

# Post Mohs Reconstruction Surgery: A Meticulous Life-changing Procedure

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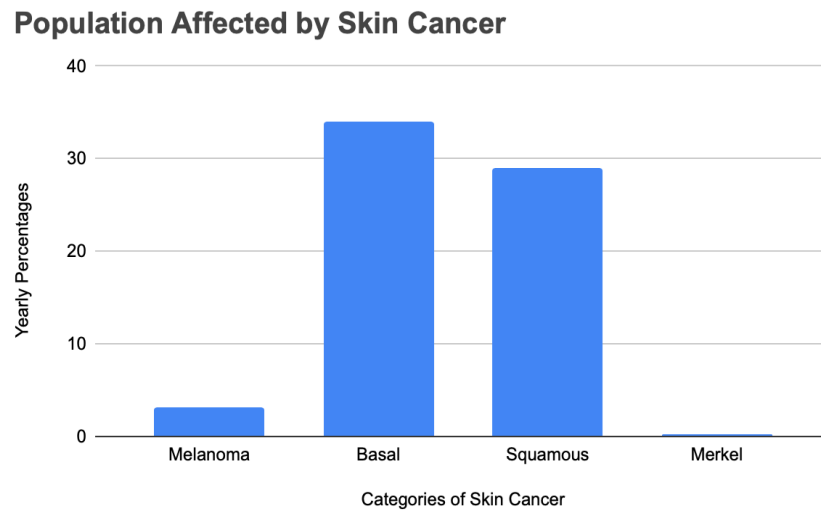
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## ABSTRACT

Skin cancer has a drastic effect on patients, as this disease is one of the most common types of cancer. Mutations occur on damaged DNA, and as a result, numerous different types of skin cancer form. Examples include Basal Cell Carcinoma, Squamous Cell Carcinoma, Melanoma, etc. During Mohs Surgery, the method of extracting skin cancer from the body occurs, and healthy tissue is lost. When this tissue is lost, drastic wounds are formed on the skin, and depending on the depth of the wound, it may affect the cartilage, and damage the epidermis, dermis, or even the fatty tissue layer of the skin. Post-Mohs Reconstruction Surgery allows for healthy tissue, or any other part of the skin lost to be replaced, using several different methods: some being skin grafts, bioengineered skin grafts, skin flaps, and even such as suturing up a wound. Depending on the average size of the wounding, one of these many procedures are performed. For patients to achieve that cosmetic outcome, Post-Mohs Reconstruction Surgery allows skin cancer wounds to be healed efficiently. Skin cancer is an overbearing disease that has a drastic effect on patients not only physically, but mentally as well. Post-Mohs Reconstruction Surgery allows for mental alleviation in these skin cancer patients' minds, which allows them to live a normal life prior to this damaging disease. From the practices of surgical skin grafts to the emotional effect on patients, Post-Mohs has a significant impact to solve it all, in just one single surgery.

## **History of Mohs Surgery And Beginning of Post Mohs Surgery**

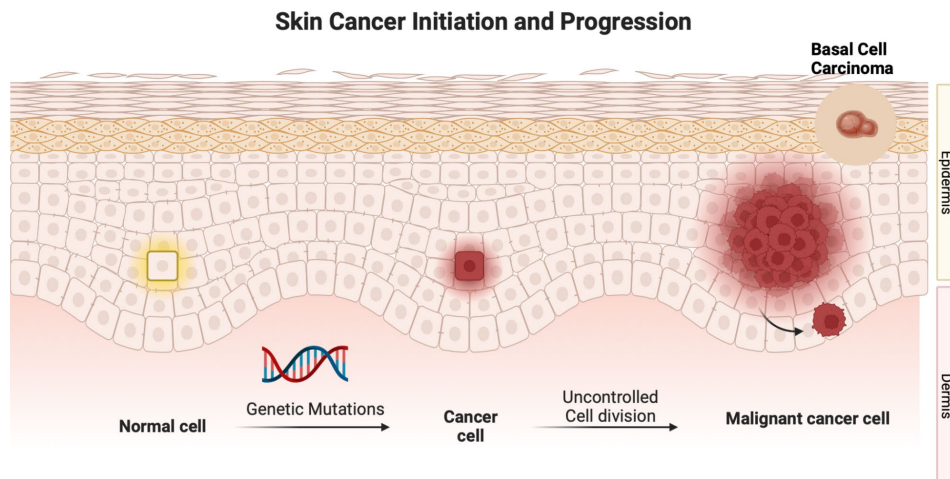
3 million people, over 3 million Americans are affected by skin cancer in a year. In 1936, Dr. Frederic Mohs created a chemosurgery on skin cancer patients to create a procedure that would use a 20% zinc chloride solution to eliminate cancerous tumors. After many trials and procedures, Dr. Mohs developed a fresh tissue technique that ensured a 100% success rate on basal and squamous cell carcinomas in 1969. In the years to come, dermatologists adapted this surgical technique to perform what is now known as Mohs Surgery, which carves out and extracts the skin cancer in the tissue. When too much tissue is carved out, especially that of healthy tissue, Post-Mohs Reconstruction Surgery comes into play. This procedure is done using skin grafts, reconstruction of sutures, as well as helping the patient's emotional state. This use of transplanting fresh tissue to replace the loss of healthy tissue is the magic of Post-Mohs Reconstruction surgery, which enables skin cancer patients to live a life like normal human beings.



