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Outcome of Intraoperative Frozen Section-Guided Excision and Reconstruction of Non-Melanoma Skin Cancer

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Abstract **Objectives: Background** Non-Melanoma Skin Cancers (NMSC) are the most common malignant tumors of the skin and are often located in cosmetically and functionally important regions such as the face. Complete elimination of the tumour with an acceptable aesthetic result and without impairing functions including speech and oral competence, continues to be a major surgical challenge. Gold standard for margin control remains Mohs micrographic surgery, but its availability is restricted in many areas. FSE-assisted resection provides a feasible intraoperative option that allows such patients to be approached in one operating session with structural balance between oncological safety and reconstruction. The outcomes: Thirty patients with histologically proven NMSC received excision under frozen section, followed by adequate reconstruction in this prospective study. The average age was 54.9 years (range, 17–81) and there were more females 18(60%). Two-thirds of cases 20(66.7%) were BCC and one-third 10(33.3%) were SCC. The cheek, the scalp and the nose were most frequently involved 6(20% each). Forty percent of the patients were closed primarily, 20% underwent skin grafting and 40% received flap coverage. Flap techniques were more commonly associated with injuries to the nasal area and lips than minimally, from an aesthetic aspect as well as functional preservation, important regions ($p = 0.003$). On multivariate logistic regression, tumour size larger than 2 cm was the only independent predictor for flap reconstruction (OR = 24.9; CI: 1.48–420.2; $p = 0.026$). **Conclusion:** These results substantiate that frozen section- guided excision is a safe and accurate method for NMSC in cosmetically sensitive regions, when Mohs surgery is not available. Tumour size is still the main factor which determines the reconstructive difficulty and large multicentric studies with long-term results are needed to validate our findings.

Key Words Non-Melanoma Skin Cancer, Basal Cell Carcinoma, Squamous Cell Carcinoma, Frozen Section, Reconstructive Surgery, Iraq

INTRODUCTION

Non-Melanoma Skin Cancers (NMSC), primarily Basal Cell Carcinoma (BCC) and cutaneous Squamous Cell Carcinoma (cSCC), are the most prevalent cancers globally. With an estimated 1.2 million new cases annually and around 6.64 million documented in 2021, these cancers occur predominantly in sun-exposed regions, particularly the head and neck, leading to significant functional and cosmetic challenges [1]. The Global Burden of Disease study indicates a rising incidence of NMSC worldwide from 1990 to 2021, particularly in areas with high UV exposure. Male predominance is noted in cSCC, while BCC increasingly affects women due to changing sun exposure habits [2].

Surgical excision with margin assessment remains the standard treatment for NMSC. Current guidelines advocate for a 4 mm clinical margin for low-risk lesions, while Mohs micrographic surgery is recommended for recurrent or high-risk cases, especially in critical anatomical areas, as it improves margin validation, reduces recurrence rates and allows for personalised reconstructions [3]. Non-surgical interventions such as photodynamic therapy are limited to specific superficial cases without providing necessary margin assessments for high-risk lesions [4].

Reconstruction is integral to surgical treatment; the "oncoplastic" approach merges oncological resection with immediate reconstruction, enhancing aesthetic outcomes and patient satisfaction while maintaining oncologic efficacy. Despite the rising incidence of NMSC in the Middle East, research on intraoperative margin control and cosmetic results remains scarce. In Iraq, increasing UV exposure and patient awareness are correlating with higher diagnosis rates, yet there is minimal data on outcomes from frozen section-guide

excisions combined with advanced rec onstructive methods. The ongoing multi-centre prospective study aims to evaluate the efficacy of frozen section-guided surgical excisions for NMSC in aesthetic regions, focusing on three areas: ideal margin control, selection of appropriate reconstructive techniques based on defect characteristics and assessment of early postoperative complications and recurrence rates. The results are anticipated to contribute valuable regional insights to the global body of literature and refine best practice guidelines in surgical management [5-9].

