REVIEW ARTICLE

Artificial Intelligence-driven Smile Design in Clinical Dentistry

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Abstract

Background: Smile esthetics are central to contemporary dentistry because patients seek predictable esthetic outcomes, and clinicians need objective tools to plan and communicate design intent. Digital smile design (DSD) evolved from analog wax-ups and mock-ups to computer-based workflows using 2D photography, 3D facial scanning, and computer-aided design/computer-aided manufacturing integration. Artificial intelligence (AI) is now being introduced to extend DSD by automating facial landmark detection, objectifying esthetic analysis, accelerating proposal generation, and integrating with restorative and orthodontic planning pipelines.

Objectives: To synthesize clinical evidence on AI-driven smile design and provide evidence-grounded practical guidance for clinicians across prosthodontics, orthodontics, and esthetic dentistry.

Materials and methods: A structured PubMed-oriented literature search identified 480 records across eight query domains. Three-criterion clinical relevance screening (AI smile design focus, clinical perspective, and peer-reviewed dental/medical journal) yielded 96 included articles. Among them, 21 articles were included for full-text extraction, providing structured clinical findings per article. Evidence was synthesized narratively involving AI technique, clinical application, and evidence quality.

Results: Artificial intelligence techniques documented in the clinical literature include convolutional neural networks, generative adversarial networks (GANs), fine-tuned segmentation models, landmark detection application programming interfaces, transfer learning for attractiveness scoring, and orthodontic generative models. Applications span 2D/3D smile simulation, automated landmark selection, shade selection, dynamic video-based DSD (Motion-DSD), and orthodontic treatment visualization (Invisalign SmileView and OrthoGAN). Key quantitative findings include a ~51% reduction in design time with AI-assisted workflows (30.8 ± 5.1 vs 63.5 ± 14.1 minutes); a patient preference rate of 69.7% for AI-generated designs in one prospective paired study, despite lower objective Dental Esthetic Screening Index scores vs expert designs; improved clinically acceptable shade matches at try-in with AI assistance (85.0% vs 70.0%); and a pooled patient/clinician satisfaction prevalence of 58% (95% CI: 30%–86%) across a meta-analysis of six studies, accompanied by substantial heterogeneity (I2 = 60%) and detected publication bias. A focused scoping review identified only four studies (2023–2024) directly evaluating AI smile design, concluding no significant difference from manual designs in esthetic perception.

Conclusion: Evidence is predominantly composed of small prospective studies, cross-sectional surveys, and technical validations; no randomized controlled trials with esthetic outcomes as primary endpoints were identified. AI-driven smile design tools currently function best as visualization and communication adjuncts requiring active clinician oversight. Shade selection and automated landmark detection show the strongest comparative clinical validation to date. Autonomous AI smile design has not been validated for routine independent clinical use. Standardized randomized trials measuring delivered restoration outcomes, patient-reported experiences, and long-term stability are needed before broader adoption recommendations can be made.

Keywords: Computer-aided design, Deep learning, Dental esthetics, Image processing, Patient satisfaction, Prosthodontics.

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Background

The smile occupies a uniquely prominent role in clinical dentistry: it is simultaneously a functional unit and the primary determinant of facial esthetic perception. For patients, it carries substantial psychosocial weight, affecting self-confidence, social interaction, and quality of life. Modern practice reflects this, with esthetic treatment demand increasing steadily across prosthodontics, orthodontics, and restorative disciplines.[1,2] Reviews of artificial intelligence (AI) applications in esthetic dentistry consistently frame smile design tools in this patient-centered context, positioning digital smile design (DSD) and predictive simulation as enabling shared decision-making by allowing patients to visualize proposed outcomes before irreversible treatment steps are undertaken.[1,2] The esthetic evaluation of a smile is inherently subjective and shaped by cultural, racial, and individual factors, which create a persistent challenge for standardizing "esthetic success" across patient populations and practice environments.[1–3]

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This clinical perspective synthesizes peer-reviewed clinical evidence on AI-driven smile design, drawn from a structured search and screening of the dental literature in PubMed only. Out of 480 records initially identified, 96 screened articles met clinical relevance criteria, and finally, 21 articles were included in the narrative synthesis. It covers the AI techniques appearing in the clinical literature, the specific clinical applications and workflows they support, the comparative clinical evidence on accuracy and esthetic outcomes, current limitations and evidence quality, and practical implications for clinicians. The evidence base described is predominantly recent years 2021–2026, reflecting the rapid emergence of this field, but is predominantly composed of small observational studies, technical validations, and preference surveys rather than controlled trials.[4,5]

From Analog to Digital: The Evolution of Smile Design

For decades, smile design relied on analog methods: chairside esthetic analysis using reference guidelines (smile arc, golden proportion, incisal edge position, and midline), diagnostic wax-ups, and provisional mock-ups that allowed the clinician and patient to evaluate proposed tooth contours before definitive restoration. These methods, while clinically sound, were time-intensive, operator-dependent, and limited in their ability to communicate intended outcomes to patients who could not easily interpret a wax-up on an articulator.[2,3]

