The American Journal of Interdisciplinary Innovation and Research
ISSN 2642-7478 | Open Access

Type Original Research
PAGE NO. 97-103

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Safety and Effectiveness of the E-File Dry Manicure Technique: A Systematic Review of Risks and Scientific Validation of Common Practices

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OPEN ACCESS

SUBMITTED 29 July 2025
ACCEPTED 20 August 2025
PUBLISHED 28 August 2025
VOLUME Vol.07 Issue 08 2025

CITATION
Mazur Sofiia. (2025). Safety and Effectiveness of the E-File Dry Manicure Technique: A Systematic Review of Risks and Scientific Validation of Common Practices. The American Journal of Interdisciplinary Innovations and Research, 7(08). Retrieved from https://theamericanjournals.com/index.php/tajiir/article/view/6866

Abstract- Against the backdrop of the rapid expansion of the global nail care segment and the parallel tightening of client expectations regarding safety and quality, hardware-based manicure methods (e-file) are coming to the fore. At the same time, their use remains surrounded by mythologized perceptions and caution, mainly due to the presumed risk of mechanical injury. This study aims at an evidence-based verification of the safety profile and effectiveness of e-file manicure using the authors' combined technique E-File Dry Manicure as a case in point. The adopted methodology includes a systematic analysis of dermatology and cosmetology literature, a comparative technical examination of the geometry of manicure bits with extrapolation of principles from podology, and a qualitative case study based on the practical implementation of the technique in the US market. The findings indicate that the decisive parameter determining the safety of the intervention is the geometry of the working part of the bit. The study demonstrates that the use of an attachment with a rounded apex (rounded cone) in combination with subsequent manual cuticle removal using nippers forms a methodically balanced protocol that minimizes the likelihood of damage to the nail matrix and periungual folds, in contrast to approaches relying on bits with a sharp tip (e.g., flame). It is concluded that the specified combined technique is a safe, universal, and clinically effective alternative capable of raising industry safety standards. The material is intended for practicing technicians, educators, salon owners, and representatives of beauty industry regulators.

Keywords: hardware manicure, e-file dry manicure, bit safety, bit geometry, rounded cone, nail matrix, mechanical injury, combined technique, podology, dermatology in cosmetology.

Introduction

The nail service industry demonstrates steady and sustained growth, rapidly evolving from a narrowly specialized practice into a significant segment of the beauty and personal care economy. As of 2024, the global nail care market was valued at 23.6 billion USD, with an expected compound annual growth rate (CAGR) of 5.2% through 2034 [1]. The U.S. market contributes substantially: its size reached 12.9 billion USD in 2024, with a projected compound annual growth rate of 6.3% for 2024–2030 [2]. At the revenue-structure level, the manicure services segment dominates, having accounted for 31.99% of total income in the United States in 2023 [3].

This economic trajectory rests on a shift in consumer practices: nail care is increasingly interpreted not only as an aesthetic manipulation but also as an integral element of self-care and well-being maintenance [4, 5]. This reappraisal raises the bar for service expectations: in addition to the quality and durability of coatings, clients insist on verified procedural safety, impeccable hygiene, and the use of non-toxic materials [6, 7, 23]. Consequently, the research agenda aimed at strengthening safety standards in nail services is driven by both economic and sociocultural determinants.

Despite technological progress and the widespread adoption of electric devices (e-files) in professional practice, a noticeable gap persists between applied techniques and their scientifically grounded risk assessment. Both myths and well-founded concerns regarding hardware-based manicure circulate among professionals and consumers. Key risks include iatrogenic mechanical injuries, thinning of the nail plate, thermal burns, and secondary infectious complications [8, 9].