Objectives

The purpose of the current multi-centre prospective study is to assess the utility of frozen section-guided surgical excision for NMSC in aesthetic areas, concentrating on three key domains:

- Obtaining an ideal margin control in histopathologic analyses
- choosing the right reconstructive techniques according to defect size and site
- Evaluate the early postoperative complications and recurrence rates

Findings are expected to provide region-specific information in the international literature and influence best practice guidelines in the surgical and reconstructive treatment of NMSC.

METHODS

Patients and Methods

Study Design: Design This study is planned as a prospective, non-randomised multi-centre clinical case series which aims to assess the approach of surgical excision, intraoperative margin control and reconstructive restoration in patients with primary or secondary NMSC.

Study Setting and Duration

The study was performed at Al-Shaheed Ghazi Al-Hariri Surgical Specialities Hospital, which is a hospital of the Baghdad Medical City Complex in Baghdad. The patients were recruited from October 2022 to May 2025.

Ethical Considerations

This research was approved by the Ethics Committee of College of Medicine-Aliraqia University (approval number 84) and conducted in accordance with the Declaration of Helsinki 2013. All participants gave their written informed consent and standardised intraoperative photographs were recorded for scientific publication.

Inclusion Criteria

- Patients of any gender and age with histopathologically proven primary or secondary NMSC
- Patients who are surgical candidates for curative resection

Exclusion Criteria

- Secondary distant metastasis at the time of diagnosis, which was confirmed by clinical examination and radiological examination
- Patients who are unfit for surgery because of significant systemic comorbidity

Preoperative Evaluation

All patients were evaluated preoperatively with:

- Past Medical History, which includes date of onset and progression of the lesion, associated risk factors and comorbidities
- Full physical examination with attention to the site, size of tumour and local or distant spread
- Baseline laboratory investigations including haemoglobin level, coagulation profile and virology screening
- Focused imaging: ultrasonography of the neck for assessment of cervical lymph nodes and chest X-rays to rule out pulmonary metastasis (Table 1)

Surgical Technique

Local anaesthesia was used in all operations with 2% xylocaine with 1:100,000 adrenaline, except those for large tumours or major anticipated intraoperative bleeding, where we preferred general anaesthesia:

Table 1: Comparing Treatment Modalities for Low-Risk and High-Risk Nonmelanoma Skin Cancers: 3-Year Recurrence Rates, Benefits, and Limitations

Treatment modality	3-Year recurrence rate	Benefits	Limitations
Primary closure	4–5%	Simple, quick, cost-effective; preserves natural tissue	Limited use for large tumours or cosmetically sensitive sites
Skin graft	5–10%	Useful for wide defects; technically simple and accessible	Colour/texture mismatch, graft contraction, less aesthetic
Local flaps (Rhomboid, Rotational, Transposition)	3–7%	Good cosmetic results; tissue match in colour and texture	Requires surgical expertise; risk of partial necrosis
Bilobed flap	3–6%	Excellent for nasal reconstruction; maintains contour	Donor site distortion is limited to specific sites
Nasolabial flap	2–5%	High tissue match for nose/lip; reliable blood supply	Visible scar; technically demanding
Karapandzic flap	5–8%	Preserves lip function, speech, and oral competence	Risk of macrosomia (reduced oral aperture)
Musculocutaneous/Advanced flaps	2–5%	Restores both function and aesthetics in large/complex defects	Longer surgery, higher morbidity, requires specialized team

- **Marking and Anaesthesia:** The lesion was demarcated with an initial safety margin of 1–2 mm before using local anaesthesia. After 7–10 min of latent time excision was begun
- **Extent of Resection and Profundity:** Lesions were resected to the subcutaneous level, end bloc if possible
- **ICMS:** The procedural specimen was submitted for frozen sectioning along with 5 distinctively labelled pieces (superior, inferior, medial, lateral) and a piece representing the core margin
- **Re-excision Procedure:** In case of positive margins, 2 mm resected material was excised from the affected area and sent for repeat pathological examination
- **Defect Repair:** Patients with clear margins underwent defect reconstruction with either primary closure, split-thickness skin grafting, or local flaps (based on the size of the defect as well as anatomic location and principles of tension-free repair)

Data Collection

Demographic information, tumour features, histopathological diagnosis, margin status, method of reconstruction and postoperative complications were recorded on a standardised data collection sheet along with recurrence rates.

