Open Access Library Journal
2026, Volume 13, e15801
ISSN Online: 2333-9721
ISSN Print: 2333-9705

Methodology for the Predicted Selection of Hair Extension Technology Depending on the Structure of Natural Hair and the Desired Aesthetic Result

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How to cite this paper: Cowan, Y. (2026) Methodology for the Predicted Selection of Hair Extension Technology Depending on the Structure of Natural Hair and the Desired Aesthetic Result. *Open Access Library Journal*, **13**: e15801.
https://doi.org/10.4236/oalib.1115801

Received: July 23, 2026
Accepted: August 17, 2026
Published: August 20, 2026

Abstract

The contemporary hair extension market has developed faster than the methodological standards that should guide professional choice. In practice, extension technology is still selected too often based on trend visibility, price, or the client's immediate aesthetic request, while the structural compatibility of natural hair is evaluated inconsistently. This creates a clinically and cosmetologically relevant problem, because the same desired result may be achieved by methods that differ greatly in traction profile, load distribution, thermal exposure, maintenance intensity, reversibility, and risk of shaft weakening. This article develops a literature-based methodology for the selection of hair extension technology based on the structure of natural hair and the desired aesthetic result. The study synthesizes twenty English-language scientific sources, including empirical studies, reviews, case reports, and technical investigations of hair fiber properties. A secondary analytical layer compares ten empirical publications (identified in Section 2.1) to isolate recurring variables usable in professional consultation. On that basis, an authorial methodology is proposed. It integrates five diagnostic blocks: fiber thickness, density, curl pattern, cumulative damage, and scalp tolerance, and aligns them with four groups of aesthetic aims: length increase, volume increase, combined transformation, and localized correction. The article argues that the safest and most convincing visual result is achieved not by the most technically impressive extension system, but by the method whose mechanical behavior matches the carrying capacity of natural hair and the realistic aesthetic objective.

Subject Areas

Cosmetology, Public Health

Keywords

Hair, Hair Preparations, Biomechanical Phenomena, Treatment Outcome, Decision Support Techniques, Cosmetics

1. Introduction

Hair extension procedures occupy an unusual position in beauty practice. They are aesthetic services, yet their success depends on biomechanical and trichological variables that behave more like clinical constraints than stylistic options. A visible transformation may be achieved in one appointment, but the true quality of the procedure becomes clear over time, when natural hair must bear additional weight, withstand repeated tension, endure correction cycles, and maintain an acceptable appearance without progressive weakening. For this reason, method selection deserves scientific attention rather than purely commercial simplification.

The relevance of the topic is underscored by two parallel trends. On the one hand, consumers increasingly request highly personalized beauty services, expecting not only length or volume but also natural movement, minimal visibility of fixation points, compatibility with frequent styling, and long wear. On the other hand, dermatological and cosmetic science literature has accumulated substantial evidence that repeated traction, local overload, prior chemical processing, and mechanical fragility can contribute to breakage, follicular stress, and traction-related alopecia when hair practices exceed the carrying capacity of the native fiber system [1]-[3]. The contradiction is clear: the more ambitious the aesthetic goal, the more carefully the method must be matched to the structure of natural hair.

A second difficulty lies in the fragmented nature of available knowledge. Research on hair disorders associated with grooming practices has usually been developed in dermatology, where the central question concerns damage and prevention [4] [5]. Hair fiber science has focused on thickness, curvature, porosity, elasticity, and treatment-induced deterioration as material properties of hair shafts [6]-[8]. Applied cosmetology has examined camouflage systems, wigs, and aesthetic alternatives for clients who cannot safely tolerate conventional attachment systems [9]-[11]. Yet these strands of evidence are rarely integrated into a single professional framework that answers a practical question: which technology is most appropriate for this hair and for this visual outcome?

The purpose of this article is to formulate such a framework. It develops a methodology for the predicted selection of hair extension technology based on natural hair structure and the desired aesthetic result, drawing on both scientific literature and a structured biomechanical dataset. The central research question is straightforward: how can existing evidence on hair structure, hair damage, and extension-related outcomes be translated into a professional, predictive methodology for selecting the technology that is both aesthetically effective and structurally appropriate?

2. Literature Review

Sources were identified in PubMed, Scopus and Web of Science (search period: January 2005 - December 2025). The search combined the terms: traction alopecia, hair extensions, hair grooming practices, hair shaft damage, hair fibre mechanics, curly hair, hair camouflage and hair prosthesis. Records were eligible if they were peer-reviewed, published in English, and reported either (i) original clinical or epidemiological data on grooming-related hair and scalp disorders, (ii) instrumental measurement of hair-fibre structure or treatment-induced damage, or (iii) review or case-based evidence on extension complications and aesthetic alternatives. Case reports were retained only where they described a mechanism not covered by larger studies. Excluded were studies of pharmacological hair-loss treatment, transplantation surgery, and non-English publications. Screening was performed by the single author in two passes—title and abstract, then full text—yielding the twenty sources [1]-[20]; reference [21] is the dataset and is not counted among them.

Within this set, ten publications reporting original empirical measurement were selected for comparative extraction: [1] [2] [4] [6] [7] [12] [13] [17]-[19]. From each, four variables were extracted: the hair or scalp parameter measured, the population and sample size, the grooming or chemical exposure examined, and the reported structural or clinical outcome. The remaining ten sources—reviews, case reports and camouflage or prosthetic overviews [3] [5] [8] [9] [10] [11] [14]-[16] [20]—were used for interpretive framing rather than variable extraction.