**Figure 1.** The graph above demonstrates severe categories of skin cancer and its statistical impact on the world population. Melanoma affects around 3.1% of the entire population, Basal cell carcinoma at 34%, Squamous cell carcinoma at 29%, and Merkel cell carcinoma at 0.2%.

## Development and Categories of Skin Cancer

Current estimates show that 1 in 5 Americans develop skin cancer in their lifetime. The main causes of skin cancer are the ultraviolet rays emitted from the sun, as well as artificial ultraviolet rays in cosmetic machines such as tanning beds. The human skin consists of the epidermis, dermis, and hypodermis. When a common occurrence of abnormal, out-of-control growth of cells starts, this is the leading start of skin cancer. For comparison, 90% of leukemia cancer cells divide every 12-13 hours. Skin cancer is essentially caused by unrepaired DNA damage which triggers mutations in the genes. These mutations create a rapid growth of skin cells as they multiply expeditiously. An example would be the development of Melanoma, and how changes in the tumor suppressor gene (CDKN2A and CDK4) prevent the control of cell growth. Rare cases also include the inheritance of xeroderma pigmentosum. The inheritance of XP results in a change of ERCC genes, and changes in one of these genes potentially result in skin cancer. This multiplication results in the formation of a malignant tumor. Skin cancer can be categorized into basal cell carcinoma, squamous cell carcinoma, melanoma, and Merkel Cell carcinoma. Basal cell carcinoma is one of the most common types of skin cancer. Basal cells are the uncontrolled growth of basal cells in the skin, which is the outermost layer of the skin, otherwise known as epidermis. Squamous cell carcinoma is another common type of skin cancer, which is the rapid, uncontrolled growth of squamous cells, which is also found in the epidermis. Merkel cell carcinoma is the most aggressive type of skin cancer, as it is most common for the recurrence to occur. Each year in the U.S.A., about 3,000 new cases of Merkel cell carcinoma are reported, and from those 700 deaths as well. This skin cancer develops in the Merkel cells in the epidermis. Finally, melanoma is a type of skin cancer that occurs in melanocytes, which are the cells responsible for creating pigment. When these melanocytes grow out of control, melanoma skin cancer occurs. Melanoma can spread into the bloodstream and lymphatic system, and cause more tumors to occur, which is important to consider finding out about these cancerous moles at early stages, and even get them extracted by using what is known as “Mohs Surgery.”

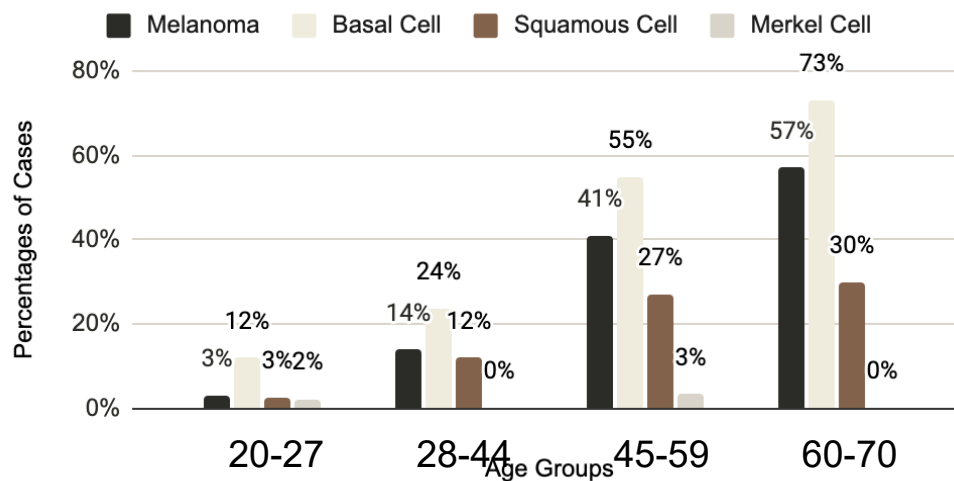


**Figure 2.** The development of a malignant tumor on a microscopic level is demonstrated above. Genetic mutations, such as that of XP inherited mutations, result in the overgrowth of cell production and produce numerous malignant cancer cells.

