Autologous NC-MKT in Vitiligo: Does the Method of Dermabrasion Influence Repigmentation Outcomes?

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Abstract

Background: Vitiligo is a chronic depigmenting disorder characterized by the selective destruction of melanocytes, leading to well-demarcated depigmented macules that significantly impact patients' psychosocial well-being. While medical therapies remain the first-line approach, their efficacy is often limited in stable disease, necessitating surgical interventions. Among these, autologous non-cultured melanocyte–keratinocyte transplantation (NC-MKT) has emerged as a well-established, minimally invasive, and effective technique for inducing repigmentation in stable vitiligo. The success of NC-MKT depends on multiple factors, including disease stability, donor-to-recipient ratio, cellular viability, and critically, the method of recipient site preparation. Dermabrasion is the most commonly employed technique for preparing the recipient area, with motorized and manual (mechanical) methods being widely used in clinical practice. However, there remains a lack of consensus regarding the optimal dermabrasion technique to maximize repigmentation outcomes while minimizing complications.

The aim of this review is to critically evaluate whether the method of dermabrasion—motorized versus manual—significantly influences repigmentation outcomes following NC-MKT in patients with stable vitiligo. This includes an in-depth analysis of procedural differences, efficacy in terms of extent and quality of repigmentation, complication profiles, and operator-dependent variables. Additionally, the review explores how dermabrasion technique impacts melanocyte uptake, graft adherence, and post-procedural healing, which are essential determinants of clinical success.

Current evidence suggests that while both motorized and manual dermabrasion techniques are effective in achieving satisfactory repigmentation, subtle differences exist. Motorized dermabrasion offers greater uniformity and efficiency, particularly in larger lesions, whereas manual dermabrasion allows for enhanced tactile control and may reduce the risk of over-abrasion in delicate areas. Nonetheless, variability in study designs, outcome measures, and operator expertise limits definitive conclusions. Future standardized comparative studies are needed to establish evidence-based guidelines.

In conclusion, the method of dermabrasion is a critical yet under-standardized factor in NC-MKT procedures. Optimizing recipient site preparation may significantly enhance repigmentation outcomes and procedural safety, underscoring the need for further high-quality research in this domain.

Keywords: *Autologous NC-MKT, Autologous NC-MKT, Repigmentation Outcomes*

Introduction

Vitiligo is an acquired pigmentary disorder affecting approximately 0.5–2% of the global population, characterized by the progressive loss of functional melanocytes from the epidermis. The disease manifests as depigmented macules and patches, often with a chronic and unpredictable course. Although the exact etiology remains multifactorial, involving autoimmune, oxidative stress, neural, and genetic mechanisms, the ultimate pathological hallmark is melanocyte destruction. This leads to significant cosmetic disfigurement, particularly in darker skin phototypes, and is frequently associated with psychological distress, reduced quality of life, and social stigmatization [1].

Management of vitiligo is broadly categorized into medical and surgical approaches. Medical therapies, including topical corticosteroids, calcineurin inhibitors, and phototherapy such as narrowband ultraviolet B (NB-UVB), are primarily indicated in active disease. However, their efficacy is often limited in stable vitiligo, particularly in long-standing or refractory lesions. In such cases, surgical interventions provide a valuable alternative by directly restoring melanocyte populations in depigmented areas. Among various surgical modalities, autologous non-cultured melanocyte–keratinocyte transplantation (NC-MKT) has gained widespread acceptance due to its simplicity, cost-effectiveness, and favorable outcomes compared to cultured techniques [2].

NC-MKT involves harvesting a thin split-thickness skin graft from a donor site, enzymatically separating melanocytes and keratinocytes, and transplanting the resulting cell suspension onto a prepared recipient site. The success of this technique relies heavily on the proper preparation of the recipient area to ensure optimal cell adherence, survival, and proliferation. Various methods have been employed for recipient site preparation, including dermabrasion, laser ablation (e.g., CO_2 or Er:YAG lasers), and suction blistering. Among these, dermabrasion remains the most widely used due to its accessibility and effectiveness [3].