The literature relevant to this topic converges around several stable findings. First, hair is not a neutral substrate. Its diameter, density, curl geometry, elasticity, porosity, and treatment history influence not only cosmetic appearance but also mechanical tolerance. The systems approach proposed by Cloete *et al.* [6] is valuable because it treats healthy hair as an interdependent set of physical, biochemical, and geometric properties rather than a simple external feature. This matters for extension practice: the specialist works not merely with "thin" or "thick" hair in a visual sense, but with a fiber system whose strength, flexibility, and surface condition determine how added material will be borne over time. Research on curly hair further complicates simplified classifications, showing that curvature affects mechanical behavior, grooming needs, and susceptibility to damage under repetitive manipulation [12].

Second, mechanical and chemical history substantially modifies tolerance. Sanad *et al.* [13] demonstrated structural changes in hair shafts after chemical straightening, while Bloch *et al.* [7] showed that both Caucasian and Afro-ethnic hair fibers experience measurable deterioration after chemical and physical treatments. He *et al.* [8] synthesized mechanisms by which dyeing and perming impair hair and scalp, drawing attention to cumulative rather than isolated injury. In extension practice, this means that compatibility cannot be judged only by current appearance. Hair that visually seems dense may still be internally compromised by previous bleaching, heat exposure, repeated smoothing, or chronic friction.

Third, the literature on traction-related disorders offers a direct warning against indiscriminate method choice. Khumalo *et al.* [1] linked hairdressing practices with scalp disease prevalence in African adults, while Wright *et al.* [4] identified hair care practices associated with scalp and hair disorders in African American girls. Gathers *et al.* [2] examined grooming practices in relation to central centrifugal cicatricial alopecia, while Haskin and Aguh [5] emphasized that not all hairstyles impose the same degree of risk. Billero and Miteva [3] summarized traction alopecia as a progressive problem emerging from repeated tension rather than a single traumatic event. This body of research is highly relevant because many extension systems, especially those relying on small fixation points or prolonged pull at the margins, reproduce the same mechanical conditions known to contribute to traction injury.

More direct evidence concerning extensions themselves confirms this concern. Yang *et al.* [14] described hair extensions as a troubling cause of hair disorders, and Ahdout and Mirmirani [15] reported a distinctive horseshoe pattern of traction alopecia caused by weft extensions. Urbina *et al.* [16] documented traction folliculitis associated with different hairstyles, suggesting that inflammatory response may precede more advanced loss. If extension systems are treated only as fashion tools, their biological cost remains invisible until obvious deterioration appears.

At the same time, the literature does not justify a purely restrictive position. Saed *et al.* [9] reviewed hair camouflage strategies, Weffort *et al.* [10] discussed how wigs should be recommended, and Ewulu *et al.* [11] reviewed prosthetic options for people with alopecia. These works widen the field of acceptable professional response. A client's request for longer or fuller hair does not automatically require a bonded or tension-bearing system. In some cases, semi-removable or fully removable alternatives may better satisfy the visual goal with lower biological cost.

Empirical studies on population practices also help identify which variables should enter the predictive model. Molamodi *et al.* [17] quantified the impact of braiding and combing on hair loss among Black South African women. Anaba *et al.* [18] examined hair care practices, severity scores, and trichoscopic features in marginal traction alopecia, while Nzeng *et al.* [19] analyzed the epidemiological-clinical profile of traction alopecia among women in salons in Yaoundé. Borovicka *et al.* [20], in a clinical and pathological study of scarring alopecia in African American women, further underline the necessity of caution when cosmetic procedures are superimposed on already vulnerable hair environments.

To illustrate how the identified variables might interact in practice, this article references a synthetic dataset [21], consisting of 108 hypothetical archetypes generated by a deterministic rule-based model, not derived from clinical observation or patient data, computing the maximum safe donor attachment weight and the appropriate recommended action for each combination of the eight input variables specified in Section 3.1. The illustrative dataset is consistent, by design, with patterns the reviewed literature implies qualitatively: that the same extension procedure produces very different outcomes depending on the structural profile of the client's hair. Notably, 17.6% of the modeled profiles reach a refusal directive, and in 58% of those cases, the reason is the scalp condition alone, active erythema, or pre-traction markers regardless of all other parameters. This finding underscores the clinical significance of scalp assessment as a precondition for any extension decision, a point that the traction literature has long implied but rarely operationalized.

Taken together, the literature reveals a conceptual gap. There is extensive knowledge about hair damage, about fiber properties, and about aesthetic compensation strategies, but there is still no widely standardized methodology that connects structural assessment of natural hair with the predicted suitability of specific extension technologies for distinct visual aims. This gap manifests in preventable mismatch: methods selected for the promise of invisibility or durability are sometimes applied to hair that cannot safely sustain them, while clients with limited but realistic goals may receive more aggressive systems than necessary.

3. Methodology

The methodological design of this article is analytical and integrative. It rests on two complementary foundations. The first is a structured review of twenty English-language publications covering hair structure, traction-related injury, hair shaft damage, camouflage strategies, and extension-associated complications. The second is an analysis of the Dataset [21], which provides 108 computationally modeled client profile archetypes mapping biological and clinical input variables to safe load limits and procedural action directives.

It should be noted that the referenced dataset consists of illustrative synthetic archetypes generated to explore relationships among parameters and does not represent empirical observations from real clients or patients.

The source base includes several types of publications. The first group consists of empirical studies of grooming-related or traction-related pathology, because these clarify which forms of load and which scalp zones tend to become vulnerable under repetitive mechanical stress [1] [2] [4] [17]-[19]. The second group includes technical investigations of hair fibers and chemically altered hair, which provide information about carrying capacity and the consequences of prior processing [6]-[8] [12] [13].