The problem is exacerbated by the absence of standardized and validated training protocols, which gives rise to heterogeneous and, in some cases, unsafe practices. For example, aggressive approaches such as the so-called Russian manicure, which entails complete device-based removal of the cuticle, are mistakenly presented as risk-free, although dermatological observations record acute paronychia (inflammation of the periungual fold) and cases of onychomadesis (detachment of the nail plate) following such interventions [10]. Numerous studies converge on the conclusion that the primary source of trauma during device-assisted processing is not the instrument per se, but the incorrect technique of its use: improperly selected rotations, excessive pressure, an erroneous angle of attack, or a bit unsuitable for the specific task [11]. These facts directly indicate a deficit of competencies and systematic training in this field.

The aim of the study is to provide a scientifically grounded assessment of the safety and efficacy of e-file dry manicure under strict adherence to a structured, evidence-based protocol.

The author's hypothesis posits that a combined e-file dry manicure technique employing a bit with safe geometry (Rounded Cone) for precise cuticle exfoliation followed by manual removal with nippers substantially reduces the risk of mechanical injury to the nail matrix and periungual tissues compared with approaches that use bits of aggressive shapes (e.g., Flame) or that rely solely on mechanical removal.

The scientific novelty lies in the systematic consideration of manicure bit geometry as a key determinant of procedural safety, with the transfer of validated principles from medical podology into the context of cosmetology practice.

Materials and methods

The present study rests on a multilevel framework. As the central methodological line, a systematic literature review was implemented, covering peer-reviewed publications from PubMed, Scopus, and Web of Science. The analytical focus is directed at the anatomical and physiological features of the nail apparatus, dermatologic conditions associated with manicure procedures, as well as occupational health aspects in cosmetology. The review is supplemented by a comparative technical analysis of the geometry, materials used, and operating parameters of manicure burs, based on technical specifications and data from the podiatric literature. The concluding section provides a qualitative interpretation of case studies based on expert evidence, illuminating the practical applicability, market reception, and outcomes of the proposed combined method.

The corpus of sources is structured across three levels. Level 1 (academic) includes peer-reviewed works on

dermatology, contact dermatitis, nail pathology, and podiatry. Level 2 (technical and professional) covers manuals on bur operation, safety regulations prepared by sectoral organizations such as the Professional Beauty Association (PBA), as well as manufacturers' specifications. Level 3 (market) comprises reports from authoritative analytical agencies with quantitative assessments of market size and characterization of consumer trends.

Results and discussion

For a correct comparison of the claimed safety advantages of the method under analysis, the industry-specific threat profile must first be systematized.

1. Chemical factors. The epidemic of allergic contact dermatitis remains one of the most acute problems in practice: the key sensitizing agents are (meth)acrylate monomers, widely present in gel, acrylic, and dip-powder systems [12]. Their exposure can provoke dermatitis not only in the periungual area but also at distant skin sites (eyelids, neck) due to manual transfer of allergens [13]. In addition to acrylates, other chemical components remain of clinical relevance, including the toxic trio — dibutyl phthalate, toluene, and formaldehyde — which pose risks to both clients and professionals under chronic inhalational and dermal contact exposure [14].
2. Biological factors. Noncompliance with sterilization and disinfection protocols creates channels for microorganism transmission: instruments, files, and pedicure tubs become reservoirs of bacterial (for example, Pseudomonas aeruginosa, associated with green nail syndrome) and fungal pathogens [15, 28]. In this context, the cuticle performs a key barrier function, shielding the nail matrix from invasion; its aggressive removal or traumatization substantially increases the likelihood of infectious complications, primarily paronychia [10, 16].
3. Mechanical factors. Iatrogenic injuries arising from improper use of manual and electric tools are not uncommon and affect various structures of the nail unit: from keratin degranulation (white spots) and onycholysis (separation of the plate from the bed) to matrix injury with subsequent irreversible nail deformities [24, 27].

The industry-proclaimed shift from chemical removal of coatings to mechanical is often construed as a healthier alternative; however, in essence it does not eliminate but redistributes risk: the reduction of chemical hazards (dehydration, ACD) is accompanied by an increase in mechanical hazards (trauma, thermal overheating). A genuinely safe protocol must simultaneously minimize both groups of hazards. The proposed combined technique addresses this dual task: the dry device-assisted step excludes aggressive solvents, whereas a carefully considered selection of burs and a two-stage sequence of operations reduces the likelihood of mechanical injury (see table 1).

