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"Discuss the technological advances in dermatological and reconstructive surgery that have had the greatest impact on skin cancer patients"

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Introduction

Skin cancer continues to be a significant public health burden, with approximately 9,000 cases of malignant melanoma and over 80,000 cases of non-melanoma skin cancer (NMSC) diagnosed per annum in England (1). Prevention, early detection and management of disease are paramount as rates of skin cancer rise (2). The historical school of thought was to simply and crudely 'cut out' disease; however, technological advances in the practice of dermatological surgery allow for more choice and accuracy in the management of skin cancer. Importantly, innovation in reconstructive surgery minimises post-operative scarring and maximises aesthetic outcomes, which can have meaningful implications for the psychological wellbeing of these patients.

The most common skin cancers are basal cell carcinoma (BCC) (~80%), squamous cell carcinoma (SCC) (~16%) and melanoma (~4%) (3). However, other less common forms of skin cancer exist. Management of a skin cancer will foremost depend on the type and extent of cancer, but other factors would include location of the cancer, patient age, and whether it is primary cancer or a recurrence. Traditionally, skin cancers were removed by excision, but technological advances have meant that dermatologists have more options in the management of skin cancer. Such advancements have affected how clinicians remove cancer, but also have affected the reconstructive component of the surgery and cosmetic outcomes.

The aims of this essay are to outline what the author views as some of the most important advances in dermatological and reconstructive surgery that have had the greatest impact on skin cancer patients. These techniques are effective and safe, may

be used as part of a patient-centred approach to skin cancer, and are successful in restoring cosmetic normality to the skin.

Mohs micrographic surgery

In recent years, Mohs micrographic surgery (MMS) has come to light as one of the most successful surgical options for many types of skin cancers. It is arguably the most revolutionary dermatosurgical technique of the last century. Dr Frederic Edward Mohs developed the surgery in the 1930s whilst he was still a medical student (4). As a research assistant, Mohs experimented with tissue fixation, discovering that zinc chloride solution could produce in situ fixation similar to the process that occurs when tissue is removed and placed in formaldehyde. By using this method of fixation, and removing the cancerous tissue in layers, Mohs could view 100% of the surgical margins under the microscope. The real ingenuity of this technique was the combination of surgery and microscopic examination: horizontal sections were produced in order to exactly map the tissue histologically, until eventually there was no evidence of tumour remaining.

Dr Tromovich and Dr Stegeman expanded the popularity and widespread acceptance of MMS in the 1970s, specifically the “fresh-tissue technique”, which does not use zinc chloride paste and where tissue can be removed under local anaesthesia (5). Since their progress, MMS has been expanding and offering novel insights into treating challenging skin cancer. It has been accepted as a one of the gold-standard managements of NMSC. A review found that when treated with MMS, there was a recurrence rate of only 1% for BCC (6), which highlights the efficacy of this surgery. The success rate for primary SCC is approximately 95%, when treated with MMS (7).

The American College of Mohs Surgery has published guidelines for the appropriate use of MMS (8). They state that the most suitable scenarios for use of MMS include high-risk BCC (including recurrent BCC), tumours in high-risk anatomical locations, BCC that has been incompletely excised, those that are large in size, and in immunosuppressed patients. Similarly, MMS should be used for invasive SCC of the head and neck. Melanoma in situ, in particular lentigo maligna, can be difficult to manage because of location on the face and poorly defined margins. Lentigo maligna can also be effectively treated with MMS (9). MMS has also been reported to be a more effective treatment in comparison to wide excision for some uncommon tumours. So far, these include dermatofibrosarcoma protuberans, microcystic adnexal carcinoma, atypical fibroxanthoma, superficial leiomyosarcomas, sebaceous carcinomas, and extra-mammary Paget's disease (10-14).

In summary, MMS has been one of the most effective advances in dermatological surgery, and is a notably safe procedure that has undergone improvement and innovation, since its conception. Importantly, it is documented for NMSC to have the highest cure rates, and it conserves tissue because the specific nature of the technique results in smaller margins. The procedure can be safely tolerated in the outpatient environment, and the clinician can begin immediate reconstruction, confident in the knowledge that they have established clear margins in their surgery. Of course, as an evolving surgery, MMS may pose challenges. In particular, waiting time for the patient may be long, as a result of the preparation of good quality sections. In terms of expense, MMS has in fact been reported to be cost effective in comparison to excision in outpatient centres (15).

Laser and photodynamic therapy

Laser ablation and photodynamic therapy (PDT) are both suitable options in the management of NMSC in patients who cannot otherwise undergo more invasive procedures. PDT destroys cancer cells by combining a photosensitising drug with light and oxygen. Photosensitising drugs include 5-ALA and the methylester of ALA (mALA). PDT offers potentially effective clearance of cancer cells with good cosmetic results, patient tolerability, and a short recovery time relative to conventional surgery.