The third group covers review and case-based material focused on extension complications, camouflage, wigs, and prosthetic alternatives [9]-[11] [14] [15], while a supplementary group sharpens risk interpretation [3] [5] [16] [20] (see **Figure 1**).

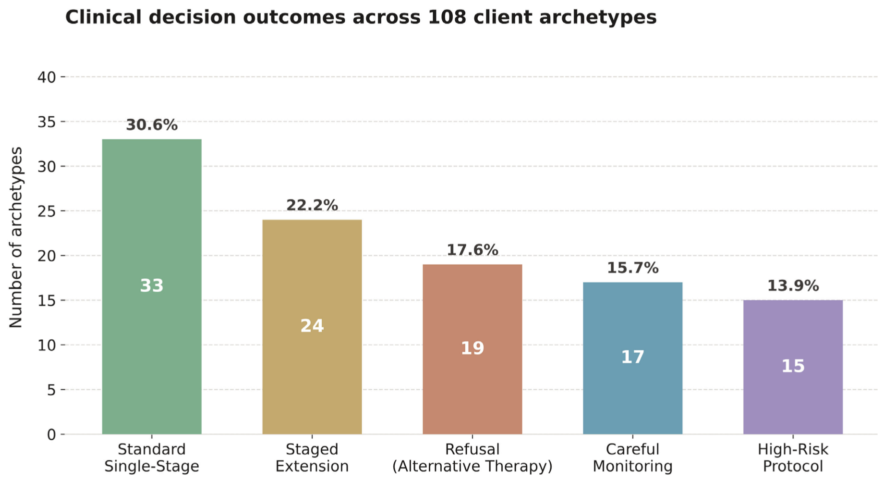

Figure 1. Predictive selection framework integrating diagnostic variables, aesthetic aims, and decision zones.

Dataset Integration

The Hair Biomechanical Tolerance Dataset [21] was incorporated as a structured empirical layer. The dataset was generated using the CEMS Method, a deterministic biomechanical algorithm that computes safe donor attachment parameters by integrating four factors: the base carrying capacity of the native hair shaft (derived from shaft diameter), a Young's Modulus Reduction Factor reflecting chemical degradation, anatomical tension mapping across scalp zones, and clinical modifiers such as active erythema or poor aftercare compliance. The dataset contains 108 archetypes, each described by eight input variables: hair thickness, shaft diameter range, chemical history, structural degradation percentage, scalp zone, follicular density, scalp condition, and aftercare compliance. Hair thickness and diameter range are paired rather than independent: thickness is the categorical descriptor used in consultation (fine, medium, coarse), while diameter range is its measured correlate in micrometres (35 - 45, 60 - 80, 90 - 110 μm), from which the base carrying capacity is computed. Thickness is therefore the variable a practitioner assesses; diameter range is the variable the algorithm uses. For each archetype, six outputs are computed: the maximum safe capsule weight (in grams), the recommended fixation type, the maximum wear cycle in weeks, the maximum strand count per zone, the mandated recommended action, and a binary refusal flag. In this article, the dataset serves to verify that the five diagnostic variables identified through literature synthesis correspond to the input parameters that prove decisive when the selection problem is operationalized computationally (see Table 1).

Table 1. CEMS decision logic: mapping of input states to Recommended_Action.

Step	Condition	Output	Confirmation in dataset
Gate 1	Scalp_Condition ≠ Healthy (erythema or pre-traction markers)	Refusal	11/11 (100%)
Rule 1	Virgin or Tinted + Supportive or Conditional zone	Standard Single-Stage	33/33

Continued

Rule 2	Virgin or Tinted + High-Risk zone	Careful Monitoring	17/17
Rule 3	Bleached + Supportive or Conditional zone	Staged Extension	17/17
Rule 4	Bleached + High-Risk zone	High-Risk Protocol	7/8
Rule 5	Compromised + Supportive zone	Staged Extension	7/9
Rule 6	Compromised + Conditional zone	High-Risk Protocol	7/7
Rule 7	Compromised + High-Risk zone	Refusal	6/6
Modifier	Fine diameter + Low aftercare compliance	escalates one step toward refusal	applies to the 4 residual cases

Two features of this logic deserve emphasis. First, Recommended_Action is not a threshold function of Max_Capsule_Weight_g: the weight ranges of the Standard Single-Stage (0.28 - 1.00 g) and Careful Monitoring (0.18 - 0.50 g) categories overlap substantially. The action is determined categorically by chemical history and scalp zone, while capsule weight is computed separately as a continuous output. Second, scalp condition operates as an absolute gate rather than as a weighted factor: no profile with active erythema or pre-traction markers received any directive other than refusal, irrespective of fibre diameter, density or compliance.

Technologies were interpreted through their dominant characteristics: distributed versus point fixation, removable versus prolonged wear, low versus moderate versus high local traction, thermal versus non-thermal application, and light versus substantial added weight. Third, desired client outcomes were grouped into four practical aims: length enhancement, volume enhancement, combined transformation, and localized corrective enhancement.

The analytical procedure followed three stages. First, each source was examined for recurring variables that could be translated into pre-procedural assessment indicators. Five such variables were retained: fiber thickness, apparent density, curl pattern, cumulative damage, and scalp tolerance to traction. Second, extension practice was simplified into method-behavior categories rather than brand names. Technologies were interpreted through their dominant characteristics: distributed versus point fixation, removable versus prolonged wear, low versus moderate versus high local traction, thermal versus non-thermal application, and lighter versus heavier added mass (see Table 2).

Table 2. Analytical structure of the predictive selection methodology.