## Effect of Mohs Surgery and its Transition into Post-Mohs Surgery

In the medical field, after a dermatology residency, some dermatologists specialize in what is called Mohs Surgery, which is a field strictly used for extracting and using surgical methods to extract skin cancer from the human body. Over 876,000 tumors are performed by Mohs Surgery per year. When this procedure occurs, in some situations, the skin cancer wound is so inflicted in the skin, that healthy tissues in the body are extracted, leaving a wound tremendously affected enough to heal on its own. With this procedure occurring, Post-Mohs Surgery comes into play as it restores that lost tissue being extracted from Mohs Surgery. Sometimes, the wound is so great that even the cartilage is affected. There are numerous ways in which Post-Mohs Surgery restores what was lost in Mohs Surgery. The end goal of post-Mohs Reconstruction Surgery is for the patient to have a normal, cosmetic outcome without any prominent wound showing reminiscences of skin cancer, the disease which they previously had. Mohs surgery is a common treatment for skin cancer that involves the removal of cancerous tissue layer by layer until all cancer cells are removed. Post-Mohs reconstruction surgery refers to the reconstruction of the skin after Mohs surgery has been performed. 9.3% complication rates occur in Mohs Surgery, which is a significant enough percentage for a post reconstruction surgery to take place. The goal of post-Mohs reconstruction surgery is to restore the form and function of the affected area while minimizing scarring and improving the aesthetic outcome. There are several options for post-Mohs reconstruction surgery, some of which include skin grafts, flaps, suturing techniques, etc. The type of reconstruction used will depend on the size, location, and depth of the wound, as well as the patient's individual needs and preferences. While post-Mohs reconstruction surgery can improve the cosmetic appearance of the affected area, it is important to note that the healing process can take several weeks or even months, and scarring may still be visible. Close collaboration between the Mohs surgeon and the reconstructive surgeon is crucial to ensure the best possible outcome for the patient. Different procedures are used for different age groups as well. The severity of skin cancer wound repair increases as patients age, which shows the impact of skin cancer on ages 59-70 years old. Ages 60-70 are at the greatest risk of skin cancer with a 30-73% risk factor percentage of several different types of cancer. Now, the different methods of removal for this cancer will include skin grafts, bioengineered skin grafts, skin flaps, sutures, nanotechnology, and even complete reconstruction called structural grafting. This surgery will help transition into the emotional well-being of skin cancer patients.

## Percentages of Skin Cancer Cases in Different Age Groups

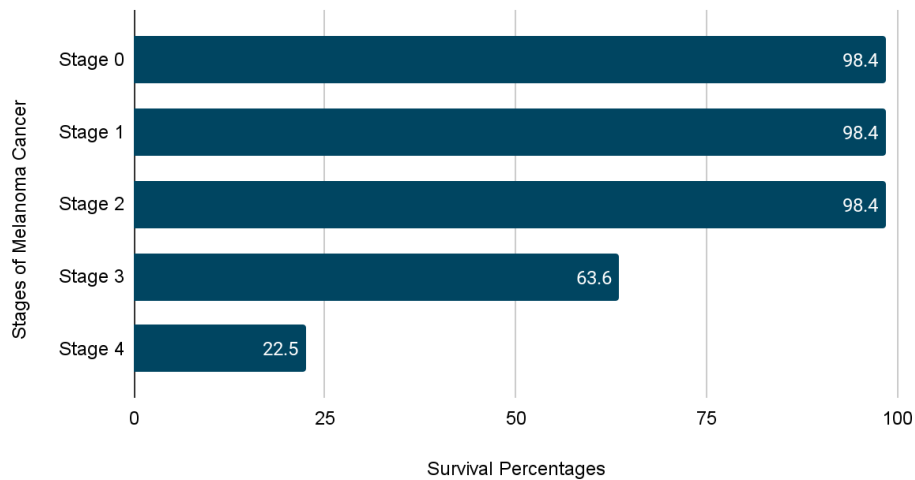


**Figure 3.** The graph demonstrates the percentages of skin cancer cases per category of age groups. This exemplifies the significance of skin cancer as humans age, making the 60-70 age group the highest percentage at risk.