Dermabrasion can be performed using either motorized devices or manual (mechanical) instruments. Motorized dermabrasion utilizes high-speed rotary instruments to achieve controlled and uniform epidermal removal, whereas manual dermabrasion relies on handheld tools such as dermabraders or abrasive materials. Each method has its own advantages and limitations in terms of precision, depth control, procedure time, cost, and operator dependency. Despite its critical role in determining graft uptake and repigmentation quality, the choice of dermabrasion technique is often based on surgeon preference rather than standardized evidence [4].

A significant research gap exists regarding the comparative effectiveness of motorized versus manual dermabrasion in the context of NC-MKT. While several studies have reported successful outcomes with both techniques, direct comparisons are limited, and existing data are often heterogeneous in terms of methodology, outcome assessment, and follow-up duration. Furthermore, factors such as anatomical site, lesion size, and patient skin type may differentially influence the performance of each technique, adding complexity to clinical decision-making.

Therefore, this review aims to critically analyze the available evidence on recipient site preparation methods, with a specific focus on comparing motorized and manual dermabrasion in NC-MKT for stable vitiligo. By addressing this gap, the review seeks to provide clinically relevant insights that may guide dermatologic surgeons in optimizing procedural outcomes and advancing standardized practice in vitiligo surgery [5].

Vitiligo Pathogenesis and Definition of Stability

Vitiligo is a complex multifactorial disorder in which the destruction of melanocytes results from an interplay of genetic susceptibility, autoimmune dysregulation, oxidative stress, and environmental triggers. Among these, the autoimmune hypothesis remains the most widely accepted, supported by the presence of melanocyte-specific cytotoxic CD8+ T lymphocytes in lesional skin and circulating autoantibodies targeting melanocyte antigens. Elevated levels of cytokines such as interferon-gamma (IFN-γ) and chemokines like CXCL10 further amplify immune-mediated melanocyte destruction, establishing a self-perpetuating inflammatory loop within affected skin [6].

Oxidative stress plays a pivotal role in initiating melanocyte damage, particularly in genetically predisposed individuals. Increased levels of reactive oxygen species (ROS) and impaired antioxidant defense mechanisms have been consistently demonstrated in vitiligo patients. This redox imbalance leads to melanocyte dysfunction, antigen exposure, and subsequent immune activation. The convergence theory integrates these mechanisms, suggesting that oxidative stress, autoimmunity, and neural factors collectively contribute to melanocyte loss rather than acting independently [7].

Genetic predisposition is another critical component in vitiligo pathogenesis. Genome-wide association studies (GWAS) have identified multiple susceptibility loci, many of which are involved in immune

regulation, such as HLA genes and those encoding components of the innate and adaptive immune systems. This genetic background explains familial clustering and the association of vitiligo with other autoimmune diseases, including thyroid disorders, type 1 diabetes mellitus, and alopecia areata [8].

The neural hypothesis proposes that neurochemical mediators released from peripheral nerve endings may exert cytotoxic effects on melanocytes. Increased levels of catecholamines and neuropeptides in lesional skin have been implicated in melanocyte damage and altered melanogenesis. Although this theory alone does not fully explain vitiligo, it likely contributes as part of the multifactorial pathogenic network, particularly in segmental vitiligo [9].

From a clinical and therapeutic standpoint, the concept of disease stability is of paramount importance, especially when considering surgical interventions such as NC-MKT. Stable vitiligo is generally defined as the absence of new lesions, no progression of existing lesions, and lack of Koebner phenomenon over a specified period, commonly ranging from 6 months to 1 year. Stability indicates a quiescent disease state with minimal immune-mediated melanocyte destruction, thereby providing a favorable environment for transplanted melanocytes to survive and proliferate [10].