Component	Description	Practical meaning
Study design	Analytical and integrative research combining literature synthesis with dataset analysis	The article develops a predictive professional framework grounded in both published evidence and computed biomechanical data.
Literature base	Dermatology, trichology, cosmetic science, and hair-fiber studies	Ensures interdisciplinary grounding of the proposed methodology
Dataset	Hair Biomechanical Tolerance Dataset [21], n = 108 client profile archetypes	Provides computed reference values for four of the five diagnostic variables identified through the literature review
Source selection	20 verified English-language sources relevant to hair structure, damage risk, traction, and aesthetic correction	Narrows the evidence base to directly applicable studies

Continued

Analytical logic	Comparison of hair structure variables, extension technologies, and desired aesthetic outcomes	Allows the study to move from descriptive review to applied selection logic
Key variables of natural hair	Density, shaft thickness, porosity, elasticity, fragility, curl pattern, previous chemical damage, scalp sensitivity	These parameters determine how much mechanical load the hair can tolerate
Key variables of extension technology	Attachment mechanism, weight load, traction level, wear duration, removability, correction frequency, thermal and chemical exposure	These factors define the safety and technical suitability of each method.
Aesthetic variables	Desired length, desired volume, local correction, natural visual blending, duration of effect	These variables reflect the client's final visual goal.
Comparative procedure	Matching natural-hair indicators with technical characteristics of extension systems, verified against dataset archetypes	Forms the basis for predicted method selection
Outcome	An authorial predictive methodology and a three-zone decision system supported by biomechanical data	Produces a practical framework for specialists

Third, desired client outcomes were grouped into four practical aims: length enhancement, volume enhancement, combined transformation, and localized corrective enhancement. These categories were then cross-referenced against the dataset archetypes. For each of the 108 profiles, the computed Recommended_Action output was examined to determine which input variables, when present together, consistently shifted the decision from a standard single-stage procedure toward a staged approach, a high-risk protocol, or a refusal. This step grounded the proposed methodology in computed patterns rather than qualitative inference alone.

One qualification applies to the correspondence between the literature synthesis and the dataset. Four of the five diagnostic variables—fibre thickness, apparent density, cumulative damage and scalp tolerance—map directly onto dataset inputs. Curl pattern does not: it was retained in the framework on the basis of the fibre-science literature [6] [12], which links curvature to mechanical behaviour and grooming susceptibility, but it is not an input to the CEMS model and was therefore not evaluated in the dataset analysis. Its inclusion in the consultation protocol rests on published evidence alone.

Four archetypes deviate from the categorical rules above; in each, low aftercare compliance combined with fine diameter escalates the directive by one step. The escalation is applied deterministically but is not fully symmetric across density levels, and this residual inconsistency in the generating model is acknowledged as a limitation.

4. Results

The comparative synthesis of the reviewed literature and the analysis of 108 biomechanical archetypes together produced the authorial methodology for the predicted selection of hair extension technology. A recurring observation across both sources was that adverse outcomes rarely arise from the mere existence of extensions. They occur when the mechanical logic of the chosen method does not correspond to the structural logic of the natural hair. At first, this mismatch may remain invisible because the immediate visual effect is often satisfying. Over time, however, the discrepancy surfaces as discomfort, traction sensitivity, breakage, edge weakening, or visible thinning. The practical value of the proposed framework is that it moves the decisive moment from post-damage correction to pre-procedure prediction.

Dataset Analysis: Decision Outcome Distribution

Analysis of the 108 illustrative archetypes shows how a structured set of clinical decisions could follow from the combination of input parameters. Standard single-stage procedures were appropriate for 33 archetypes (30.6%), meaning that roughly one in three profiles supported an immediate, unrestricted intervention.

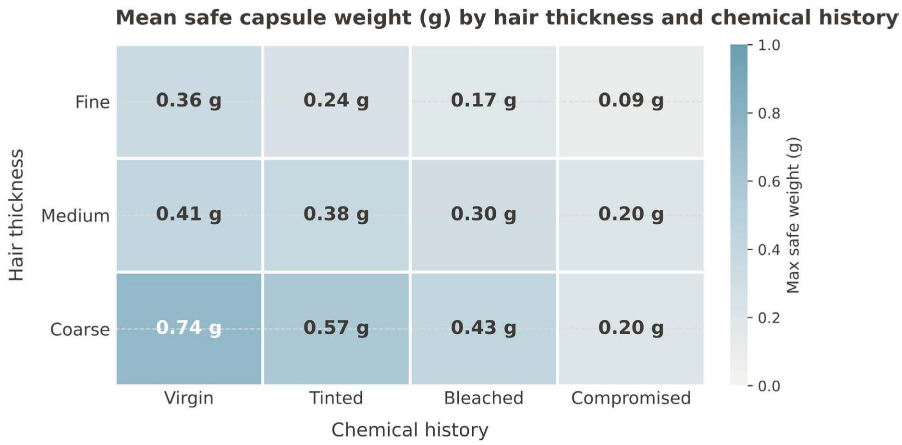

Figure 2. Distribution of clinical decision outcomes across 108 biomechanical archetypes [21].

Staged extension was required for 24 profiles (22.2%), all of which involved bleached or compromised hair; no virgin or lightly tinted profile triggered a staged directive. Careful monitoring was indicated for 17 profiles (15.7%), while a high-risk protocol applied to 15 (13.9%). Refusal of the procedure was the mandated output for 19 archetypes (17.6%), representing approximately one in six clients (Figure 2). Of the 19 refusal cases, 11 were driven exclusively by scalp condition: the presence of active erythema or pre-traction markers overrode all other parameters, including favorable hair thickness and density. This finding has a direct practical implication: scalp inspection is not a secondary step in consultation. It is a primary gate that determines whether any further technical assessment is relevant.