Statistical Analysis

Statistical calculations were conducted using the IBM SPSS Statistics software, version 29.0 (IBM Corp., Armonk, NY, USA). Continuous data were presented as mean ± Standard Deviation (SD) and categorical data in the form of frequencies and percentages. Chi-square or Fisher's exact tests were employed to test relationships between categorical variables ($p<0.05$ was considered statistically significant).

RESULTS

Number of patients for the analysis and age distribution. The analysis consisted of a total of 30 patients (mean age = 54.9 years, range = 17-81 years). The population was predominantly female 18(60%). Basal Cell Carcinoma (BCC) was the most common histological subtype 20 (66.7%), while10 (33.3%) of cases were SCC (Figure 1). For the topography of lesion distribution, the cheek scalp and nose were the most commonly involved sites, accounting for) 6 20% (of overall cases (Table 2).

Regarding reconstructive modalities, primary closure was performed in 40% of patients, while flap techniques (including nasolabial, rhomboid, bilobed, rotational and Karapandzic flaps) were primarily used for nasal and lip lesions. Conversely, skin grafts were predominantly utilized for scalp defects (Table 3, Figure 2 and 3).

On multivariate logistic regression analysis, tumour size >2 cm emerged as the only independent predictor of flap reconstruction (OR = 24.9; 95% CI: 1.48–420.2; p = 0.026), whereas patient gender, histological type and tumour site did not retain statistical significance after adjustment (Table 4).

Reconstructive techniques also varied significantly (p = 0.05). Primary closure was the preferred method (40.0%), particularly for small, localised lesions with minimal tension risk, as demonstrated in Figure 4. The nasolabial flap and simple dressing approaches (each 13.3%) were reserved for intermediate defects, while more advanced reconstructions-including skin graft, rhomboid flap, Karapandzic flap, rotational flap and bilobed flap (each 6.7%)-were applied to large or anatomically challenging defects.

Table 2: Baseline Characteristics of Patients, Lesions and Reconstructive Modalities (N = 30)

Characteristic	Value
Sex	Male: 12 (40.0%) Female: 18 (60.0%)
Age (years)	Mean 54.9 (range 17–81)
Histological type	BCC: 20 (66.7%) SCC: 10 (33.3%)
Tumor size	<2 cm: 12 (40.0%) >2 cm: 18 (60.0%)
Tumor site	Cheek: 6 (20.0%) Scalp: 6 (20.0%) Nose: 6 (20.0%) Lower eyelid: 4 (13.3%) Lower lip: 2 (6.7%) Lower limb: 2 (6.7%) Medial canthus: 2 (6.7%)
Reconstructive plan	Primary closure: 12 (40.0%) Skin graft: 6 (20.0%) Nasolabial flap: 4 (13.3%) Rhomboid flap: 3 (10.0%) Karapandzic flap: 2 (6.7%) Rotational flap: 2 (6.7%) Bilobed flap: 2 (6.7%)

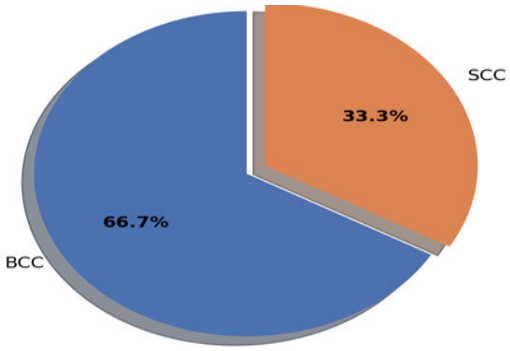

Figure 1: Distribution of Basal Cell Carcinoma (BCC) and Squamous Cell Carcinoma (SCC) in the Study Cohort. BCC Represented 66.7% of Cases, while SCC Accounted for 33.3%, Findings Consistent with Global Epidemiological Trends of Nonmelanoma Skin Cancers