## Stages of Skin Cancer & How That Plays into Surgery

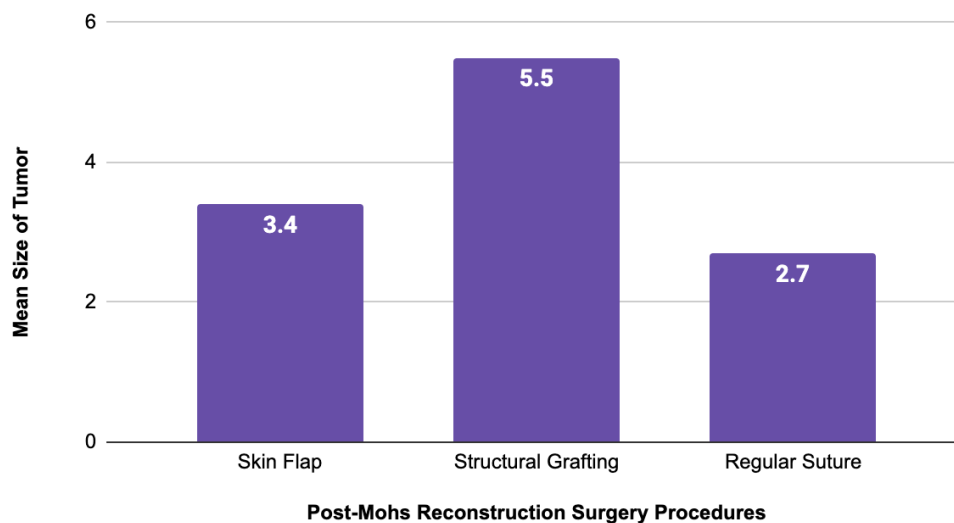
Similar to that of any other type of cancer, skin cancer can progress into more severe cases. When skin cancer is caught at early stages by a biopsy check, it is safer for the patient to get diagnosed, and prevent any further development or severity from happening. It is important to clarify that more precarious forms of skin cancer, such as melanoma, are divided into stages. The severity of melanoma can be divided into Stage 0, Stage 1, Stage 2, Stage 3, and Stage 4. If melanoma develops to Stage 4, being the most severe case, the patient’s life is in immediate danger as cancer has spread to other regions of the body. The percentages for surviving the next 5 years for melanoma patients range within the different stages. Stage 0, 1, and 2 is 98.4%, Stage 3 is 63.6%, and Stage 4 is 22.5%. These precautions and categorizations of stages are to ensure that the procedure necessary for post-Mohs aligns with the concern and underlying damage present in the patient. If a patient has Stage 4 Melanoma cancer, the skin cancer has detrimentally affected the cartilage, tissues, and many other areas of the body. This means chemotherapy and other fundamental immunotherapies are one of the only treatments plans available for the severity of cancer. When Post-Mohs Reconstruction Surgery is performed, the reconstruction of skin cancer relates to non-life-threatening cases. An example would be a case where basal cell carcinoma has inflicted the cartilage and tissue. Because of this, the procedure used would be “Structural Grafting.” Other factors such as the location of the tumor play a vital role in the operational procedure, but the tumors aren’t pertaining to the potential immediate death of the patient. Furthermore, the size of the tumor plays a drastic role in the procedure, and rankings of extraction. The mean sizing of the skin cancer stage and the number of defects for the flap procedure is around 3.4. A comparison to that would be 5.5, which is the mean data for a procedure that requires a structural graft. Skin grafting also ranges through 3.4, as a skin flap procedure is an alternative to skin grafting. A mean of 2.7 demonstrates not much significance, which results in a regular suturing procedure for the wound. By demonstrating the average of defects and stages of cancer in the skin, it is evident the significance and number of tumors in the skin play a role in selecting a certain procedure to be performed during the process. (Memar O, Caughlin B. Post-Mohs Reconstruction Methods of a Combination Dermatologist and Facial Plastic Surgeon Practice. *Clinic Res Dermatol* 2018;1(1):1-4).

### Melanoma Survival Percentages Over Next 5 years



**Figure 4.** This graph demonstrates the impact of fatality on different stages of melanoma. The next 5 years are an extremely short lifetime, which exemplified the true damage melanoma can do to a patient.