The first result of the analysis is the identification of five diagnostic variables that should be assessed in every consultation. The first is fiber thickness. Fine hair carries less load at each anchoring point and reacts more visibly to added tension. Medium and coarse fibers offer broader technical freedom, although this freedom is still modified by the remaining variables. The second is density, which determines how the total extension mass is distributed across the existing hair base. The third variable is curl pattern, because curvature changes how fibers respond to tension, smoothing, friction, and blending requirements. The fourth is cumulative damage (see Figure 3).

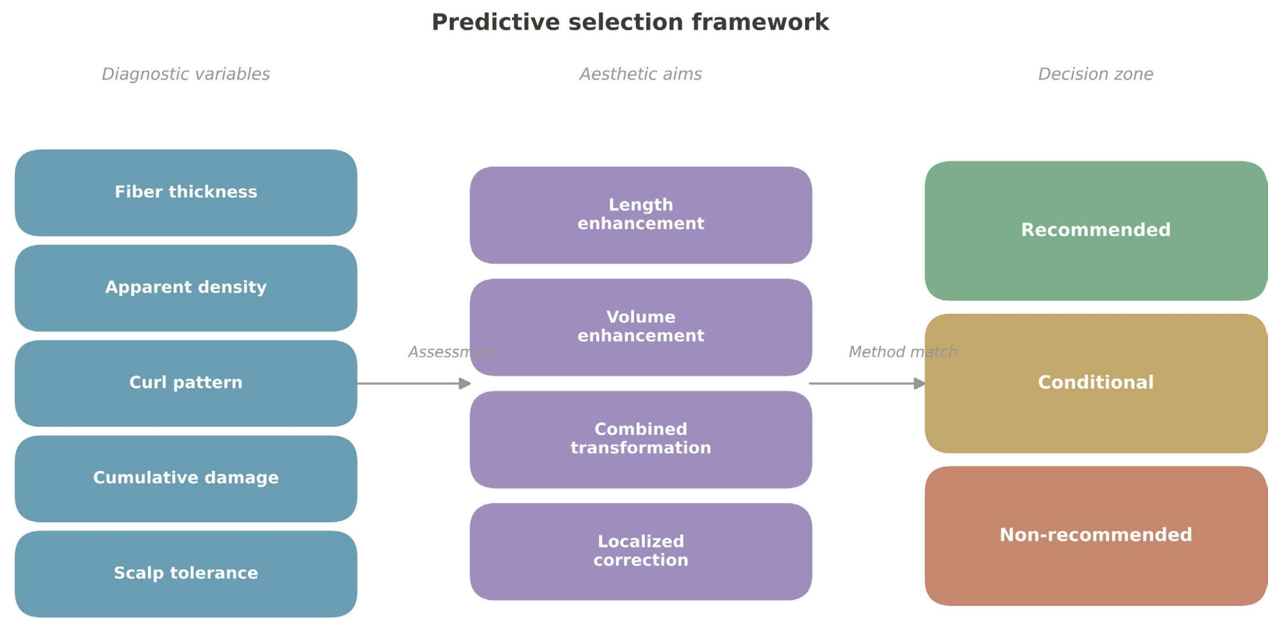

Figure 3. Mean safe capsule weight (g) by hair thickness and chemical history across the 89 non-refusal archetypes; profiles with a refusal directive (weight = 0.00 g) are excluded.

This variable proved indispensable because empirical and technical studies repeatedly show that bleaching, straightening, perming, and thermal styling reduce structural reserve even when the hair still appears full [7] [8] [13]. The fifth variable is scalp tolerance, especially in the marginal and high-mobility zones, where traction-related disorders are most often described [3] [18].

The synthetic dataset illustrates a clear hierarchy among these variables, as encoded in its generating model in terms of their effect on safe load limits. Hair thickness alone produced a 1.8-fold difference in mean maximum capsule weight between fine (0.30 g) and coarse (0.54 g) profiles. Chemical history introduced an additional gradient: virgin hair tolerated, on average, 0.55 g per attachment, while compromised hair dropped to 0.25 g, a reduction of more than half. Scalp zone further modified these values: the same hair profile could safely carry 38% less load in the high-risk marginal hairline zone than in the supportive crown zone (0.51 g vs 0.32 g) (Figure 2). In every such case (6 of 6 profiles combining compromised chemical history with a high-risk zone).

The second result is the grouping of aesthetic requests into four operational aims. A length-dominant request seeks a visible downward extension and usually requires continuity of movement and blending along the lower contour. A volume-dominant request seeks optical fullness and may be achieved with lighter total added length. A combined request demands both length and density and therefore places the highest burden on the natural base. A localized corrective request seeks targeted enhancement, for example, filling sparse zones or balancing a haircut. This distinction is central because many professional errors occur when a high-burden method is selected for a low-burden goal merely because the method is popular or familiar.

On the basis of these two analytical steps, the authorial methodology proposes a three-zone decision system. In the recommended zone, the structural profile of the natural hair is compatible with the mechanical behavior of the technology and with the client's visual request. In the conditional zone, the method may be used only with a reduced load, modified installation pattern, shortened wear cycle, or explicit limitation of the expected result. In the non-recommended zone, the method should be refused, and either a less invasive extension option or a removable camouflage solution should be offered instead.