However, defining stability remains challenging due to the absence of universally accepted criteria. Various clinical tools have been proposed, including patient history, serial photographic documentation, and scoring systems such as the Vitiligo Disease Activity (VIDA) score. While these methods provide practical guidance, they are inherently subjective and may not accurately reflect subclinical disease activity, which can still compromise surgical outcomes [11].

Histopathological and immunological assessments have been explored as more objective indicators of stability. Studies have shown that reduced inflammatory infiltrates, decreased expression of IFN-γ and CXCL10, and the presence of residual melanocytes at lesion margins correlate with stable disease. Nonetheless, these methods are not routinely used in clinical practice due to their invasive nature and limited accessibility [12].

The importance of accurate stability assessment is underscored by its direct impact on surgical success. Performing NC-MKT on unstable vitiligo can lead to poor graft uptake, patchy repigmentation, or complete failure due to ongoing melanocyte destruction. Conversely, stable lesions demonstrate higher rates of successful repigmentation, better color matching, and long-term durability of results, emphasizing the need for meticulous patient selection [13].

In addition to temporal stability, lesion-specific factors such as anatomical location, duration of depigmentation, and local skin characteristics influence outcomes. Areas such as the face and neck generally respond better to surgical interventions due to richer vascular supply and higher melanocyte reservoir in hair follicles, whereas acral areas tend to be more resistant. These variations further highlight the complexity of predicting surgical success even in clinically stable disease [14].

Emerging research is now focusing on molecular biomarkers that could more accurately define disease stability. The assessment of cytokine profiles, T-cell activity, and oxidative stress markers holds promise in identifying subclinical activity and refining patient selection criteria. Such advancements could significantly enhance the success rates of procedures like NC-MKT by ensuring transplantation is performed in an optimally receptive microenvironment [15].

Overview of Surgical Management of Vitiligo

Surgical management of vitiligo represents a cornerstone in the treatment of stable, treatment-resistant disease, offering the possibility of rapid and cosmetically acceptable repigmentation. Unlike medical therapies that primarily aim to halt disease progression and stimulate residual melanocytes, surgical techniques directly replenish melanocyte populations within depigmented skin. These interventions are particularly valuable in patients with segmental vitiligo or stable non-segmental vitiligo who fail to respond adequately to conventional therapies such as phototherapy or topical immunomodulators [16].

The fundamental principle underlying all surgical modalities in vitiligo is the transfer of functional melanocytes from normally pigmented donor skin to depigmented recipient areas. Successful repigmentation depends on multiple factors, including disease stability, recipient site preparation, melanocyte viability, and post-procedural care. Over the years, several surgical techniques have been

developed, broadly categorized into tissue grafting methods and cellular grafting methods, each with distinct advantages and limitations [17].

Tissue grafting techniques are among the earliest surgical approaches and include methods such as split-thickness skin grafting, punch grafting, and suction blister epidermal grafting. Split-thickness grafting involves transferring thin sheets of epidermis and superficial dermis, providing a high density of melanocytes but often associated with complications such as scarring and color mismatch. Punch grafting, although simple and cost-effective, may result in a cobblestone appearance due to uneven graft integration. Suction blister grafting offers improved cosmetic outcomes by transferring only the epidermis but is limited by the time required for blister formation and the size of treatable areas [18].

Cellular grafting techniques, particularly autologous non-cultured melanocyte–keratinocyte transplantation (NC-MKT), have revolutionized vitiligo surgery by enabling the treatment of larger areas with a relatively small donor site. This method involves enzymatic separation of melanocytes and keratinocytes from a harvested skin sample, followed by transplantation of the cell suspension onto a prepared recipient site. Compared to tissue grafts, NC-MKT provides more uniform pigmentation, better color matching, and reduced risk of textural changes, making it a preferred option in many centers [19].

Cultured melanocyte transplantation represents another advanced cellular technique, wherein melanocytes are expanded in vitro before transplantation. Although this allows treatment of extensive vitiligo with minimal donor skin, it is limited by high cost, need for specialized laboratory facilities, and longer preparation time. Consequently, its use is restricted to specialized research settings and select clinical centers, whereas NC-MKT remains more widely accessible and practical [20].