### Mean Sizing of Tumor to Determine Post-Mohs Procedure



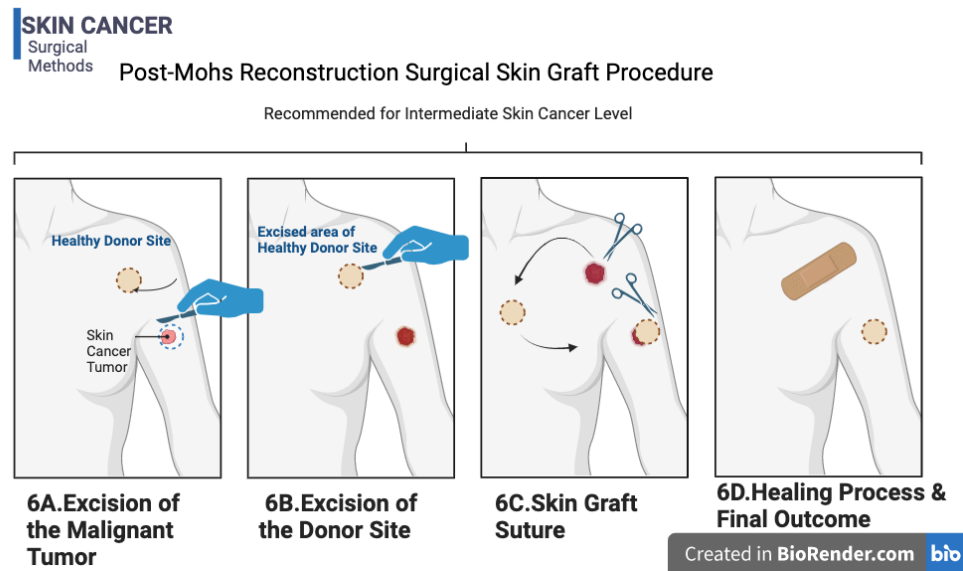
**Figure 5.** This graph shows the categorization of the mean sizes of tumors. According to the average sizing of these tumors on the body, certain procedures are going to be performed. For example, the highest mean tumor size of 5.5 would require structural grafting.

## **Non-drastic Wound Suturing Process of Reconstruction**

Without any complications occurring, Post-Mohs Reconstruction Surgery usually is conducted by a method of suturing. However, this is only if the wound is minor, and is not thick or dense in any form. If the wound is small enough, sutures will be replaced on the skin to aid in the healing process of the post-Mohs skin cancer site. “While a patient may feel that one or two stitches are all that’s needed, 10 or more may in fact be required to close their skin.” states Sanova Dermatology. Sutures are a necessity when healing wounds, which will help aid in the cosmetic appearance. Regular suturing is a widely used technique in Post-Mohs reconstruction surgery for repairing small to medium-sized defects resulting from the removal of skin cancers. This technique involves the use of fine sutures to bring the edges of the wound together, allowing for the natural healing process to occur. The success of regular suturing in post-Mohs reconstruction surgery depends on several factors, including the size and location of the defect, the skill of the surgeon, and the patient’s overall health. While regular suturing is a simple and effective technique for repairing small to medium-sized defects, it may not be suitable for larger defects or those located in areas of high tension or movement, such as the face. In these cases, other techniques such as flap reconstruction or skin grafting may be necessary. Nonetheless, regular suturing remains an important tool in the reconstructive armamentarium for post-Mohs surgery. Additionally, this suturing procedure of Post-Mohs Reconstruction Surgery is known as “Primary Closure”. When the wound isn’t as small, however, there needs to be more than just 10 sutures to help the wound heal.

## **Skin Grafts and How They Play a Role in Surgery**

In order for Post-Mohs Reconstruction to occur on non-suturable wounds, there needs to be a skin graft conducted to enable a successful process. A skin graft involves the transplantation of skin, where healthy skin is removed from a healthy site of the body to cover damaged or lost tissue. Skin grafts are a common technique used in Post-Mohs reconstruction surgery. They are often necessary to repair the surgical defect created after the cancerous tissue has been removed. During a skin graft procedure, a thin layer of skin is removed from another part of the body, called the donor site, and transplanted to the surgical site. The transplanted skin then grows and heals over time, covering the defect created by the Mohs surgery. Skin grafts can be used in various forms, such as full-thickness, split-thickness, and composite grafts, depending on the size and location of the surgical defect. Overall, skin grafts have proven to be an effective and safe option for Post-Mohs reconstruction surgery, with high success rates and good aesthetic outcomes. When Mohs Surgery operates by removing skin cancerous tissue, some remaining healthy tissue may be lost. By using skin graft techniques, patients can achieve that cosmetic outcome with no scars, and no remaining remarks. The success rate of skin grafts is 80%-89%, although usually, a second skin graft is necessary for optimal recovery and healing. The process of using skin grafts includes excising a thick layer of skin from another site of the body and using that skin to be sutured onto the wound to cover up. The donor site is then sutured up for healing, and the wound is sutured on to promote a cosmetic-based look.