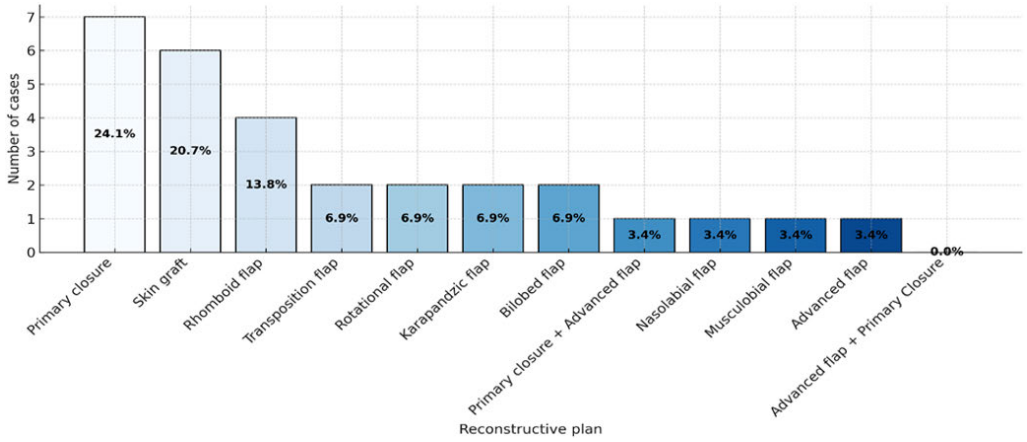

Figure 2: Reconstructive Modalities by Tumor Site. Flap Reconstructions Were More Frequently Employed for Nasal and Lip Lesions, Whereas Skin Grafts Were Most Commonly Used for Scalp Defects (Chi-Square Test, p = 0.003)

(A) (B)

(C) (D)

Figure 3: Perioperative and Postoperative Photographs of a Patient with Basal Cell Carcinoma (BCC) Excision and Reconstruction with a Full-Thickness Skin Graft (A) Preoperative Close-Up View with Lesion Measurement (B) Frontal Preoperative View (C) Intraoperative Close-Up View with Lesion Measurement (D) Postoperative Frontal View after Graft Placement

Figure 4: Perioperative and Postoperative Images of basal Cell Carcinoma (BCC) Excision with Nasolabial Flap Reconstruction

Table 3: Differentiating Low-Risk and High-Risk Basal and Squamous Cell Carcinoma according to NCCN Guidelines

Parameter	Low-risk	High-risk
Location/Size thresholds	L: <20 mm; M: <10 mm; H: <6 mm	L ≥20 mm, M ≥10 mm, H ≥6 mm; critical cosmetic/functional sites
Clinical margins	Well-defined, clear borders	Poorly defined, ill-demarcated borders
Tumor status	Primary lesion	Recurrent lesion
Immunosuppression	No	Yes (transplant, immunosuppressive therapy, HIV, etc.)
Previous RT/chronic irritation	No	Yes
Growth/neurologic symptoms	No rapid growth or neurologic signs	Rapid growth, neurologic symptoms
Histopathology	Well/moderately differentiated; depth <2 mm	Poorly differentiated; depth ≥2 mm; aggressive histology
Perineural/vascular invasion	Absent	Present

Table 4: Differentiating Low-Risk and High-Risk Basal and Squamous Cell Carcinoma according to NCCN Guidelines

Variable	OR	95% CI	p-value
Age	0.97	0.82-1.14	0.696
Male sex	2.38	0.14-39.91	0.548
Tumour size >2 cm	24.9	1.48-420.2	0.026*
Tumour type (SCC)	0.051	0.001-1.775	0.100
Site-Lower eyelid	0.052	0.00-11.21	0.281
Site-Lower limb	0.00	N/A	1.000
Site-Lower lip	2.58e+11	N/A	1.000
Site-Medial canthus	0.00	N/A	1.000
Site-Nose	0.43	0.007-26.01	0.684
Site-Scalp	0.043	0.00-3.71	0.166
Site-Upper lip	0.58	0.004-83.93	0.830

Figure 5: Perioperative and Postoperative Pictures of a Patient with Basal Cell Carcinoma (BCC) Excision and Reconstruction with Primary Closure

Figure 5 showcases a nasolabial flap reconstruction for a nasal BCC, achieving excellent contour and colour match, in line with recent literature documenting high patient satisfaction and functional preservation for this technique.