Within this framework, low-tension removable systems are predicted to be the most appropriate when the hair is fine, chemically compromised, or associated with high traction sensitivity, especially if the goal is occasional transformation rather than continuous wear. Distributed lightweight systems with careful mass control are more suitable than point-loaded methods when density is limited, but the client still seeks moderate improvement. By contrast, methods that create persistent pull at small fixation points or require substantial total added weight become increasingly unsuitable as soon as one or more of the following conditions are present: fine fiber diameter, low density, recurrent bleaching, chronic smoothing, fragile edges, or previous signs of traction discomfort. The literature does not support the idea that durability is automatically synonymous with professional superiority. Quite often, the opposite is true: the most durable system may be the least proportionate solution for a biologically vulnerable base [14] [15] (see **Table 3**).

Table 3. Main findings and their practical interpretation.

Finding	Detail	Meaning for practice
One in three profiles supports immediate procedure	30.6% of archetypes received a Standard Single-Stage directive	A standard approach is appropriate only when the full diagnostic profile is favorable
Staged extension is exclusively damage-driven	All 24 staged profiles involved bleached or compromised hair; no virgin or tinted profile triggered staging	Chemical history is the primary driver of phased planning
One in six profiles requires refusal	17.6% of archetypes received a Refusal directive	Refusal is a predictable, data-supported outcome, not an exception
Scalp condition overrides all other parameters	58% of refusals were caused by active erythema or pre-traction markers alone	Scalp inspection is a primary gate, not a secondary check
Hair thickness produces a 1.8-fold load difference	Mean safe weight: Fine 0.30 g, Medium 0.40 g, Coarse 0.54 g	Fiber diameter sets the mechanical ceiling for extension mass

Continued

Chemical history halves safe load.	Virgin 0.55 g vs Compromised 0.25 g	Cumulative cosmetic damage must be assessed, not assumed from visual appearance
Zone reduces capacity by 38%	Supportive zone mean 0.51 g vs High-Risk zone 0.32 g	Anatomical placement of attachments is as important as hair type
The most durable method is not the most appropriate	High-load systems are incompatible with fine, damaged, or marginal-zone profiles	Method selection should prioritize structural compatibility over technical prestige

The framework also produces a practical rule concerning cumulative damage and desired aesthetic scale. When the client requests a combined length-and-volume transformation but the diagnostic profile demonstrates fine diameter, reduced density, and prior chemical compromise, the specialist should not search for a "stronger" attachment method. The appropriate professional response is to reduce the transformation scale, redistribute the visual goal, or replace durable extension with a partial or removable system. Across the empirical subset, the most recurrent predictive indicators of risk were repetition of tension, vulnerable margins, and pre-existing fragility. Studies focused on grooming practices and traction pathology consistently implied that method safety is relational, not absolute: the same practice may be better tolerated in a robust hair environment and harmful in a compromised one [1] [4] [17] [19]. This secondary empirical layer reinforces the methodology's central claim that extension choice must be predicted through compatibility rather than fashion preference.

A further result concerns the role of alternatives. The reviewed camouflage and prosthetic literature demonstrates that refusing a specific extension system does not mean refusing beauty enhancement altogether [9]-[11]. For clients with high vulnerability and high aesthetic motivation, the most competent solution may be a method outside the conventional extension hierarchy.

The mapping below is a consultation heuristic derived from the framework and the computed archetypes; it is a proposed decision aid, not a validated clinical protocol (see **Table 4**).

Table 4. Decision rule linking diagnostic profile and aesthetic aim to permitted method behaviour.

Diagnostic Profile	Purpose	Permitted Method Category	Modification	Alternative/Referral
Virgin/tinted, medium-coarse, supportive zone, healthy scalp	Length, volume, or combined	Distributed or point fixation, prolonged wear	None	—
Virgin/tinted, fine, or high-risk zone	Length or volume	Distributed low-traction, lighter mass	Reduced strand count; shortened wear cycle	Removable system if goal is occasional

Continued

Bleached, any zone	Length or volume	Distributed, non-thermal, staged installation	Phased build-up over ≥2 sessions; reduced load	Partial system if scale is high
Bleached, high-risk zone	Any	Point fixation excluded	Minimal load; marginal zone avoided	Removable or camouflage solution
Compromised, supportive zone	Localized correction	Distributed, lightest mass, non-thermal	Strict load ceiling; short cycle	Camouflage [9] [11]
Compromised, conditional zone	Any	High-risk protocol only	Documented consent; monitoring	Removable alternative preferred
Compromised, high-risk zone	Any	None permitted	—	Refusal; referral to camouflage/prosthetic options [9]-[11]
Any profile, non-healthy scalp	Any	None permitted	—	Refusal; dermatological referral before reassessment
Virgin/tinted, medium-coarse, supportive zone, healthy scalp	Length, volume, or combined	Distributed or point fixation, prolonged wear	None	—
Virgin/tinted, fine, or high-risk zone	Length or volume	Distributed low-traction, lighter mass	Reduced strand count; shortened wear cycle	Removable system if goal is occasional

5. Discussion

The proposed methodology has several implications for theory and practice. Its first contribution is epistemological. It shows that extension selection should be understood as an interdisciplinary decision rather than a stylistic preference. Too often, the beauty field separates visual expertise from biological reasoning, leaving structural assessment underdeveloped. The reviewed literature suggests that this separation is artificial. Aesthetic success depends on the same factors that determine damage risk, because naturalness of appearance, durability of result, comfort during wear, and preservation of the native hair are all consequences of structural compatibility.

A second implication concerns the understanding of good results. In extension culture, spectacular before-and-after images often become the implicit measure of procedural quality. Several sources reviewed here indicate that early visual success may coexist with progressive biological cost if the chosen method imposes an excessive or improperly distributed load [3] [14]. The methodology therefore reframes success in longitudinal terms. A good result is not one that simply looks convincing immediately after installation. It remains visually coherent while preserving the client's own hair across wear, maintenance, and removal cycles.