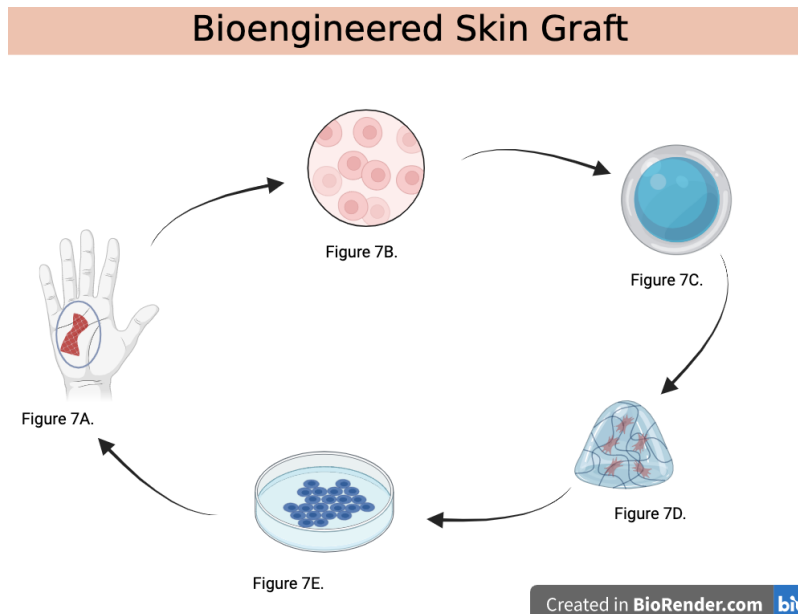


**Figure 6A:** The excision of the malignant tumor is the extraction of skin cancer, which typically is performed during Mohs Surgery. Extracting the skin cancer itself allows for the role of Post-Mohs Reconstruction Surgery in the next few steps. **Figure 6B:** By excising the donor site, this marks the first step of Post-Mohs Reconstruction Surgery. The removal of the donor site permits the reconstruction process, specifically that of a skin graft procedure. **Figure 6C:** If not sutured, the donor site could potentially leave a wound because of the extraction of the epidermis layer of the skin. Suturing allows the donor site to be healthy, while simultaneously taking that epidermis layer of the donor site and suturing on top of the excision of the malignant tumor wound. **Figure 6D:** After the suturing process, the skin donor site wound is then properly dressed with a sterile bandage, wound dressing, and other means necessary for proper healing. The malignant tumor site is also dressed properly after the suturing process, and reconstruction is then accomplished.

## Bioengineered Skin Grafts and their Structural Benefit

When the patient doesn't have enough healthy skin sites, surgeons use something called a bioengineered skin graft. A bioengineered skin graft is an artificial tissue that consists of an epidermal and dermal layer of the skin, between subcutaneous tissue. This artificial tissue is embedded in the support structure of the skin, specifically the acellular matrix. By using bioengineered skin grafts, the cells in the skin grow and accelerate the healing process of the wound. In the circumstance of Post-Mohs Reconstruction Surgery, this bioengineered skin graft is placed near the support structure of the skin cancer wound to excel in the healing process. Some scientists even claim that bioengineered skin grafts are more efficient in wound healing than regular skin grafts, as there are fewer complications in the procedure. These skin grafts also have a 73.3% success rate and healing rate in surgery. However, unlike regular skin grafts, a second skin graft is not needed for a 90% or higher healing rate. Bioengineered skin grafts, also known as tissue-engineered skin substitutes, are also a newer development in Post-Mohs reconstruction surgery. These grafts are created by combining living cells with biomaterials to create a synthetic skin substitute that mimics the natural skin structure. Bioengineered skin grafts offer several advantages over traditional skin grafts, such as improved integration with surrounding tissues, reduced risk of rejection, and the ability to grow in a laboratory setting, making them more readily available. These grafts can be used in both partial and full-thickness defects and have been shown to provide excellent aesthetic outcomes. However, bioengineered skin grafts are still relatively new, and further research is needed to fully assess their effectiveness and long-term outcomes in Post-Mohs reconstruction surgery. The cost of

these grafts may also be a limiting factor in their widespread use, as they are often more expensive than traditional skin grafts. Nonetheless, bioengineered skin grafts have the potential to revolutionize the field of Post-Mohs reconstruction surgery and offer a promising option for patients with complex surgical defects.