Across all cases, perioperative planning integrated oncologic clearance with aesthetic consideration and postoperative follow-up confirmed satisfactory cosmetic integration with no early recurrences detected during the study period.

DISCUSSION

In this project, the clinic pathological char acteristics of Non-Melanoma Skin Cancer (NMSC) were studied and impact factors on reconstructive modalities were investigated. In our series, Basal Cell Carcinoma (BCC) was dominantly outnumbered by Squamous Cell Carcinoma (SCC), 66.7 and 33.3%, respectively. This is in line with the international epidemiology where BCC remains invariably the most common subtype, especially in sun-exposed areas of the head and neck [10,11]. The cheek, scalp and nose were the most common sites, constituting 20% of cases each, emphasising the importance of chronic Ultraviolet (UV) exposure in NMSC development as suggested by previous reports [12] Notably, women accounted for 60% of our cohort, a percentage that is higher than some international series where men outnumber women and this may be explained by local demographic or referral tendencies [13].

Regarding reconstruction, primary closure was the most common technique (40%), while skin grafts were predominantly used for scalp lesions (20%). Flap reconstructions-including nasolabial, rhomboid, bilobed, rotational and Karapandzic flaps-were mainly applied to nasal and lip lesions, where both function and aesthetics are critical. This pattern supports prior evidence that reconstructive choice is largely dictated by anatomical site, particularly in cosmetically sensitive areas [14]. Our univariate analysis confirmed a significant association between tumor site and reconstructive modality ($p = 0.003$). Multivariate logistic regression demonstrated that tumor size greater than 2 cm was the only independent predictor of flap reconstruction (OR = 24.9; 95% CI: 1.48–420.2; $p = 0.026$). Neither sex, histological subtype, nor tumor site retained statistical significance after adjustment. This aligns with surgical principles emphasizing that larger tumors inevitably produce defects requiring more complex reconstructions [15]. Nevertheless, the wide confidence intervals reflect limited statistical power due to the small sample size and these findings should therefore be interpreted with caution. Although recurrence outcomes were not assessed in our series, previous large studies report high local control rates for NMSC. Apthorp *et al.* reported five-year local control rates of 98.8% for NMSC excised with appropriate margins, with no significant differences between BCC and SCC [16]. However, incomplete excision remains a concern, with margin positivity rates of up to 15-19% in head and neck lesions [17,18]. Such factors emphasize the importance of meticulous surgical planning and may affect reconstructive outcomes as well.

The limitations of this study include the modest sample size (N = 30), the absence of prospective recurrence data and the lack of adjustment for other potential confounders such as comorbidities, skin phototype and margin status. Sparse data in some anatomical subgroups also compromised model stability.

Nonetheless, this study has notable strengths: it provides one of the first regional analyses of reconstructive approaches in NMSC, integrates NCCN risk stratification and applies multivariate modelling despite limited resources.

CONCLUSION

In conclusion, while tumor site influences reconstructive choice, lesion size emerged as the primary independent predictor of flap use. These findings, although exploratory, contribute valuable insights into surgical decision-making and emphasise the need for larger, multicenter prospective studies incorporating recurrence, functional, cosmetic and quality-of-life outcomes.

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Ethical Statement

Ethical approval for this study was obtained from the Ethical Review Board of the Department of Surgery, Al-Iraqia University/College of Medicine-Baghdad, Iraq.

REFERENCES

[1] El-Rassi, Y. *et al.* "A Visual representation of the hand in the resting somatomotor regions of the human brain." *Scientific Reports*, vol. 14, 2024, p. 18298. https://doi.org/10.1038/s41598-024-69248-z

[2] Maw, J. *et al.* "Hand anatomy." *British Journal of Hospital Medicine (London)*, vol. 77, no. 3, 2016, pp. C34–C40. https://doi.org/10.12968/hmed.2016.77.3.C34

[3] Stevens, K.A. "Flexor tendon lacerations." *StatPearls*, StatPearls Publishing, 2023.