Digital smile design, introduced and popularized in the early 2010s, addressed these limitations by integrating standardized clinical photography, video, and digital planning tools into a structured workflow.[2,3] DSD platforms enabled clinicians to superimpose proposed tooth contours and proportions onto facial photographs, produce patient-viewable simulations, and link design outputs to computer-aided design/computer-aided manufacturing (CAD/CAM) fabrication chains. The integration of 3D facial scanning alongside 2D photography-based workflows further expanded dimensional accuracy, with reviews in the clinical literature noting that 3D designs offer greater accuracy than 2D counterparts.[4]

The Rationale for Introducing Artificial Intelligence

Despite the gains offered by conventional DSD, the workflow retains important limitations. Manual landmark placement—identifying reference points on facial photographs for midline, smile arc, gingival levels, and tooth proportions—is time-consuming and operator-dependent, introducing variability that can affect design quality and reproducibility.[2,3] The creative and analytical demands of smile design also require experienced clinicians; delegation to less experienced team members is constrained by the skill threshold involved.

Artificial intelligence is being introduced at multiple points in this workflow to address these constraints. In the literature reviewed here, AI is applied to automated facial landmark detection; 2D and 3D smile simulation and proposal generation; tooth segmentation and region-of-interest extraction from photographic or scan data; tooth shade analysis and color matching; and downstream prosthetic and orthodontic planning components, including tooth morphology prediction and aligner simulation.[1–3] Surveys of dental professionals support the practical rationale: in a cross-sectional study of 320 dental professionals, 68% reported awareness of AI applications in smile design, but only 23% reported implementing AI tools in clinical practice, with 76% citing improved accuracy and 64% citing enhanced patient communication as primary perceived advantages, while barriers included cost, limited training, and restricted access to AI-integrated systems.[5,6]

Artificial intelligence-driven smile design refers to the use of machine learning and computer-vision functions within DSD workflows to automate landmarking, generate or refine smile proposals, and support patient communication through predictive simulations and visualizations.[1,2] AI is discussed both as (1) a set of algorithmic components embedded in DSD and (2) a workflow enabler that changes efficiency and communication rather than autonomously delivering a definitive treatment plan.[2,3]

The current clinical evidence base remains mixed in design and maturity, with much of the published work consisting of small comparative studies, surveys, technical feasibility validations, and case reports, alongside a smaller number of controlled or prospective comparative evaluations and systematic reviews synthesizing heterogeneous primary studies.[1,3–5] A scoping review on AI applications in smile design identified only four included studies from a much larger initial search, illustrating how narrow the direct clinical literature on AI smile design remains when strict inclusion criteria are applied.[5]

Evidence Base

Systematic syntheses suggest that AI-enabled DSD tools can improve esthetic outcomes and satisfaction metrics, but certainty is limited by heterogeneity and bias concerns.[7] In a systematic review and meta-analysis of AI-based DSD, AI tools such as SmileCloud, REBEL, and Invisalign SmileView were reported to improve esthetic outcomes, including smile symmetry, lip arcs, and incisal edge visibility, and the pooled satisfaction prevalence across six studies was 58% (95% confidence interval 0.30–0.86).[7] That same meta-analytic evidence demonstrated substantial between-study heterogeneity and noted participant selection bias as a prominent risk-of-bias domain, limiting the strength and generalizability of pooled conclusions.[7] A separate scoping review concluded that AI-generated smile designs were not significantly different from manually created designs in esthetic perception and that 3D designs were more accurate than 2D designs, but also emphasized the need for more primary studies in the field.[5]

Artificial Intelligence Methods Described in the Clinical Literature

Across reviews of AI in esthetic dentistry and AI-enabled DSD integration, the methods most often described include convolutional neural networks (CNNs) for segmentation and analysis, generative adversarial networks (GANs) for image generation or enhancement, and broader machine-learning approaches such as support vector machines and fuzzy logic in adjacent esthetic tasks.[1,2] In the DSD-specific literature, automation is frequently concentrated on segmentation and tooth-generation elements.[3]

Motion-DSD fine-tuned the Segment, Anything Model using low-rank adaptation modules for facial structure and teeth segmentation, reporting mean Dice coefficients of 0.886 (facial

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dataset) and 0.969 (intraoral dataset) as part of a workflow that transfers an intraoral DSD onto a frontal facial video.[8] For dynamic orthodontic or visualization-related generation, a StyleGAN2-based approach was described for predicting posttreatment outcomes from pretreatment facial photographs, with variable accuracy by facial region and different acceptance across evaluator groups.[9] Other technical pipelines focus on tooth- and mouth-region editing for orthodontic visualization; OrthoGAN reported higher clinician-rated simulation authenticity and image quality than comparator approaches and incorporated pose fitting intended to support tooth-alignment visualization in frontal facial images.[10]

Clinical Workflows and Applications

Artificial intelligence-enabled smile design workflows span static 2D preview generation, 3D planning integration, dynamic video-based simulation, and adjacent esthetic support tasks such as shade selection and tooth arrangement for dentures.[1,3] Narrative reviews emphasize reduced design time, improved interdisciplinary communication, and enhanced patient engagement, while also noting that many supporting studies are qualitative and lack standardized metrics for diagnostic accuracy or outcome predictability.[3] Table 1 shows available platforms and features.

