for recurrence of the primary lesion during postoperative follow-up appointments at the office or with the patient's referring dermatologist. Follow-up data evaluating tumor recurrence were obtained for 25 of the patients, demonstrating no recurrence (mean follow-up, 35.4 months). Longer follow-up data would be more informative, but our findings nonetheless demonstrate that MMS is an effective treatment option for cutaneous malignancies of the digits.

Additional limitations of this case review include its single-center and retrospective design, the small sample size, and 1 Mohs surgeon having performed all surgeries.

Conclusion

This study provides further evidence of the benefit of MMS for the treatment of malignant melanoma and NMSCs of the digits. This procedure provides margin-controlled excision of these malignant neoplasms while preserving maximal normal tissue, thereby providing patients with improved postoperative function and cosmesis. Long-term follow-up data demonstrating a lack of tumor recurrence underscores the assertion that MMS is safe and effective for the treatment of skin cancer of the digits.

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