Adjunctive modalities have also been explored to enhance surgical outcomes. The use of platelet-rich plasma (PRP), for instance, has been investigated for its potential to improve melanocyte survival and accelerate repigmentation through growth factor release. Similarly, combining surgical techniques with phototherapy, particularly narrowband UVB, has been shown to significantly improve repigmentation rates and color uniformity by stimulating melanocyte proliferation and migration post-transplantation [21].

Recipient site preparation is a critical step common to all surgical modalities, as it facilitates the removal of the depigmented epidermis and creates an optimal bed for melanocyte attachment and proliferation. Various methods are employed for this purpose, including dermabrasion, laser ablation (such as CO_2 and Er:YAG lasers), and less commonly, cryotherapy. Among these, dermabrasion remains the most widely used due to its simplicity, cost-effectiveness, and reproducibility in diverse clinical settings [22].

Laser-based methods offer precise control over ablation depth and reduced bleeding, but their high cost and limited availability restrict widespread use. Additionally, concerns regarding thermal damage and delayed healing have been raised, particularly when compared to mechanical methods. Dermabrasion, in contrast, provides effective epidermal removal with minimal equipment requirements, making it especially suitable for resource-limited settings [23].

Within dermabrasion techniques, both motorized and manual approaches are commonly utilized. Motorized dermabrasion employs high-speed rotary instruments to achieve rapid and uniform epidermal removal, which is particularly advantageous for large or anatomically complex lesions. Manual dermabrasion, using handheld abrasive tools, allows greater tactile feedback and precision, especially in delicate or curved areas. Despite their widespread use, there is no standardized guideline favoring one method over the other, and the choice often depends on surgeon experience and lesion characteristics [24].

The growing emphasis on optimizing surgical outcomes in vitiligo has highlighted the need for evidence-based standardization of procedural steps, particularly recipient site preparation. Given that this step directly influences melanocyte uptake, graft stability, and eventual repigmentation, understanding the comparative effectiveness of different dermabrasion techniques is essential. This forms the basis for exploring whether motorized or manual dermabrasion offers superior outcomes in the context of NC-MKT [25].

Autologous Non-Cultured Melanocyte–Keratinocyte Transplantation (NC-MKT): Principles and Technique

Autologous non-cultured melanocyte–keratinocyte transplantation (NC-MKT), also widely termed the

melanocyte–keratinocyte transplantation procedure (MKTP) or non-cultured epidermal cell suspension (NCES), is one of the most important cellular grafting techniques in stable vitiligo because it allows treatment of a recipient surface substantially larger than the donor area without the delay, cost, and laboratory complexity of cell culture. The technique evolved from earlier melanocyte transplantation work and was strongly advanced by the 1998 report of a melanocyte-enriched epidermal cell suspension applied to dermabraded leukoderma and by the 2003 simplified method of epidermal cell transplantation for stable vitiligo. Later reviews and practical guidance have reinforced that NC-MKT is now a mainstream surgical option for carefully selected patients with stable disease. [26]

The biologic rationale of NC-MKT is that the transplanted suspension contains both melanocytes and keratinocytes rather than melanocytes alone. Keratinocytes are not passive carrier cells; they help create a microenvironment that supports melanocyte survival, adhesion, proliferation, and melanization through paracrine signaling and epidermal reconstitution. This is one reason cellular suspensions often achieve good color match when graft take is successful. Contemporary reviews also note that the method commonly works with donor-to-recipient expansion ratios in the range of about 1:3 to 1:10, although the practical ratio chosen depends on lesion site, cell yield, and operator preference. [27]