Table 1. Comparative analysis of health risks in manicure services and their mitigation using the combined E-File Dry Manicure technique (compiled by the author based on [9, 15, 16, 19]).

Risk category	Common causes and manifestations	Mitigation using the combined technique
Chemical	Allergic contact dermatitis from (meth)acrylates; irritation and systemic effects from solvents (acetone, toluene).	The dry method eliminates the use of acetone for removal. Careful e-file work minimizes skin contact with uncured product.
Biological	Bacterial and fungal infections (P. aeruginosa, Staphylococcus spp.) due to contaminated instruments; paronychia caused by cuticle damage.	The protocol entails delicate cuticle work, preserving its barrier function. Mandatory sterilization of all instruments (bits, nippers).

Mechanical	Damage to the nail matrix, onycholysis, troughing of the nail plate, thermal burns from improper device operation (incorrect bit, speed, pressure).	Use of a bit with safety geometry (rounded cone) prevents punctures and cuts. A two-step protocol reduces the risk of excessive mechanical impact.

The key to a safe electric file manicure lies in precise knowledge of the structure of the nail unit and an understanding of the biomechanics of contact between the rotating bit and tissues. The nail unit includes the nail plate, bed, matrix, proximal and lateral folds, as well as the cuticle. The matrix, hidden beneath the proximal fold, functions as a factory of the nail: its germinative cells ensure growth of the nail plate. Any injury to the matrix, whether mechanical or thermal, entails temporary or persistent dystrophies: longitudinal or transverse grooves, variations in thickness, and even cessation of growth [17, 18].

During device operation, the kinetic energy of the bit is distributed between useful work in the form of abrasive material removal and heat generation. Excessive applied pressure, an overly high rotational speed, or dwelling with the bit at one point provokes overheating with thermal injury and creates excessive mechanical stresses. Violation of the angle of attack leads to kerfs—local thinning of the nail plate—as well as damage to the living tissues of the periungual folds [8].

Bit selection is not a matter of taste but an engineering control of risk. In US practice, two geometries are widely used for cuticle treatment. The Flame bit has a teardrop-shaped body tapering to a sharp tip; this form facilitates access to the lateral sinuses and lifting of the cuticle, but the sharp apex substantially increases the risk of perforation of the proximal fold and injury to the matrix, especially with insufficient skill or unexpected client movement [20-22]. The Rounded Cone bit has a conical shape with a smoothed, atraumatic apex; working predominantly with the lateral surface allows precise guidance of the bit along the cuticle line and along the lateral folds, while the rounded tip acts as a passive safety element, gliding over the skin without puncturing and thereby virtually eliminating the likelihood of accidental damage to living tissues. This principle of instrument selection directly corresponds to the clinical logic of podology. Consequently, preference for a Rounded Cone bit is not the intuition of the technician but a transfer of proven principles of medical instrument safety into a cosmetology procedure (see fig.1).