It can also be used in training contexts. One persistent problem in beauty education is the transfer of fragmented technical routines without a decision framework explaining when each method should, should not, or should only conditionally be applied. By grouping technologies according to their mechanical behavior and by treating the client's request as an adjustable variable rather than a fixed command, the proposed model may improve consultation quality.

Incorporating a biomechanical dataset into a literature-driven article is useful even without a primary salon experiment, because it shifts the status of the proposed framework from conceptual to empirically grounded. The Hair dataset [21] does not report observations from live clients. Its archetypes are computationally modeled. However, the patterns that emerge from those 108 profiles are consistent with the clinical and biological evidence reviewed in the literature: scalp condition functions as a gate, not a modifier; chemical damage compounds zone-related vulnerability; and the combination of compromised hair and a high-risk attachment zone produces a refusal directive in every instance (6 of 6 profiles), while fine, bleached hair in the same zone produces refusal only when a secondary risk factor—poor aftercare compliance or scalp erythema—is also present (2 of 3 profiles). These patterns are not surprising to a trichologist familiar with the literature. Their value lies in being explicit, reproducible, and organized into a format that a practitioner can use during consultation.

The limitations of the article must nevertheless be stated clearly. The proposed methodology is literature-driven and depends on the strengths and constraints of the existing evidence. Much of the direct research concerns traction-related pathology, grooming habits, or broad damage mechanisms rather than brand-specific extension systems. This is why the article deliberately interprets methods through behavior categories instead of proprietary labels. Another limitation is that the methodology is predictive, not yet prospectively validated. It provides a structured rationale for decision-making, but future observational studies are needed to test how consistently it improves outcomes in salon practice.

A further issue involves cultural and hair-type diversity. Some of the most informative studies concern African and Afro-textured hair contexts because traction-related pathology has been documented there with particular clarity [1] [2] [4]. These sources are invaluable, yet this approach should not be reduced to a single hair population. Their importance lies in the mechanical principles they reveal: repeated pull, marginal fragility, cumulative damage, and mismatch between grooming strategy and fiber tolerance.

Finally, the methodology has a practical ethical dimension. Refusal is sometimes a sign of expertise, not of limitation. When the structural profile of the hair cannot safely support the requested transformation, the specialist who redirects the client toward a lighter or removable option acts more professionally than the one who accepts the request for the sake of immediate visual drama. The reviewed literature on camouflage and prosthetics makes this redirection easier to justify because it broadens the definition of success beyond the narrow prestige hierarchy of extension techniques [9] [11].

6. Conclusions

The article has demonstrated that the predicted selection of hair extension technology can be approached as a structured scientific problem rather than as an intuitive stylistic decision. A review of twenty English-language sources showed that the critical determinants of safe and convincing method choice are not trend value or attachment novelty, but the interaction between natural hair structure, cumulative vulnerability, and the scale of the desired aesthetic result. The literature consistently indicates that repeated localized traction, prior chemical compromise, fragile margins, and low carrying capacity increase the likelihood of adverse outcomes, while lighter, more proportionate, and sometimes removable solutions can preserve both appearance and biological integrity.

On this basis, the article proposed a predictive methodology built around five diagnostic variables, four groups of aesthetic requests, and a three-zone decision logic of recommended, conditional, and non-recommended methods. Analysis of 108 biomechanical archetypes showed that four of the five variables identified through the literature review—thickness, density, cumulative damage and scalp tolerance—are the parameters that prove decisive when the selection problem is computed algorithmically; curl pattern was not represented in the model and remains supported by the fibre literature rather than by the computed analysis. Notably, approximately one in six client profiles in the dataset resulted in a refusal directive, and nearly three in five of those refusals were determined by scalp condition alone, a finding that reinforces the clinical status of scalp assessment within the selection process. The framework does not replace professional judgment and does not claim predictive infallibility. Its value lies in providing a structured consultation logic that helps align the mechanical behavior of extension technologies with the structural reality of the client's hair.

Future research should move toward prospective validation. Observational salon studies could test whether using this methodology reduces traction complaints, breakage, and early dissatisfaction while improving the retention of aesthetic quality over time. The biomechanical dataset used here represents a first step in that direction: it provides computed reference thresholds that future clinical studies could test against real-world outcomes. Even before such validation, the framework offers a meaningful shift in professional practice. It replaces the question "Which method is most impressive?" with the more useful question "Which method is most proportionate to this hair and this goal?" In contemporary beauty practice, that shift is both scientifically justified and practically necessary.

Conflicts of Interest

The author declares no conflicts of interest.

References

[1] Khumalo, N.P., Jessop, S., Gumedze, F. and Ehrlich, R. (2007) Hairdressing and the Prevalence of Scalp Disease in African Adults. *British Journal of Dermatology*, **157**,

981-988. https://doi.org/10.1111/j.1365-2133.2007.08146.x

[2] Gathers, R.C., Jankowski, M., Eide, M. and Lim, H.W. (2009) Hair Grooming Practices and Central Centrifugal Cicatricial Alopecia. *Journal of the American Academy of Dermatology*, **60**, 574-578. https://doi.org/10.1016/j.jaad.2008.10.064

[3] Billero, V. and Miteva, M. (2018) Traction Alopecia: The Root of the Problem. *Clinical, Cosmetic and Investigational Dermatology*, **11**, 149-159. https://doi.org/10.2147/ccid.s137296