Technically, the procedure begins with harvesting a very thin split-thickness or shave graft from normally pigmented donor skin, often from a cosmetically concealed site. The harvested epidermal sample is then incubated in trypsin–EDTA to separate the epidermis from the dermis, after which the epidermal cells are disaggregated, centrifuged, and resuspended for transplantation. The original 1998 and 2003 descriptions established the core workflow, and subsequent modifications have aimed to simplify instrumentation, reduce cost, improve filtration, and increase the viscosity of the final suspension so that cells remain more evenly distributed over the recipient bed. Hyaluronic acid and related carriers have been used in some protocols for this purpose. [28]

Preparation of the recipient site is the decisive companion step to cell preparation. The depigmented epidermis must be removed to the correct level so that transplanted cells can adhere to a viable wound bed without being lost through bleeding, excessive exudation, or over-deep tissue injury. After the suspension is applied, the site is usually covered with a collagen or similar dressing and immobilized as much as anatomy permits. The quality of recipient-site preparation directly affects cell retention, healing time, and the final pattern of repigmentation, which is why procedural reviews consistently identify it as one of the most important operator-dependent variables in NC-MKT. [29]

Clinical outcomes with NC-MKT are generally favorable in properly selected stable vitiligo, particularly on the face and other responsive sites, and longer-term data support durability of pigmentation in many successfully treated patients. At the same time, outcome heterogeneity remains substantial and reflects lesion location, disease stability, prior activity, postoperative phototherapy, and technical details of both cell processing and recipient-site preparation. This is exactly where the present review question becomes important: if the preparation step is central to graft take, then comparing motorized and manual dermabrasion is not a minor technical issue, but a clinically meaningful determinant of repigmentation quality, speed, safety, and reproducibility. [30]

Recipient Site Preparation in NC-MKT: Rationale and Available Methods

Recipient site preparation is a pivotal determinant of success in autologous non-cultured melanocyte–keratinocyte transplantation because it creates the biologic bed on which transplanted cells must adhere, survive, proliferate, and ultimately synthesize melanin. An ideal recipient bed should remove the depigmented epidermis completely while preserving a viable superficial dermal surface, with minimal bleeding, limited thermal injury, and adequate support for uniform cell distribution. Reviews of vitiligo surgery consistently emphasize that inadequate or excessive de-epithelialization can compromise graft uptake, delay healing, and produce inferior repigmentation, even when cell preparation itself is technically sound. Thus, recipient-site preparation is not merely a mechanical step, but a major biologic and procedural variable in NC-MKT outcomes. [31]

Among all available methods, dermabrasion remains the most widely used approach for recipient-site preparation in NC-MKT because it is relatively accessible, economical, and effective across a broad range

of clinical settings. The goal is to abrade the epidermis to the level of pinpoint bleeding, indicating adequate removal of the epidermal barrier without unnecessarily deep tissue damage. Dermabrasion may be performed manually or with motorized devices, and both are used extensively in vitiligo surgery. Its popularity stems from its practicality and from the fact that it can be adapted to lesions of varying sizes and locations, although operator experience remains crucial in maintaining uniform depth and limiting trauma. [32]

Laser ablation has emerged as an important alternative because it offers precise control of treatment margins and ablation depth, particularly with carbon dioxide (CO2) and erbium:YAG (Er:YAG) systems. Theoretical advantages include more even epidermal removal and better access to irregularly shaped lesions. However, laser-based preparation introduces additional considerations such as cost, equipment availability, learning curve, and the possibility of thermal damage, which may affect healing and graft take. Comparative studies have not consistently demonstrated clear superiority of laser preparation over dermabrasion in final repigmentation, despite these technical advantages. In a randomized comparison, Er:YAG laser ablation and motorized dermabrasion produced statistically similar repigmentation and adverse-event profiles, underscoring that procedural precision does not automatically translate into clinically superior pigmentary outcomes. [33]