**Figure 7A:** The figure displayed shows the starting hand used or needed for a bioengineered skin graft. **Figure 7B:** A sample of cells are collected from the target site, the hand, in order for the identical fit of the bioengineered sample onto the hand. **Figure 7C:** The sample of the cells are transferred with a 3D hydrogel. This 3D Hydrogel will ensure the synthesis of biomaterial to create that bioengineered skin graft feel. **Figure 7D:** The sample of cells infuses with the 3D hydrogel, creating this sample of cell growth with the synthesis of biomaterial. **Figure 7E:** After a certain period of time, the cells grow rapidly to then create a sample of a bioengineered skin graft after completion. With the addition of hydrogel, biomaterials, and human body cells, these all create the product of a bioengineered skin graft.

## Skin Flaps' Substitutional Role and Procedure

Not only are skin grafts used for Post-Mohs wounds, but something called skin flaps are also used. A skin flap is a skin and subcutaneous tissue that can survive based on its own blood supply. Skin flaps are another commonly used technique in Post-Mohs reconstruction surgery. Similar to skin grafts, skin flaps involve the transfer of healthy tissue from one part of the body to the surgical site. When there is inadequate vascularity in the wound, the skin graft is unable to survive on its own. Because of this, skin flaps are used instead. These flaps are, again, incisions on top of the wound as they are adjacent to healthy tissue. Used as a substitute for skin grafts, skin flaps are another way to heal the treating of the wound. Skin grafts are more thick, dense layers of skin compared to the thin layer of tissue on Skin Flaps. However, unlike skin grafts, skin flaps include the underlying tissue, blood vessels, and muscles, allowing for greater versatility and larger defect reconstruction. This method allows for the creation of a flap with a base that remains attached to the donor site while the tissue is rotated, advanced, or transposed to cover the surgical defect. This procedure has a failure rate of less than 5%, which means a 95% success rate, deemed highly effective. Skin flaps are especially useful in areas where skin is limited, and the defect cannot be closed primarily. The type of flap used depends on the size, location, and complexity of the defect. The most common flaps used in Post-Mohs reconstruction surgery include the advancement flap, rotation flap, and transposition flap. Skin flaps have a high success rate and can



provide excellent cosmetic outcomes with minimal scarring. However, the technique requires specialized training and experience, and not all surgical defects are amenable to skin flap reconstruction.

## **Effects of Cartilage Inflicted Wound; Structural Grafting Impact**

When the skin cancer wound is inflicted deep within the cartilage, there's a necessary procedure used to complete the reconstruction of damaged cartilage. For example, the skin cancer wounds on the nose and ear are deep enough to damage the cartilage underneath the skin. This is when ear reconstruction and nose reconstruction come into play. For nose reconstruction, a donor site is selected for random cartilage sites on the body and uses those small parts of cartilage from the donor site to replace the lost cartilage on the skin cancer wound. By excising the cartilage on the donor site and placing it onto the skin-cancer lost cartilage wound, the cartilage structure is then repaired. Repairing the structure contributes to the reconstruction aspect of the underlying cartilage wound. For ear reconstruction, cartilage from behind the ear is used for the same procedure of taking the donor site cartilage and repairing the cartilage on the ear skin cancer wound. This entire process of reconstructing the skin cancer wound is called "Structural Grafting". Structural grafting is a common technique used in Post-Mohs reconstruction surgery to repair defects resulting from the removal of skin cancers. This technique involves the transfer of tissue from one part of the body to another to reconstruct the lost tissue. The structural grafts used in these procedures can be divided into two categories: autografts and allografts. Autografts are harvested from the patient's own body, while allografts are taken from a donor. Structural grafting can be used to reconstruct defects of various sizes and locations, and the success of the procedure depends on factors such as the type of graft used, the location of the defect, and the skill of the surgeon.

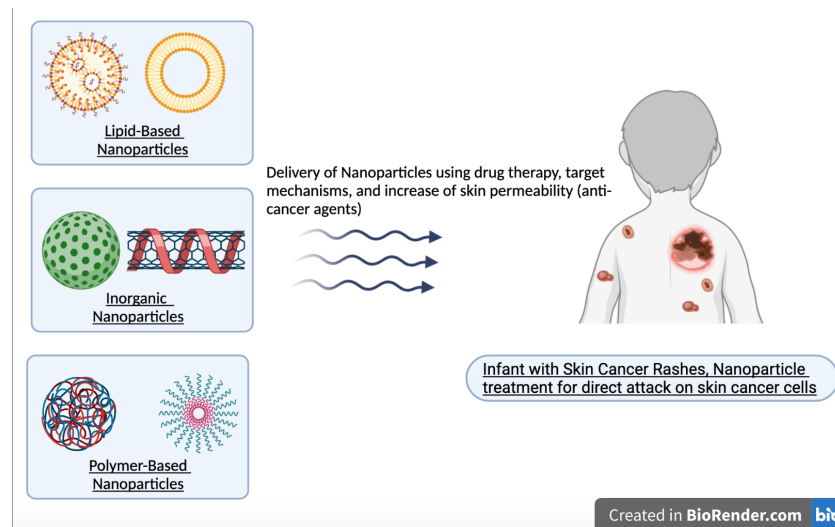
## **Use of Nanotechnology in Skin Cancer Surgery**