[4] Karjalainen, T. *et al.* "Epidemiology of flexor tendon injuries of the hand in a northern finnish population." *Journal of Hand Surgery European Volume*, vol. 41, no. 3, 2016, pp. 277–282. https://doi.org/10.1177/1457496916665544

[5] Dy, C.J. *et al.* "The Epidemiology of reoperation after flexor tendon repair." *Journal of Hand Surgery American Volume*, vol. 37, no. 5, 2012, pp. 919–924. https://doi.org/10.1016/j.jhsa.2012.02.037

[6] Ishak, A. *et al.* "The evidence-base for the management of flexor tendon injuries: A review." *Injury*, vol. 50, no. 9, 2019, pp. 1680–1684. https://doi.org/10.1016/j.injury.2019.06.019

[7] Chim, H. and K.C. Chung, *Advances in Microsurgical Reconstruction in the Upper Extremity*. Elsevier Health Sciences, 2024. https://doi.org/10.1016/S0749-0712(24)00007-6

[8] Epanomeritakis, I.E. *et al.* "Mesenchymal stromal cells for the enhancement of surgical flexor tendon repair in animal models: A systematic review and meta-analysis." *Bioengineering*, vol. 11, no. 7, 2024, p. 656. https://doi.org/10.3390/bioengineering11070656

[9] Liu, G. *et al.* "Suture techniques in the surgical management of flexor tendon, Achilles tendon and cruciate ligament injuries: a systematic review." *BMC Musculoskeletal Disorders*, vol. 25, no. 1, 2024, p. 1087. https://doi.org/10.1186/s12891-024-08200-8

[10] Mortada, H. *et al.* "Maximizing hand function following zone II flexor tendon repair: A Systematic Review and Meta-Analysis of Rehabilitation Strategies." *Journal of Hand and Microsurgery*, vol. 16, no. 5, 2024, p. 100152. https://doi.org/10.1016/j.jham.2024.100152

[11] Catapano, J. *et al.* "The effect of epitendinous-first repair of flexor digitorum profundus in zone II on gapping and load-to-failure in a cadaveric simulated active motion model." *Journal of Hand Surgery*, vol. 50, no. 5, 2025, pp. 554–559. https://doi.org/10.1016/j.jhsa.2025.01.029

[12] Lim, Y. *et al.* "Outcomes of outpatient hand extensor tendon injury repairs in Northern Ireland's Regional Plastic Surgery Service." *Injury*, vol. 56, no. 10, 2025, p. 112647. https://doi.org/10.1016/j.injury.2025.112647

[13] Chevalley, S. *et al.* "Passive mobilization with place-and-hold versus active mobilization therapy after flexor tendon repair: 5-year minimum follow-up of a randomized controlled trial." *Journal of Hand Surgery American Volume*, 2024. https://doi.org/10.1016/j.jhsa.2024.08.011

[14] Huynh, M.N.Q. *et al.* "A systematic review of patient outcomes for primary pediatric flexor tendon repairs." *Journal of Hand and Microsurgery*, vol. 16, no. 4, 2024, p. 100062. https://doi.org/10.1016/j.jham.2024.100062

[15] Renberg, M. *et al.* "Range of motion following flexor tendon repair: comparing active flexion and extension with passive flexion using rubber bands followed by active extension." *Journal of Hand Surgery*, vol. 49, no. 12, 2024, pp. 1203–1210. https://doi.org/10.1016/j.jhsa.2024.08.003

[16] Kim, H.Y. *et al.* "Multilayer film with bioactive and antiadhesive layers for accelerated tendon regeneration." *ACS Applied Bio Materials*, vol. 8, no. 4, 2025, pp. 3375–3388. https://doi.org/10.1021/acsabm.5c00131

[17] Pönkkö, A.M. *et al.* "Wrist ligament surgeries: Nationwide incidence in a 25-year follow-up." *Journal of Hand Surgery Global Online*, vol. 7, no. 4, 2025, p. 100713. https://doi.org/10.1016/j.jhsg.2025.02.006

[18] Mereddy, R.R. *et al.* "Optimizing flexor digitorum profundus tendon repair: A narrative review." *Journal of Functional Biomaterials*, vol. 16, no. 3, 2025, p. 97. https://doi.org/10.3390/jfb16030097