2D Smile Preview and Landmark Automation

A clinically relevant instantiation of AI in DSD is automated landmark selection for facially driven smile design. In an online preference study, smile designs were generated in an "AI mode" vs a "manual mode" in the Smile Designer App, with the AI mode leveraging automated facial-landmark detection [via the Microsoft Face application programming interface (API)], and participants chose which of the two designs was more attractive.[11] This workflow positions AI primarily as an automation layer for reference point identification and tooth repositioning rather than a full restorative-design engine.[11]

3D or Hybrid 2D–3D Integration

A dental technique report described an AI-facilitated workflow in a fully edentulous maxillary case in which a 2D frontal facial photograph was merged with a 3D digitized wax-rim record base to create a facially guided virtual tooth setup and to generate a prototype for prosthetically driven implant planning.[12] This workflow was then used in conjunction with dual-scan cone-beam computed tomography (CBCT) planning and CAD/CAM fabrication steps, illustrating how AI functions can be embedded in broader digital planning and manufacturing pathways.[12]

Dynamic Video-based Simulation

Motion-DSD was explicitly designed to transfer an intraoral DSD onto a frontal facial video under varying expressions, supported by segmentation and an alignment algorithm; the authors reported clinical feasibility while calling for further quantitative validation of simulation accuracy.[8] In orthodontics, Dynasmile was introduced as an AI-driven, video-based smile analysis approach that reduced analysis time to less than 3.5 minutes and reported reliable dentofacial measurements consistent with orthodontic evaluations.[13]

Shade Selection and Esthetic Restorative Support

In a prospective parallel-group comparative study at try-in, an AI-DSD workflow increased the proportion of clinically acceptable shade matches (defined using the CIEDE2000 acceptability threshold) from 70.0% to 85.0% and reduced the mean color difference at try-in (1.42 ± 0.56 vs 1.88 ± 0.72).[14] The AI workflow also shortened chairside selection time (2.9 ± 0.8 vs 4.6 ± 1.2 minutes) and reduced the frequency of shade adjustments (10.0% vs 22.5%).[14]

Tooth Arrangement and Denture Esthetics

An AI-aided tooth arrangement system using a CNN trained on 2,500 clinically validated denture cases was evaluated on 40 edentulous patient datasets and was reported to significantly reduce arrangement time while achieving equal or superior esthetic scores (including midline accuracy and proportional harmony), with comparable lay attractiveness ratings vs conventional digital workflows.[15]

Comparative Clinical Evidence

Across preference and perception studies, clinician and lay responses to AI-generated versus manually crafted designs are not uniform.[16–19] In a cross-sectional preference study using ExoCAD cases, there was no statistically significant preference for AI-generated vs manual designs across cases overall, while manually crafted designs were consistently preferred as a trend; AI acceptance approached ~39% in some scenarios.[19] In another large online preference study focused on landmark automation (AI vs manual landmark selection), dentists generally preferred manually created designs for three cases, while preferences were split in the symmetrical face case depending on prior program use.[11]

Clinical Advantages

When advantages are quantified in comparative studies, the most consistently demonstrated benefit is efficiency. In a prospective paired virtual study, AI reduced mean smile design time from 63.48 ± 14.12 minutes to 30.82 ± 5.14 minutes, corresponding to a 51.46% reduction in planning time.[16] In the video-analysis domain, Dynasmile completed video-based smile analysis in less than 3.5 minutes while producing measurements described as consistent with orthodontic evaluations.[13]

SmileFy's reported mean geometric error difference vs a conventional ExoCAD workflow was 0.29 ± 0.095 mm in an accuracy study, with no significant differences in several anatomy-related categories, suggesting potential noninferiority for certain design output comparisons under study conditions.[17] For shade selection, the AI-DSD approach improved clinically acceptable matching at the try-in and reduced chairside selection time, illustrating an advantage in a task with a clear clinical reference standard.[14] Reviews and case reports repeatedly position AI-enabled DSD as a communication amplifier within interdisciplinary workflows, describing improved interdisciplinary communication and patient engagement alongside workflow efficiency, even though these benefits are often reported qualitatively.[3,20]

Limitations and Risks

A key limitation across many studies is that performance is often validated on simulated or virtual outputs rather than on definitive restorations and long-term clinical outcomes. The prospective paired study of AI vs expert smile design evaluated proposed digital designs in a virtual laboratory setting and did not assess translation to definitive restorations under occlusal, phonetic, biologic, and material constraints.[16] Motion-DSD reports clinical feasibility and segmentation performance but states that further investigations are needed to quantitatively validate simulation accuracy and its advantages over static methods.[8]