A review of these techniques found that clearance rates for superficial BCC and SCC in situ were up to 100%, but much lower at 8% for invasive SCC (16). However, the reviewers were unable to ascertain precise recurrence rates, which ranged from 0% to 31% for superficial BCC, up to 52% for SCC in situ and 82% for invasive SCC. This technology does appear to be inferior to MMS on comparison of the recurrence rates, but multiple treatments could make these techniques more efficacious, and methods are constantly evolving. Despite the comparisons with MMS, laser and PDT is exceptionally useful in patient groups that cannot receive more invasive surgery, such as the elderly.

Advances in reconstructive surgery

The removal of skin cancer has improved, and along with this has come remarkable advances and refinements in reconstruction. Historically, defects produced by Mohs surgeons were allowed to heal by second intention, but dermatological surgeons have been leaders in innovation of novel and creative reconstructions that utilise sophisticated flaps and grafts. It is well known that a common site for BCC is the nose.

One example is that of Dr Zitelli, who helped to transform nasal reconstruction by redefining the arc of rotation for a bilobed flap (figures 1-3) (17).

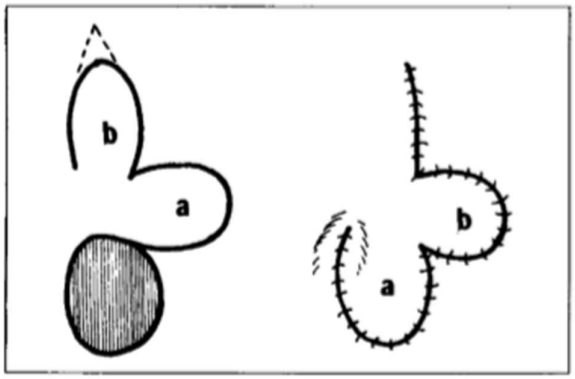

Fig 1.—The standard design of the bilobed flap. This design results in a prominent dog ear at the point of rotation.

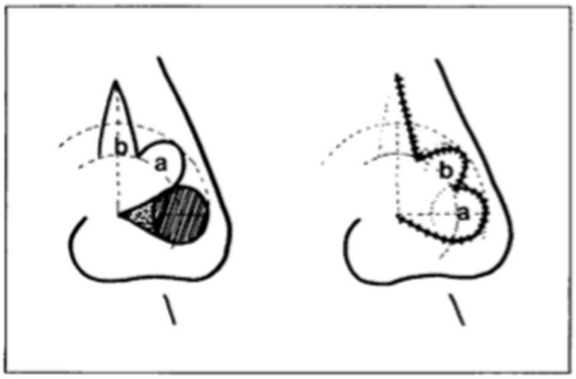

Fig 2.—The improved design. These changes minimize dog ear formation and reduce the chance of trapdoor or pincushion formation.

Fig 3.—Left, Preoperative defect on the ala with the incision in preparation for a laterally based, improved bilobed flap. Center, Immediate postoperative result. Right, Cosmetic result 1 year later.

Arguably, such reconstructive techniques require no exceptional technology to perform, but are still significant technical advancements in reconstruction nonetheless. However, some dermatologists publishing in the field of reconstructive surgery have more futuristic methods. For example, one group used a tissue-engineered biological dressing, called Human Skin Substitute, to treat full thickness wounds (18). The dressing consisted of a bovine collagen matrix containing human fibroblasts with an overlying sheet of stratified human epithelium containing living human keratinocytes, derived from neonatal foreskin. Patients receiving the dressing were compared to those that underwent secondary intention healing. The Human Skin Substitute was

well-tolerated by the patients, produced a less vascular scar compared healing through secondary intention, and appeared to result in a more acceptable cosmetic result. Therefore, tissue engineering has the potential to become a revolutionary advancement in post-operative wound healing following complex surgery for skin cancer, which involves wide surgical margins.

Treatment of surgical scars

The cosmetic appearance of scars after skin cancer surgery can be of great importance, especially in light of the fact that skin cancers often affect exposed areas such as the face. Consequently, patients can feel unhappy with their scar, and this may have a subsequently psychological effect on their self-esteem. Each patient will have a unique propensity for wound healing, and this may then lead to scar correction becoming a necessity. Laser therapy has been used for the treatment of scars after skin cancer surgery, such as after MMS of the face. Both pulsed dye lasers and non-ablative fractionated lasers have been shown to improve surgical scar outcomes, such as pigmentation and erythema (19,20). This is an example of how technological advances can improve a patient's quality of life.

Conclusion

In conclusion, technological advances have made a significant impact upon the care of patients with skin cancer. Practically, these importantly include the evolution of MMS, which has allowed dermatological surgeons to remove skin cancer with more certainty and smaller margins, which lead to a better cosmetic result. They also include the use of laser and PDT in patients who might have otherwise been unfit for surgical management. As a result of technical innovation, reconstructive surgery has

and continues to improve, and exciting techniques such as tissue engineering could be the future of reconstruction. Finally, technologies available to treat post-operative scarring may have an immense impact on psychological outcomes, and ultimately lead to more satisfied patients.

Word count: 1,487 words (excluding figures and references)

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