[4] Rucker Wright, D., Gathers, R., Kapke, A., Johnson, D. and Joseph, C.L.M. (2011) Hair Care Practices and Their Association with Scalp and Hair Disorders in African American Girls. *Journal of the American Academy of Dermatology*, **64**, 253-262. https://doi.org/10.1016/j.jaad.2010.05.037

[5] Haskin, A. and Aguh, C. (2016) All Hairstyles Are Not Created Equal: What the Dermatologist Needs to Know about Black Hairstyling Practices and the Risk of Traction Alopecia (TA). *Journal of the American Academy of Dermatology*, **75**, 606-611. https://doi.org/10.1016/j.jaad.2016.02.1162

[6] Cloete, E., Khumalo, N.P., Van Wyk, J.C. and Ngoepe, M.N. (2019) Systems Approach to Human Hair Fibers: Interdependence between Physical, Mechanical, Biochemical and Geometric Properties of Natural Healthy Hair. *Frontiers in Physiology*, **10**, Article 112. https://doi.org/10.3389/fphys.2019.00112

[7] Bloch, L.D., Goshiyama, A.M., Dario, M.F., Escudeiro, C.C., Sarruf, F.D., Velasco, M.V.R., *et al.* (2019) Chemical and Physical Treatments Damage Caucasian and Afro-Ethnic Hair Fibre: Analytical and Image Assays. *Journal of the European Academy of Dermatology and Venereology*, **33**, 2158-2167. https://doi.org/10.1111/jdv.15761

[8] He, Y., Cao, Y., Nie, B. and Wang, J. (2023) Mechanisms of Impairment in Hair and Scalp Induced by Hair Dyeing and Perming and Potential Interventions. *Frontiers in Medicine*, **10**, Article 1139607. https://doi.org/10.3389/fmed.2023.1139607

[9] Saed, S., Ibrahim, O. and Bergfeld, W.F. (2017) Hair Camouflage: A Comprehensive Review. *International Journal of Women's Dermatology*, **3**, S75-S80. https://doi.org/10.1016/j.ijwd.2017.02.016

[10] Weffort, F., Sales Martins, S., Plata, G.T., Duraes, C.T. and Melo, D.F. (2020) Do You Know How to Recommend a Wig to Your Patient? *Journal of Cosmetic Dermatology*, **20**, 724-728. https://doi.org/10.1111/jocd.13602

[11] Ewulu, A., Amibang, R. and Deng, M. (2023) Review of Hair Prosthetic Options for Patients with Alopecia. *Journal of Cosmetic Dermatology*, **23**, 8-16. https://doi.org/10.1111/jocd.15907

[12] Westgate, G.E., Ginger, R.S. and Green, M.R. (2017) The Biology and Genetics of Curly Hair. *Experimental Dermatology*, **26**, 483-490. https://doi.org/10.1111/exd.13347

[13] Sanad, E.M., El-Esawy, F.M., Mustafa, A.I. and Agina, H.A. (2018) Structural Changes of Hair Shaft after Application of Chemical Hair Straighteners: Clinical and Histopathological Study. *Journal of Cosmetic Dermatology*, **18**, 929-935. https://doi.org/10.1111/jocd.12752

[14] Yang, A., Iorizzo, M., Vincenzi, C. and Tosti, A. (2009) Hair Extensions: A Concerning Cause of Hair Disorders. *British Journal of Dermatology*, **160**, 207-209. https://doi.org/10.1111/j.1365-2133.2008.08924.x

[15] Ahdout, J. and Mirmirani, P. (2012) Weft Hair Extensions Causing a Distinctive Horseshoe Pattern of Traction Alopecia. *Journal of the American Academy of Dermatology*, **67**, e294-e295. https://doi.org/10.1016/j.jaad.2012.07.020

[16] Urbina, F., Sudy, E. and Barrios, M. (2009) Traction Folliculitis: 6 Cases Caused by Different Types of Hairstyles That Pull on the Hair. *Actas Dermo-Sifiliográficas* (*English Edition*), **100**, 503-506. https://doi.org/10.1016/s1578-2190(09)70108-8

[17] Molamodi, K., Fajuyigbe, D., Sewraj, P., Gichuri, J., Sijako, B., Galliano, A., *et al.* (2021) Quantifying the Impact of Braiding and Combing on the Integrity of Natural African Hair. *International Journal of Cosmetic Science*, **43**, 321-331. https://doi.org/10.1111/ics.12699

[18] Anaba, E.L., Akinkugbe, E.O., Otrofanowei, E., *et al.* (2022) Marginal Traction Alopecia: Hair Care Practices, Severity Score and Trichoscopic Features in Lagos, Nigeria. *West Africa Journal of Medicine*, **39**, 808-815.

[19] Mbussuh Nzeng, L.F., Nguefack-Tsague, G., Kotto, R., Tounouga, D.N., Sigha, O.B., Nkoro, G.A., *et al.* (2022) Hair Care and Epidemiological-Clinical Profile of Traction Alopecia among Women in Hair Salons in Yaoundé, Cameroon. *Skin Health and Disease*, **3**, e158. https://doi.org/10.1002/ski2.158

[20] Borovicka, J.H., Thomas, L., Prince, C. and Mehregan, D.R. (2009) Scarring Alopecia: Clinical and Pathologic Study of 54 African-American Women. *International Journal of Dermatology*, **48**, 840-845. https://doi.org/10.1111/j.1365-4632.2009.04129.x

[21] Cowan, Y. (2026) Research Toolkit Biomechanical Tolerance Dataset and Computational Model for Safe Hair Extension Architecture. Zenodo. https://doi.org/10.5281/zenodo.21037485