Table 1: Showing the available platforms and features

Platform name	*AI capabilities*	*Primary use case*	*Key features*	*Input data required*	*Integration workflow*	*Target users*	*Pricing model*
Allisone[22]	Deep learning/AI analyses 2D dental X-rays (panoramic/periapical), highlights findings with color overlays, provides a "second opinion," generates patient reports; includes implant-identification capability ("Spotimplant")	AI-assisted diagnosis support from X-rays plus patient communication to support treatment acceptance.	AI "second opinion"; 2D X-ray analysis with color highlighting; automated postconsultation patient reports; visual aids (e.g., periodontal line display); implant identification; integration with practice management/radiography software	2D dental X-rays (panoramic, periapical/retroalveolar).	Integrates with radiology and business software to autoupload X-rays; clinician reviews AI visualizations and builds treatment plan in existing software; generates a postconsultation report	Dental practices (private dentists, offices, centers).	Subscription-based; public pricing not consistently disclosed.
ArchForm[23]	AI automation for tooth segmentation from STL scans and initial tooth alignment for clear aligner planning	Orthodontic planning and manufacturing workflow for clear aligners (in-office and enterprise/brands)	Automated segmentation/alignment; browser-based 3D tooth movement editor; staging/attachments/IPR controls; export optimized for 3D printing; enterprise API; optional white-label manufacturing	Intraoral scans (.stl).	Import STL → AI autosegmentation/setup → clinician edits plan → export print-ready files; enterprise API for portal/DB/manufacturing pipeline integration	Orthodontists, dental labs, aligner brands.	Not consistently disclosed publicly
Banuba Dental Tech AR[24]	AR with AI-based face/teeth segmentation to simulate teeth whitening in real time on photos/video	Patient communication/marketing to demonstrate whitening outcomes (remote or chairside)	Real-time whitening simulation; natural-looking results; SDK for mobile/web/desktop; online/offline modes; no special hardware; additional AR features (e.g., face beautification options)	Live video (phone/webcam) or photos.	Integrated via Banuba Face AR SDK into apps (including video consult tools); Banuba provides documentation and code samples	Dental clinics; healthcare app developers; brands integrating AR smile simulation	Trial available; pricing typically usage/MAU-based and quote-driven
Dentrino Leads/API[25]	AI smile simulations from a patient selfie (whitening/ortho/cosmetic modes), designed to preserve nondental facial features; offered as widget and API	Website lead generation for practices (capture contact info, trigger follow-up).	Website widget/landing pages; multiple simulation modes; captures patient contact info prior to showing results; mobile-browser friendly; custom branding; enterprise API	Smiling selfie photo from patient.	Embed widget/landing page on practice website → patient selfie + contact info → simulation displayed → lead routed to CRM/email/automation	Dental practices; DSOs/aligner brands (API/enterprise).	Subscription pricing varies by plan; may include per-lead tiers
Dentrino Reveal (formerly ToothBooth)[26]	AI generates before/after smile simulations for whitening, orthodontic, and cosmetic treatments from a chairside photo; designed for fast turnaround	Chairside iOS app for patient communication and case acceptance.	Multimode simulations; iPhone/iPad workflow; kiosk mode; email/share outputs; designed as "plug-and-play"	Chairside photo (iPhone/iPad).	Standalone iOS app; capture photo → pick mode → generate simulation → discuss/share; no required integration with other dental software	Dental professionals and staff involved in consults	Freemium/subscription; plan/pricing varies by region/app store
Diagnocat[27]	AI analysis of CBCT, panoramic, and intraoral X-rays; can generate reports, highlight findings, and support 3D visualization/segmentation workflows	Diagnostic support, treatment planning support, and patient communication across ortho/implants/restorative contexts.	2D/3D imaging analysis; CBCT segmentation and 3D model generation; reports; visual overlays for patient communication; exports for downstream planning tools; optional PMS integration depending on deployment	CBCT DICOM, panoramic X-rays, intraoral X-rays; optional intraoral scans for superimposition	Upload/transfer imaging → AI report/visualization → review/annotate → export/share; some deployments integrate with PMS for automated transfer	Dental practitioners, clinics, labs.	Subscription tiers and/or quote-based enterprise
Digital Smile Design (DSD)[28]	Digital facial/photo/video analysis for facially-driven smile design; supports 2D/3D simulation and planning services (specific AI methods not always detailed publicly)	Smile design plus interdisciplinary planning and communication workflow (tools + expert services).	DSD App for initial simulation; planning center service; facially-driven protocol; integrated workflow from design to execution; patient communication assets; interdisciplinary case planning	Photos/videos (protocol), intraoral scans (STL), and often CBCT (DICOM) for comprehensive planning; app may start from a single smiling photo.	Start with app → submit records to DSD planning services → receive plan/design outputs and guides; integrates with aligner/CAD ecosystems via exports/workflow steps	Dentists across specialties, especially cosmetic/restorative/ortho; DSD members	App may be free; services/membership are paid (plan-based)