Nanotechnology has emerged as a promising approach in the field of Post-Mohs reconstruction surgery. Nanotechnology-based therapies can help overcome this challenge of lost skin by providing innovative strategies for promoting tissue regeneration and wound healing. For instance, the use of nanofibers as scaffolds for cell growth and differentiation can accelerate the formation of new skin tissue. Nanoparticles can also be designed to deliver drugs or growth factors directly to the wound site, promoting angiogenesis and tissue regeneration. These nanotechnology-based approaches hold immense potential for improving the outcomes of Post-Mohs reconstruction surgeries, offering a less invasive and more efficient alternative to traditional approaches.

## **Psychological Effect of Skin Cancer on Patients**

Depression, weight loss, weight gain, insomnia, hypsomnia, psychomotor agitation, daily fatigue, insecurities, suicidal thoughts, and difficulty thinking are just some of the symptoms and mental struggles that skin cancer patients face, especially those with melanoma. Skin cancer is a potentially life-threatening disease that affects millions of people worldwide. While much attention is given to the physical aspects of skin cancer, it is important to consider the impact it can have on an individual's mental health. The diagnosis and treatment of skin cancer can be a stressful and emotional experience, leading to anxiety, depression, and other mental health issues. Additionally, the visible nature of skin cancer and its treatment can result in social stigma and negative body image, further contributing to mental health concerns. Increasing awareness and understanding of the mental health impact of skin cancer is important for providing effective support and care for individuals affected by this disease. By addressing the psychological effects of skin cancer, healthcare professionals can improve the overall quality of life for patients and promote a more holistic approach to cancer treatment. For example, chemotherapy is mentally, and physically draining on melanoma patients. Over time, different treatments provided a better approach to this deadly disease, but sometimes, a patient's mental health is still at risk. Melanoma is the most severe case of skin cancer, which has the most drastic mental effect on

patients. When dermatologists diagnose skin cancer in patients, mental health is a priority. During appointments, checking in with the patients should be of utmost importance.



**Figure 8.** The figure above displays the delivery of different based nanoparticles to deliver onto the affected area for target mechanisms to occur. This increases skin permeability, while simultaneously aiding in skin regeneration. This drug therapy would be an example of a nano-therapy related treatment plan.

## How Post-Mohs Reconstruction Surgery Improves Mental Health in Patients?

Post-Mohs reconstruction surgery not only has physical benefits but also has a positive impact on a patient's mental health. Skin cancer can cause emotional distress and anxiety due to the visible nature of the disease and the potential disfigurement that can result from treatment. The physical appearance of the wound can also be a constant reminder of the cancer diagnosis, leading to negative body image and self-esteem issues. Post-Mohs reconstruction surgery can help to alleviate these concerns by restoring the appearance of the affected area and improving the patient's sense of self-confidence and well-being. Studies have shown that patients who undergo Post-Mohs reconstruction surgery report improved mental health outcomes, including reduced anxiety and improved quality of life. Moreover, reconstructive surgery can also improve physical function, such as the ability to eat, speak or move, which can also contribute to the overall mental health of the patient. By addressing both the physical and psychological aspects of skin cancer treatment, Post-Mohs reconstruction surgery can help to promote better overall health outcomes for patients.

## Conclusion

In conclusion, Post-Mohs reconstruction surgery is a complex and challenging procedure that aims to restore the functionality and aesthetics of the skin after the removal of cancerous tissue. Traditional methods of reconstruction often involve invasive surgeries that may result in significant scarring and long recovery times. With the help of new, innovative procedures such as skin grafts, skin flaps, structural grafting, bioengineered skin grafts, and the emerging field of nanotechnology in skin cancer, these all provide for an efficient improvement in the aesthetic recovery of skin cancer patients. These procedures also imply a better means of mental health in patients. Removing a skin cancer patient's cancerous scar also alleviates their mental scarring, which could help them in numerous ways mentally and physically. This miracle surgery benefits and impacts people in ways one can only imagine, as Post-Mohs Reconstruction Surgery allows for a life-changing procedure for skin cancer, and melanoma patient.

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