align education

Rethinking clinical imaging in orthodontic practices: workflow efficiency observations from a multi-site pilot.

Real-world observations from a multi-site Smile Doctors pilot with the Invisalign® Practice App and iTero Lumina™ intraoral scanner.

Dr. Zach Casagrande received his Doctor of Dental Surgery, Master of Science, and his orthodontic degree from the Medical College of Virginia (MCV). He remains part of the Medical College of Virginia as a professor in the Department of Orthodontics teaching advanced Invisalign techniques and practice management to the residents. He is the founder of Northern Virginia Orthodontics in Ashburn, Reston, One Loudoun, and Tysons Corner, Virginia. Dr. Casagrande serves as the Clinical Director of Aligners for Smile Doctors working with hundreds of Smile Doctors clinics, educating doctors and their teams on best practices and systems.

Dr. Farah Kar is a proud Iranian, Canadian, American orthodontist. She attended the University of Minnesota School of Dentistry for her DDS and Master of Science degree and Certificate of Orthodontics. She is double-board certified and a Diplomat of the American Board of Orthodontics and Royal College of Dentists of Canada. Dr. Kar has been an Invisalign certified orthodontist since 2014 and an Invisalign Diamond Plus Provider who has treated over 4,000 cases. She enjoys merging her background in fine arts, architecture, and project management with practicing orthodontics efficiently and with flare! Check out Dr. Kar's Instagram for a snapshot of her life as an orthodontist: @the.ortho.queen

Dr. Joshua Adcox is passionate about creating confident smiles and making orthodontic care a positive, personalized experience. After earning his Doctorate of Dental Surgery from the University of Southern California and completing his orthodontic specialty training at Vanderbilt University, Dr. Adcox has continued to blend clinical expertise with the latest technology to give patients the very best. A board-certified orthodontist, Dr. Adcox has also played a leadership role in advancing remote orthodontic care nationwide, helping orthodontists deliver treatment that's both more convenient and effective. At True Smile Orthodontics, his focus is simple: providing exceptional orthodontic care while making patients feel comfortable and cared for every step of the way. When he's not in the office, you'll likely find Dr. Adcox spending time with his wife, Jamie, and their five kids, enjoying the outdoors, surfing, or testing out a new recipe on his smoker. He's also a self-proclaimed "lawn perfectionist" who takes pride in keeping those yard stripes picture-perfect.

Dr. Estee Wang is a board-certified orthodontist and founder of Lakes Orthodontics in Shoreview and Maplewood, Minnesota. A California native, she earned degrees in Molecular Cell Biology and French Literature from University of California, Berkeley before completing her dental training at Harvard. She later earned her Master's and orthodontic specialty from the University of Michigan. Dr. Wang is certified by the American Board of Orthodontists and has been recognized as a national speaker in many areas of orthodontics including craniofacial growth, MARPE treatment, airway, digital workflows, and complex aligner cases. She has taught at the University of Minnesota and the Mayo Clinic and holds leadership roles in state and regional orthodontic organizations.

Dr. Dan Lil has been a specializing in orthodontics since 2003 and currently has practices in Winchester and Front Royal, VA that are nearly 90% digital. His passion lies in creating life-changing smile transformations unmatched in the orthodontic community using the latest techniques with aligners. He's considered a top global Invisalign provider and early adopter having treated 10K successful comprehensive cases including 1500 First patients. He enjoys the challenge of cases that others would not treat with plastic while providing a great experience across all age groups. Building relationships with patients through their orthodontic journey provides drive to do the best for them and inspire a creation of their own smile story to #BeMore in life.

Introduction

At the core of orthodontic profitability lies a straightforward principle: the more efficiently a practice can move patients through the clinical workflow without compromising care quality, the greater its capacity to improve operational efficiency within existing clinical workflows. This is especially true in the dominant parallel-chair operating model, where a single orthodontist supervises multiple treatment stations staffed by clinical assistants, and scheduling efficiency determines whether the practice is operating at its revenue potential or leaving capacity on the table[1,2]. Even small per-appointment inefficiencies, measured in minutes, add up to a meaningful reduction in clinical capacity when multiplied across a full day of patients, across multiple locations, and across months of operation.

The biennial JCO Orthodontic Practice Study, conducted since 1981, has tracked the financial dynamics of U.S. orthodontic practices for over four decades[3]. In the most recent survey cycle, the JCO 2023 study reported a median overhead rate of 56%, while the Levin 2024 survey reported 55.5% overhead and 44.5% net profit[4]. However, this margin has been under sustained pressure: staffing costs rose roughly 10% year-over-year, total overhead increased 5–6% annually, driven primarily by labor costs and supply chain inflation, and in 2022, nearly half (49%) of surveyed practices reported declining profitability[5]. Levin emphasized that while production is the most commonly tracked metric, profit- not production-is the true indicator of financial health, since a practice can grow production while simultaneously losing income if overhead rises faster[2,4].

Against this backdrop, the adoption of advanced technologies has become a defining characteristic of high-performing orthodontic practices. Digital workflows, including intraoral scanners, CAD/CAM appliance design, remote monitoring platforms, and cloud-based practice management systems, have been described in the literature as shortening chair time, reducing dependence on manual skill, improving consistency and reproducibility, and enabling practices to do more with fewer steps[6,7]. In the authors' assessment, the most impactful technologies are those that consolidate what were previously separate, sequential tasks into a single integrated step. When technology replaces not only an instrument but also the workflow around it: training, setup, capture, transfer, storage- the cumulative efficiency gain can be substantial.