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Platform name	*AI capabilities*	*Primary use case*	*Key features*	*Input data required*	*Integration workflow*	*Target users*	*Pricing model*
DTX Studio Suite (Envista)[29]	AI features for sorting/organizing imaging, fusing CBCT + intraoral scans, tracing nerves/segmenting teeth, and supporting tooth setup/virtual extraction features depending on module	Unified platform for imaging, diagnostics, implant planning, and collaboration.	Unified 2D/3D imaging hub; AI-assisted data prep and findings overlays; implant planning tools; open architecture; patient visualization; cloud sharing/collaboration	DICOM (CBCT/X-ray), STL (intraoral scans), common image formats (JPG/PNG) depending on module	Acts as central workflow hub: import imaging/scans → AI-assisted fusion/segmentation/planning → collaborate/share → export to guides/navigation/workflows as applicable	Dental clinicians, implant-focused practices, DSOs, labs.	Often bundled with equipment and/or subscription modules; public list pricing not consistently disclosed
exocad Smile Creator[30]	AI-assisted facial feature detection/alignment; can generate realistic smile simulation outputs (including video simulation features depending on configuration/services).	2D/3D smile design integrated into restorative CAD workflow (labs/clinics)	In-CAD smile design; AI-assisted facial analysis; simultaneous 2D/3D design; photorealistic previews; report/sharing; downstream manufacturing setup outputs	Patient photos plus 3D scans; optional face scan or short video for certain simulation features	Add-on module within exocad CAD ecosystem; align photos with 3D scans → create setup → use for wax-ups/provisionals/finals; share/export to lab/printing tools	Dental labs, dentists, technicians using exocad.	Sold as module (perpetual or subscription options); some services via credits/subscription
Invisalign Outcome Simulator[31]	Uses 3D modeling/algorithmic simulation based on iTero scan data to visualize potential ortho outcomes chairside	Chairside visualization tool for Invisalign providers, based on iTero scans.	3D simulation from iTero scan; interactive patient communication; used to motivate and explain potential outcomes	iTero intraoral scan/3D model.	Capture scan on iTero → generate simulation → review with patient chairside; workflow depends on Invisalign/iTero ecosystem	Invisalign providers and patients.	Typically included/available within Invisalign/iTero ecosystem; public standalone pricing not consistently disclosed
Invisalign SmileView[32]	AI/proprietary smile-assessment algorithm generates an instant simulation from a single selfie; includes guided capture/standardization	Patient-facing marketing/engagement and lead capture tool to motivate consultations	Generates simulation from selfie; accessed by link/QR/app; guided photo capture; lead captured to Invisalign provider dashboard	Single smiling selfie.	Patient uses link/QR/app → uploads selfie → simulation generated → lead routed to provider system	Prospective patients; Invisalign providers using it for marketing.	Often presented as a provider feature; treatment cost set by provider
Ivoclar IvoSmile/KEYsmile[33]	AR + AI/automation to superimpose treatment previews onto a live "digital mirror" view; supports esthetic/orthodontic preview modes	Consultation/communication tool for real-time virtual previews.	Real-time AR visualization; supports restorative libraries and orthodontic previews; save/share media; web-based free option (KEYsmile) and app (IvoSmile) variants	For ortho previews: compatible intraoral scan (e.g., TRIOS workflow); for esthetics: live photo/video or patient photos depending on mode	Import/transfer scan/photos → generate preview → present in AR; share images/videos; CAD export support varies by product/version	Dental professionals (general/cosmetic/ortho) and labs (via sharing)	Free/basic tiers may exist; advanced features via subscriptions/in-app purchase; pricing varies.
Maestro 3D Smile Creator[34]	Provides facial analysis and design tools; some "AI" features may be marketed but not intended for medical use depending on vendor statements	Smile design and patient/lab communication workflow	2D photo-based design; facial analysis; align 3D scan onto 2D photo; mock-ups; web viewer sharing	2D photos and 3D scan/model data.	Create 2D design → align/extend into 3D project → share via web viewer; third-party integration varies	Dentists, dental technicians.	License- or credit-based options depending on vendor plan