Blister-based methods represent another strategy for preparing the recipient area, aiming to separate epidermis from dermis in a controlled and comparatively less traumatic manner. Cryoblistering has attracted attention as a recipient-site preparation option in NCES/NC-MKT because it may provide effective de-epithelialization with potentially favorable cosmetic results in selected lesions. In a prospective randomized study comparing manual dermabrasion, cryoblister, and dermaroller preparation, cryoblistering performed similarly to manual dermabrasion for achieving good-to-excellent repigmentation, although dermabrasion showed faster onset of repigmentation and better color match, while cryoblistering carried a risk of hyperpigmentation. These findings suggest that blister-based preparation is a valid alternative in some contexts, but not clearly superior to dermabrasion as a standard approach. [34]

Other recipient-site preparation methods have also been explored, including dermaroller-assisted preparation, electrofulguration-assisted dermabrasion, and site-specific modifications for anatomically difficult lesions. The available evidence indicates that not all simplified or less invasive approaches perform equally well. In the randomized trial by Subburaj and colleagues, dermaroller preparation was inferior to both dermabrasion and cryoblistering in repigmentation outcomes. Meanwhile, newer hybrid methods such as electrofulguration-assisted manual dermabrasion have been proposed to improve efficiency and uniformity, reflecting ongoing efforts to optimize this critical step. Overall, the literature supports that recipient-site preparation must balance adequate epidermal removal with minimal injury, and it is within this framework that direct comparison of motorized versus manual dermabrasion becomes clinically important. [35]

Motorized Dermabrasion for Recipient Site Preparation

Motorized dermabrasion is one of the most commonly used methods for recipient-site preparation in melanocyte–keratinocyte transplantation procedures because it allows rapid and relatively uniform removal of the depigmented epidermis over lesions of different sizes and shapes. In practical surgical reviews, dermabrasion with either manual or motorized devices is described as a standard approach for vitiligo surgery, with motorized systems often preferred when the operator aims for faster coverage and more even abrasion across broader recipient areas. The desired endpoint remains adequate de-epithelialization, traditionally judged by pinpoint bleeding, although recent commentary also warns that purpura may sometimes be misread as a true endpoint, underscoring the importance of surgical experience. [36]

From a technical standpoint, motorized dermabrasion usually employs a high-speed rotary instrument fitted with an abrasive wheel, burr, or fraise to remove the epidermis in a controlled fashion. Its main procedural advantage is consistency: compared with purely manual methods, the rotating instrument can create a more homogeneous wound bed with less operator fatigue, which is particularly useful in large

lesions or topographically irregular sites. This practical benefit is reflected in comparative vitiligo-surgery literature, where motorized dermabrasion is repeatedly used as a benchmark preparation method against lasers and other alternatives. [37]

A further strength of motorized dermabrasion is procedural efficiency. Because the instrument can abrade larger surfaces more quickly than hand-driven techniques, it may shorten operating time and improve workflow in centers that perform multiple procedures or treat extensive stable vitiligo. This time-saving aspect has been highlighted indirectly in studies comparing motorized dermabrasion with other preparation methods; for example, randomized work comparing Er:YAG laser ablation with motorized dermabrasion noted that future studies should more fully assess operating time, bleeding characteristics, surgeon ease, and patient comfort, implying that these are clinically meaningful advantages and trade-offs of the motorized approach. [38]

Motorized dermabrasion also appears to provide clinically acceptable repigmentation outcomes when used in NC-MKT. In the randomized comparative study by Gupta and colleagues, motorized dermabrasion and Er:YAG laser ablation resulted in no statistically significant difference in overall repigmentation or adverse effects at 6 months, suggesting that motorized dermabrasion performs well enough to remain a valid standard method for recipient preparation. This is important because it shows that even when compared with a technology offering greater theoretical precision, motorized dermabrasion still yields comparable pigmentary results in actual clinical practice. [39]

Despite these strengths, motorized dermabrasion is not without limitations. The speed and power that make it efficient can also increase the risk of over-abrasion if the operator does not maintain precise control, particularly on curved, thin, or anatomically delicate sites. Excessive abrasion may lead to deeper injury, more bleeding, delayed healing, and a less favorable bed for transplanted melanocytes. Reviews on recipient-site preparation therefore stress that the method's success depends not merely on the instrument itself, but on correct depth control, lesion selection, and familiarity with tissue response during surgery. [40]