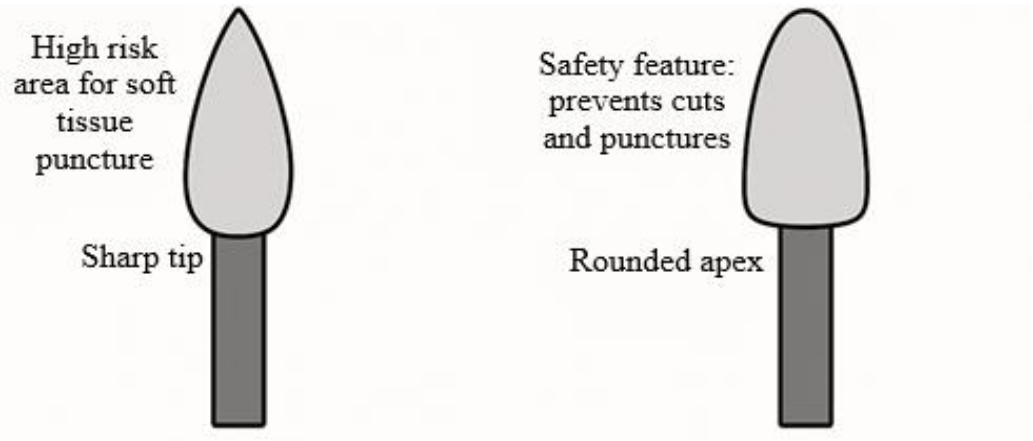

Fig. 1. Comparative geometric analysis of manicure cutters [20-23].

The proposed authorial technique is a complete, scientifically verified protocol that systematizes the e-file manicure procedure with priority given to risk control and biosafety.

Stage 1: mechanical exfoliation. A rounded-cone bit is used at a strictly regulated rotational speed (for work with the cuticle, the optimal range is 5 000–10 000 rpm) with minimally sufficient contact with the tissues. The objective of this stage is to gently separate and lift exclusively the true cuticle (pterygium), that is, the nonviable keratinized layer, from the surface of the nail plate. This selectively gentle approach is fundamentally opposed to practices of total cuticle removal, which disrupt the natural protective barrier of the proximal

nail fold [10].

Stage 2: manual removal. The lifted nonviable tissue is carefully excised with sterile manual nippers. The combination of e-file preparation (speed and geometric precision) with a final, targeted cut under full tactile control allows execution of the most critical moment of the intervention without traumatizing the living structures of the eponychium and with a predictable cleanliness of the cut.

Universality. In contrast to purely device-based strategies, which on certain cuticle phenotypes (for example, hyperhydrated or markedly elastic) prove to be of limited effectiveness or increase the risk of injury, the combined technique demonstrates high adaptability and is easily tuned to the client's individual characteristics while maintaining a stable safety profile and quality of outcome [25, 26] (fig.2).