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Platform name	*AI capabilities*	*Primary use case*	*Key features*	*Input data required*	*Integration workflow*	*Target users*	*Pricing model*
Maestro 3D Ortho Studio[35]	AI-based automation for scan correction and automatic tooth segmentation/labeling; supports aligner planning workflow	End-to-end aligner planning module from scan to export.	Scan correction; auto segmentation; virtual setup for movements/IPR/attachments; CBCT crown-root combination options; reports; cloud sharing	STL scans; optional CBCT-derived compatible formats; photos/face scans depending on workflow	Import scan → automated processing/segmentation → plan movements and staging → export models/reports; cloud service for sharing	Orthodontic clinics/teams (exact target audience varies by vendor).	License or pay-per-use/credit-based plans depending on vendor
Medit Orthodontic Suite[36]	AI/ML landmark detection on cephalometric X-rays (optional) plus simulation workflows within Medit ecosystem	Orthodontic simulation for patient consultation and monitoring.	Realistic treatment simulations; multiple treatment options; model management/analysis; progress monitoring; sequential aligner/retainer design support	Intraoral scan (STL); optional cephalometric X-ray.	Runs via Medit Link workflow; receives scan paths/data from Medit Link; optional service integrations depending on deployment	Orthodontic dental professionals using Medit ecosystem.	Not consistently disclosed publicly (often bundled within ecosystem)
Medit Smile Design[37]	AI tools to align photos and apply facial guidelines; supports 2D smile simulation and adjustment tools	2D consultation tool for quick smile simulations and patient engagement.	Photo-based 2D design; template teeth libraries; whitening/braces simulation; auto facial guidelines; measurement tools; before/after views; anonymization/retouching	Full-face 2D photos; optional scans for advanced wax-up workflow	Used within Medit Link; import photos → design → save back to case; export images for downstream 3D design workflows if needed	Dentists and labs using Medit Link.	Often offered free within ecosystem (availability can vary)
Modjaw[38]	Captures/uses motion data and algorithms for jaw-motion processing; some AI-assisted motion processing features depending on platform module	Integrates dynamic jaw motion into digital dentistry for functional diagnosis and design	4D jaw motion capture; mandibular kinematics analysis; collaborative platform features; export to CAD/CAM workflows; functional design support	Intraoral scans (STL/PLY/OBJ), face scan/photos, reference points, recorded mandibular movement sequences.	Capture motion with device → build "digital twin" → process on platform → export to CAD/CAM (e.g., for restoration/ortho design)	Clinicians and labs/technicians.	Not consistently disclosed publicly.
ORCA Dental AI (CephX)[39]	AI automation for cephalometric tracing/analysis; may include CBCT segmentation and image processing depending on product modules	Automate orthodontic diagnostic imaging workflows and analysis.	Automated cephalometric tracing; analysis for 2D/3D; segmentation modules; cloud platform; API/integration with imaging/PMS systems depending on deployment	CBCT DICOM; 2D ceph images; facial images; intraoral scans (varies by module)	Cloud-based workflow; integrates via API/connectors with imaging and practice systems for streamlined submission/results	Orthodontists, DSOs, clinicians, labs, imaging providers	Subscription plans and per-case options depending on vendor
Overjet[40]	Vision AI for dental radiographs (bitewings/periapicals) including detection/quantification features; includes imaging enhancement module and ambient documentation product lines	Radiograph analysis to support diagnostics, administrative automation, and patient communication (primarily clinical/operational)	Radiograph overlays; quantified measurements (e.g., bone levels); imaging enhancement; integration with practice systems; dashboards/analytics	Dental radiographs; may also use PMS data via integration.	Integrates with existing imaging software/PMS; overlays appear in workflow; onboarding includes integration/training/support	Dental providers, practices, DSOs, schools, payers.	Not consistently disclosed publicly; demo/quote common.

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Platform name	AI capabilities	Primary use case	Key features	Input data required	Integration workflow	Target users	Pricing model
Pearl[41]	AI radiologic analysis of 2D X-rays and 3D CBCT imagery; "Second Opinion" products for pathology detection/highlighting and practice intelligence add-ons	Diagnostic support plus workflow/practice operations support.	AI overlays on radiographs; 2D and 3D tools; practice intelligence features; integration with practice management/imaging systems	2D dental X-rays; 3D CBCT depending on module.	Designed to integrate with existing imaging/PMS; AI results presented as overlay within workflow	Dental professionals (solo, DSOs, specialists, educators).	Subscription starting tiers and enterprise options depending on vendor; list pricing may vary
Praxis AI Smile Simulator[42]	AI-based instant before/after simulations for cosmetic treatments (details vary by vendor materials)	Case acceptance tool for cosmetic treatment visualization and booking	Fast simulations; chairside "tablet mode"; sharing; consent/disclaimer capture; CRM/scheduler integration; tracking/reporting	Patient selfie/photo.	Integrates with practice systems/CRM depending on configuration; generates simulation and attaches to record; enables follow-up workflows	Dental practices.	Per-location subscription; public pricing may be listed by vendor
PreVu Dental[43]	AI-based facial/dental analysis to generate personalized smile simulations; includes whitening simulation features	Cosmetic simulation/smile design for patient communication and case acceptance	Multitreatment simulations; fast turnaround; practice-branded printouts/email sharing; unlimited simulations in some plans; team-friendly interface	Patient photos (plus demo photos for practice)	Standalone web-based workflow: take/upload photo → generate simulation → present/share; integrations not always emphasized publicly	Dental professionals in cosmetic/reconstructive practices	Subscription tiers (e.g., whitening-only vs full suite); free trial/demo may be available
Smilecloud (Straumann)[44]	AI-assisted smile planning workflow using facial reference points; can generate proposals and photorealistic video simulations depending on module	Cloud workspace for dentists/technicians to create designs and share with patients/teams	AI-assisted biometric design; before/after video simulation; "Blueprint" stacking of records; cloud collaboration; lab integration; iPad app	Patient portrait photo; optional intraoral scans/CBCT/motion data for advanced planning	Web-based collaborative platform; export/send designs to labs; integrates into broader Straumann digital ecosystem depending on setup	Dentists, technicians, clinicians, educators	Subscription tiers with trials; enterprise options
SmileFy[45]	AI for facial/smile analysis and automated proposal generation; can produce 3D mock-ups/models for production workflows	Treatment planning + in-office smile makeover workflow (simulation → plan → production)	AI simulation + harmony analysis; treatment plan outputs; 3D print-ready models for mock-ups/veneers/temporaries; cloud-based; scanner-agnostic positioning; collaboration features	Portrait photo; for 3D workflows: photo + intraoral scan.	Cloud workflow from simulation to 3D design; export/print for in-office production	Dentists/clinics/DSOs and labs focused on cosmetic/restorative work	Subscription tiers; may be credit-based for certain plan elements
Smilo.ai[46]	AI computer vision screening from smartphone images for oral health indicators; may include whitening assessment and smile simulations; human review component may be included depending on workflow	Screening, education, and virtual consult/triage workflows (not a diagnostic replacement)	Smartphone screening; risk-level reports; conversational chatbot for triage/scheduling; offline-capable web platform; human-in-the-loop review	Smartphone-captured oral images; platform may be trained on de-identified clinical images/records	Web-based platform with potential rapid integration to practice systems; syncs when connectivity available	Clinics, DSOs, insurers, aged care/disability providers, public health systems, patients/families	Not consistently disclosed publicly.
Smile4D.ai[47]	AI autosegmentation of teeth/lips/skin boundaries to generate fast smile previews; can create video animations from static images	Educational visualization for cosmetic case acceptance (chairside and potentially web lead magnet)	Rapid previews; multiple images + video per case; encryption/HIPAA-positioning claims in vendor materials; export/share options; integrations may be "roadmap"	Frontal patient photo.	Upload/import photo → generate preview/video → present/export/share; native PMS integrations may be optional/roadmap	Dental clinicians; lab communication use cases	Subscription + per-case add-ons depending on plan