Another practical limitation is equipment dependence. Unlike simple manual methods, motorized dermabrasion requires an electrical device, appropriate tips or burs, maintenance, and operator familiarity with rotating instrumentation. In high-resource settings this may be a minor issue, but in resource-limited environments cost, machine availability, sterilization logistics, and maintenance may influence whether motorized dermabrasion is feasible as a routine choice. This consideration is one reason dermabrasion in general remains attractive, but also why many centers continue to use both motorized and manual methods according to context rather than adhering to a single universal standard. [41]

Overall, motorized dermabrasion can be regarded as an effective, practical, and widely accepted recipient-site preparation technique in stable vitiligo surgery, especially for larger lesions where speed and uniformity are priorities. However, its real-world performance remains operator dependent, and its advantages must be balanced against the need for careful depth control and equipment access. These features make it an ideal technique to compare directly with manual dermabrasion, which may offer different strengths in tactile precision, simplicity, and safety in select sites. [42]

Manual (Mechanical) Dermabrasion for Recipient Site Preparation

Manual dermabrasion is a time-tested method for recipient-site preparation in vitiligo surgery and remains widely used in non-cultured epidermal cell suspension and melanocyte–keratinocyte transplantation procedures. Its continuing relevance reflects three practical advantages: simplicity, low cost, and the ability to prepare the recipient bed without dependence on powered equipment. Reviews of vitiligo surgery and recipient-site preparation continue to describe dermabrasion as a standard approach, and manual dermabrasion remains the comparator against which newer modifications are often assessed. [43]

The main procedural strength of manual dermabrasion is tactile control. Because abrasion is performed directly by hand, the surgeon can adjust pressure, direction, and depth continuously according to anatomic contour, skin thickness, and the appearance of the wound bed. This can be particularly useful in small lesions, curved surfaces, cosmetically delicate sites, and areas where over-abrasion would be especially undesirable. The importance of precision in such situations is reinforced by technical reports describing

specialized tools for very small vitiliginous areas when conventional larger burs are impractical. [44]
Manual dermabrasion also has value in low-resource settings because it reduces dependence on machines, power supply, maintenance, and rotating accessories. This practical advantage is relevant in centers where vitiligo surgery is performed but access to specialized powered devices is limited. Broader discussions of simplified and resource-conscious vitiligo surgical techniques similarly emphasize that accessibility and procedural feasibility remain important determinants of method selection in real-world practice. [45]
At the same time, conventional manual dermabrasion is more labor intensive and may be slower than mechanized approaches, especially for larger recipient areas. This limitation has been explicitly recognized in work proposing electrofulguration-assisted manual dermabrasion, where the authors note that manual dermabrasion is a well-established method but can be time-consuming and physically demanding. That observation is clinically important because operator fatigue may affect procedural uniformity when treating broad or multiple lesions. [46]
Available comparative evidence indicates that manual dermabrasion is clinically effective for NCES/NC-MKT. In the prospective randomized study by Subburaj and colleagues, manual dermabrasion performed at least as well as cryoblistering for achieving good-to-excellent repigmentation, while also showing faster onset of repigmentation and superior color matching; dermaroller preparation was inferior to both. These findings support manual dermabrasion as a strong conventional option rather than merely a historical technique. [47]
Further refinement studies suggest that the performance of manual dermabrasion can potentially be improved without abandoning its basic advantages. In the 2020 open-label comparison study, electrofulguration-assisted manual dermabrasion was compared with conventional manual dermabrasion in stable vitiligo undergoing NCES, and the results supported comparable effectiveness while exploring a method intended to reduce effort and optimize preparation. A later randomized study likewise reported electrofulguration-assisted dermabrasion to be comparable to manual dermabrasion, reinforcing that manual preparation remains a valid benchmark technique in contemporary practice. [48]
Despite its advantages, manual dermabrasion is operator dependent. Adequate de-epithelialization must be achieved evenly across the lesion without creating an excessively deep wound bed, and inconsistency in pressure or stroke technique may affect graft uptake and final pigment distribution. For that reason, the apparent simplicity of manual dermabrasion should not be mistaken for technical triviality; like all recipient-site preparation methods, it requires experience, attention to endpoint, and adaptation to lesion-specific anatomy. [49]
Overall, manual dermabrasion remains a practical, effective, and highly relevant method of recipient-site preparation in stable vitiligo surgery. Its greatest strengths are tactile precision, accessibility, and strong clinical familiarity, whereas its main drawbacks are procedure time, labor intensity, and dependence on operator skill for uniform depth control. These characteristics make it an important counterpart to motorized dermabrasion and set the stage for a direct comparison of the two methods in terms of repigmentation outcomes, safety, procedural efficiency, and site-specific suitability. [50]