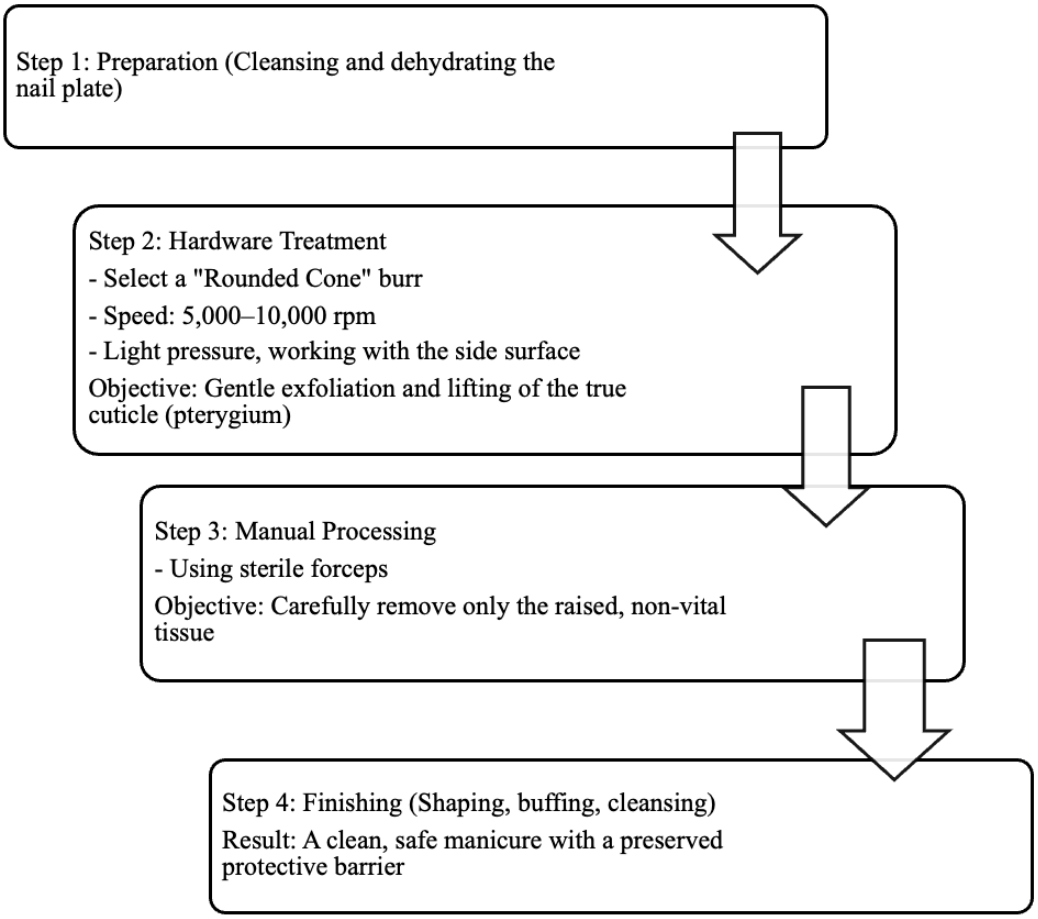

Fig.2. Block diagram of the E-File Dry Manicure combined technique protocol (compiled by the author based on [10, 25, 26]).

The empirical corpus of observations accumulated in the course of practical work convincingly corroborates the theoretical theses regarding the safety and effectiveness of the proposed method, serving as its external and internal validation. The demonstration of a successful rollout of the technique in the State of Arizona, where it had previously been scarcely represented, combined with the attainment of the status of the highest-paid specialist in the e-file dry manicure segment, indicates pronounced consumer value and an audience willingness to invest in reliable and predictable outcomes. In so doing, the client demand for gentle, nonaggressive practices that minimize trauma is empirically confirmed.

The sell-out of seats for master classes within the largest industry exhibitions in the USA (Chicago, Portland, Utah) attests to a deficit of competencies among practicing technicians and to a sustained demand for training in safe techniques. These observations are directly consistent with the problem outlined in the introduction of the absence of unified training standards.

Practical cases of nail plate restoration in clients after the use of acrylic and dip systems, as well as after improper work with burs by other specialists, serve as direct indicators of the therapeutic and reparative

potential of the method. The technique provides not only a pronounced aesthetic effect but also contributes to the restoration of the functional condition of the nail apparatus.

Victory at the OMC World Championship in Paris in the salon manicure category constitutes an objective marker of international recognition of both the safety and the high aesthetic level of the technique. Additionally, the documented increase in graduates' income by 50–100% upon completion of training represents quantitative evidence of the economic rationality of transitioning to safer and professionally validated work protocols.

Conclusion

The analysis conducted demonstrates that the safety of hardware manicure is not an intrinsic property of the equipment; rather, it is formed as a function of three interrelated determinants: evidence-based training grounded in deep knowledge of the nail unit anatomy; a standard-compliant execution technique (rational control of speed, pressure, and instrument angle of attack); and the correct selection of instrumentation, primarily the geometry of the working part of the bit.

The data obtained consistently support the initial hypothesis: the combined E-File Dry Manicure protocol, which involves delicate exfoliation with a rounded cone bit followed by manual cuticle removal, sets the benchmark for contemporary practice. This sequence of actions significantly reduces the probability of mechanical injury, preserves the integrity of the natural protective structures of the nail complex, and ensures high aesthetic and clinical outcomes recognized by the professional expert community.

The practical significance lies in the fact that the proposed methodology constitutes a reproducible, safe, and economically rational model for technicians, educators, and salon owners. The institutionalization of such an evidence-based protocol can substantially elevate safety and quality standards of services in the industry, meeting the growing client demand for healthy and informed care.

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