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Platform name	*AI capabilities*	*Primary use case*	*Key features*	*Input data required*	*Integration workflow*	*Target users*	*Pricing model*
Smile Virtual[48]	Not primarily an AI simulation tool; focuses on virtual consultation workflow (asynchronous review and personalized video consults)	Teledentistry/virtual consult platform for cosmetic practices.	Branded portal; patient submissions; asynchronous video consults; before/after gallery; messaging/widgets; analytics	Patient-uploaded photos and questionnaire responses	Patient submits via portal → dentist records consult video → patient reviews → schedules in-person visit; widget integrates into practice website	Cosmetic dental practices and patients seeking consults	Subscription tiers; public pricing may be listed by vendor
SmileViz[49]	AI-powered image/video simulations of potential cosmetic/ortho outcomes with dentist review/approval workflow	Fast smile simulation platform for chairside or virtual consult use	Image + video simulations; rapid turnaround; clinician approval loop; shareable links; revision allowances depending on product stage	HIPAA-positioned photo upload.	Upload photo → select treatment type → review/approve simulation → optionally share via link; integrations not always stated	Dentists and patients	Credit-based subscription tiers
SmylDesign (by DentView)[50]	AI-generated photorealistic smile previews from a photo with chairside speed; "teeth-only" modifications to preserve facial features	Chairside communication tool to increase cosmetic case acceptance.	Fast previews; presets (whitening/aligners/etc.); teeth-only mode; clinic branding/sharing features depending on plan; image handling/storage controls depending on settings	Single smiling photo (common image formats).	Web-based workflow: upload/capture → pick preset or prompt → generate preview → export/share; integrations not emphasized	Dental professionals and teams	Freemium with paid pro/clinic tiers
SureSmile (Dentsply Sirona)[51]	AI/automation for 3D modeling and segmentation to support orthodontic planning and simulation	Comprehensive orthodontic treatment planning (aligners/wires) with patient simulation module	Planning with aligners/wires; simulator for 3D visualization; staging tools; CBCT compatibility; export for 3D printing depending on workflow; scanner openness varies by module	Intraoral scan (often via DS Core workflow); optional CBCT for certain workflows	Upload scan to DS Core → simulator generates visualization → share with patient → proceed into SureSmile planning/order workflows	Orthodontists and dentists providing aligner therapy.	Requires platform subscription; module pricing not always public
VITA assistedSMILE[52]	AI-assisted facial proportion analysis from photos to support esthetic planning and shade/shape/position adjustments	Web-based smile design tool for dental professionals	Photo-based design; proportion analysis; adjustment controls; export to CAD/CAM ecosystems	Patient photos (frontal/profile).	Web-based workflow; export designs to CAD/CAM (e.g., common dental CAD environments) depending on configuration	Dentists and labs	Free (as positioned by vendor materials)
VITA mobileAssist+[53]	Recognizes dental arch from a photo and simulates bleaching outcomes; can pair with shade measurement device data depending on workflow	Mobile app for shade communication and whitening simulation	Bleaching simulation; shade info display; device connectivity options; before/after view; sharing	Patient photo; optional shade measurement results from compatible device	Shade device sends data to app (when used) → combine with patient photo → simulate outcome → share	Dentists, labs, patients (communication)	Not consistently disclosed publicly
WebCeph[54]	AI-driven cephalometric landmark detection and analysis; includes superimposition and simulation features depending on module	Web-based ortho/orthognathic analysis and patient communication.	Automated cephalometric tracing; VTO/STO simulations; superimposition; analysis tools; STL viewer; reporting/presentation modes; companion app options	2D images (X-ray/CT-derived images) and 3D STL models depending on module.	Web-based platform (no local install); upload images/models → run analysis/simulation → generate reports; companion mobile app for communication may be available	Dental professionals, especially orthodontists/orthognathic teams	Subscription tiers (free + paid levels)