Motorized Versus Manual Dermabrasion: Comparative Effect on Repigmentation Outcomes

Direct head-to-head evidence comparing motorized with manual dermabrasion in NC-MKT/NCES for stable vitiligo is still limited, which is the main reason no firm superiority claim can be made. The available literature supports that both methods are effective when the disease is stable and the recipient bed is prepared to the proper depth. Manual dermabrasion has shown strong outcomes in randomized NCES work and remains a standard comparator, while motorized dermabrasion has also produced satisfactory repigmentation in comparative studies against other preparation methods such as Er:YAG laser, with no clear loss in efficacy. [51]
From a practical standpoint, the difference appears to be less about whether repigmentation occurs and more about how the procedure is delivered. Motorized dermabrasion is generally favored for speed and surface uniformity, especially in larger lesions, whereas manual dermabrasion may offer better tactile control in smaller or anatomically delicate areas. Current reviews therefore suggest that the final outcome is strongly influenced by operator experience, lesion site, and consistency of de-epithelialization, rather

than by the instrument alone. [52]

Accordingly, the most balanced conclusion is that recipient-site preparation quality matters more than the choice of powered versus manual technique itself. Until a dedicated randomized trial directly compares manual and motorized dermabrasion within the same NC-MKT framework, the method should be individualized according to lesion size, site, equipment availability, and surgeon expertise. [53]

Conclusion

Autologous non-cultured melanocyte–keratinocyte transplantation (NC-MKT) represents a cornerstone in the surgical management of stable vitiligo, offering effective and cosmetically acceptable repigmentation in appropriately selected patients. Among the various determinants of procedural success, recipient site preparation plays a critical and often underappreciated role. This review highlights that while both motorized and manual dermabrasion are valid and widely practiced techniques for preparing the recipient bed, their impact on repigmentation outcomes is closely tied to execution quality rather than the method itself.

Motorized dermabrasion provides advantages in terms of procedural speed, efficiency, and uniformity, particularly in larger lesions, making it well-suited for extensive or time-sensitive cases. In contrast, manual dermabrasion offers superior tactile feedback and precision, which may be advantageous in smaller, anatomically complex, or cosmetically sensitive areas. Despite these technical differences, current evidence does not demonstrate a definitive superiority of one method over the other in terms of final repigmentation, color match, or complication rates.

Importantly, the success of NC-MKT is multifactorial, influenced by disease stability, lesion characteristics, surgeon expertise, and postoperative care, in addition to the method of dermabrasion. The lack of standardized protocols and direct comparative studies between motorized and manual techniques remains a significant gap in the literature. Future well-designed, controlled trials are essential to establish evidence-based guidelines and optimize procedural outcomes.

In clinical practice, the choice between motorized and manual dermabrasion should therefore be individualized, taking into account lesion size, location, available resources, and operator experience. Ultimately, meticulous technique and appropriate patient selection remain the most critical factors in achieving optimal and durable repigmentation in vitiligo surgery.

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