AI, artificial intelligence; API, application programming interface; AR, augmented reality; CAD/CAM, computer-aided design/computer-aided manufacturing; CBCT, cone-beam computed tomography; CRM, customer relationship management; CT, computed tomography; DB, database; DSOs, dental service organizations; HIPAA, Health Insurance Portability and Accountability Act; IPR, interproximal reduction; JPG, Joint Photographic Experts Group; MAU, monthly active users; ML, machine learning; OBJ, object file; PLY, polygon file format; PMS, practice management system; PNG, Portable Network Graphics; QR, quick response; SDK, software development kit; STL, standard tessellation language; STO, surgical treatment objective; VTO, visual treatment objective

Generalizability and bias issues are emphasized at the evidence-synthesis level. Meta-analytic evidence on satisfaction and esthetic outcomes reports substantial heterogeneity and flags participant-selection bias as a key risk-of-bias domain.[7] Reviews also highlight that algorithmic bias may arise from underrepresentation of diverse populations and that patient-centered outcomes remain underresearched compared with technical accuracy and procedural efficiency endpoints.[1]

A study assessing SmileView realism notes that the use of two-dimensional images limits precision, that dental proportions can be inaccurate when teeth are not properly aligned, and that 2D cannot capture the depth implied by a U-shaped arch; real-world use of a mobile phone front camera may also introduce variable angles relative to study conditions.[21] The shade-selection comparative trial similarly notes that generalizability depends on standardized acquisition (lighting, cross-polarization, and white balance) because the AI pipeline was trained and validated on the local imaging protocol.[14]

Ethical and governance considerations described in esthetic dentistry reviews include data privacy constraints on sharing high-quality datasets, limited transparency of "black box" models, and cost barriers that may widen disparities in access to advanced AI-integrated digital systems.[1,3]

Implementation Realities

Survey evidence indicates that awareness does not reliably translate into clinical adoption. In a cross-sectional survey of 320 dental professionals, 68% reported awareness of AI applications in smile design, but only 23% reported implementing AI tools in clinical practice; barriers included cost, lack of training, and limited access to AI-integrated systems.[6] The same survey respondents most often cited improved accuracy (76%) and improved patient communication (64%) as perceived advantages, consistent with how narrative reviews frame AI-enabled DSD as a tool for efficiency and engagement.[3,6]

Practical Clinical Guidance

The most defensible current role for AI-driven smile design is as a decision-support and communication layer that can accelerate preliminary proposals, automate measurement tasks, and facilitate shared decision-making, rather than as an autonomous generator of definitive restorations or orthodontic outcomes.[1,3] When AI is used for pretreatment simulation (e.g., SmileView), clinicians should explicitly counsel patients that simulations are not definitive treatment plans because simulation predictability varies by parameter and may be limited for qualitative elements such as smile arc and lower incisor exposure.[18,21]

Where AI is used for esthetic proposal generation, the evidence supports treating the outputs as a starting point to be checked against biologic and functional constraints and refined in hybrid workflows because fully automated outputs have usually been studied without clinician refinement, and virtual evaluations do not confirm outcomes after restoration fabrication and delivery.[16] Clinicians adopting AI-supported shade selection should prioritize standardized photographic protocols and consistent device calibration when the AI pipeline depends on specific imaging conditions, and should interpret improvements at try-in as short-term endpoints that do not guarantee postcementation or long-term esthetic success.[14]

Future directions emphasize the need for more high-quality prospective studies and longer follow-up that link AI-generated previews and proposals to delivered restorations and patient-centered outcomes, along with multicenter validation that tests robustness across varied imaging conditions and more diverse populations.[1,7,14] Implementation planning should include training and resource assessments because cost and lack of training are reported barriers among dental professionals, and broader reviews caution that affordability and access issues may widen disparities.[1,6] Where AI is used for patient-facing previews, clinicians should explicitly frame outputs as decision aids to support shared decision-making rather than guarantees of outcomes, aligning with the literature's emphasis on visualization benefits alongside validation gaps and subjectivity in esthetic perception.[1,3]

Conclusion

The evidence is predominantly composed of small prospective studies, cross-sectional surveys, and technical validations; no randomized controlled trials with esthetic outcomes as primary endpoints were identified. AI-driven smile design tools currently function best as visualization and communication adjuncts requiring active clinician oversight. Shade selection and automated landmark detection show the strongest comparative clinical validation to date. Autonomous AI smile design has not been validated for routine independent clinical use. Standardized randomized trials measuring delivered restoration outcomes, patient-reported experience, and long-term stability are needed before broader adoption recommendations can be made.

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Author Contributions

ZP conceptualized and designed the study, coordinated the overall review process, and served as the corresponding author. Team 1 (NY, HKR, AP) was responsible for literature search, data extraction, and drafting of the initial manuscript. Team 2 (SO, RT, HDT) contributed to critical analysis, synthesis of evidence, and refinement of the narrative structure. ZP supervised both teams, provided intellectual input, and finalized the manuscript.

All authors reviewed and approved the final version of the article.

AI Use Declaration

No AI tools were used in the preparation of this manuscript.

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