This paper examines one such workflow transformation: the transition from conventional DSLR-based clinical photography to a digital imaging workflow enabled by the iTero Lumina™ intraoral scanner and the Invisalign® Practice App. It quantifies the operational burden of the traditional photographic workflow, describes the enabling technologies, and presents real-world data from a multi-site pilot conducted by Smile Doctors, one of the largest orthodontic support organizations in the United States. The pilot observed an association between implementation of the workflow and changes in new patient examination capacity.

The hidden cost of DSLR-based clinical photography

Association observed between workflow adoption and new patient examination (NPE) capacity within the parallel-chair model. Each NPE represents a potential case start, and the number of NPE slots available per production day is a key performance indicator for practice growth[1,2]. Any workflow step that consumes unnecessary chair time, however routine, compounds into measurable revenue erosion across days, months, and locations. Technology that shortens chair time has been recognized as a practical way to increase practice capacity, as it enables practices to increase throughput without proportionally increasing fixed costs[1,2,6].

Clinical photography is integral to orthodontic documentation, supporting diagnosis, treatment planning, progress monitoring, patient communication, and medico-legal protection[8-11]. A standard initial record set typically requires eight or more views (extraoral and intraoral), captured at multiple milestones throughout treatment[12,13]. In a recent nationwide survey of 304 orthodontists in Spain, 68% reported using DSLR cameras with macro lenses and ring flashes as their primary equipment, and 76% expressed interest in additional photography training, underscoring the technical demands of achieving consistent quality[14]. The DSLR workflow imposes a cumulative operational burden that is rarely quantified at the practice level:

Equipment cost and maintenance. A professional DSLR body, 100 mm macro lens, ring flash, intraoral mirrors, and cheek retractors represent a dedicated set of equipment for each operatory, alongside ongoing maintenance and replacement requirements[10,13,15].

Operator training and variability. Each team member must master manual exposure settings (small apertures to achieve intraoral depth of field, wider apertures for extraoral portraits), macro focusing, flash configuration, mirror insertion technique, and fog prevention, skills that degrade without regular practice and vary significantly across experience levels[13,15]. Sandler et al. (2009) found that while all three groups: orthodontists, professional photographers, and auxiliaries, produced clinically acceptable photographs, orthodontists achieved a significantly higher proportion of optimal-quality intraoral images ($P = 0.046$), suggesting that operator experience influences consistency at the highest quality tier[16].

Chair-time consumption. Each intraoral view requires mirror insertion, soft-tissue retraction, patient positioning, fog management, focus acquisition, capture, and quality verification. A multi-step sequence repeated for every view. Extraoral photographs require background setup, patient repositioning, and precise Frankfort horizontal alignment[12,13,17]. Across a full set of eight or more views, these steps add meaningful cumulative chairside time per patient[13].

Post-capture workflow. Images must be transferred from the camera's memory card to a workstation, renamed according to the practice's filing convention, uploaded into the patient management system, and quality checked. This administrative sequence adds time per patient and introduces opportunities for mislabeling, misassignment, or data loss. Unlike scanner-based data that flows directly into the digital patient record, DSLR photographs exist as disconnected files that require manual integration into the clinical workflow[18].

A streamlined alternative: iTero Lumina™ intraoral scanner and the Invisalign® Practice App

The workflow evaluated in the Smile Doctors pilot uses two complementary digital tools that address the extraoral and intraoral components of clinical imaging simultaneously.

The Invisalign® Practice App (IPA) is a smartphone application, available on both iOS and Android platforms, that enables standardized extraoral photograph capture for use with AI-based smile visualization[19]. During image acquisition, the app displays on-screen prompts- head orientation,

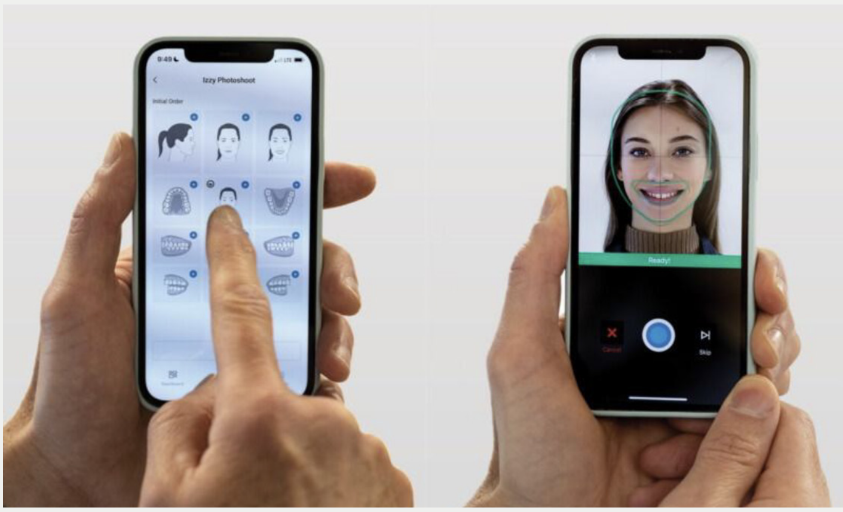

Figure 1: The Invisalign® Practice App (IPA) workflow for standardized photographic capture. Left: Photo selection interface displaying the required set of views. Right: Guided image capture screen showing on-screen facial-alignment markers and a "Ready" indicator confirming that patient positioning meets acceptance criteria prior to image acquisition.

smile orientation, and face orientation markers- that indicate to the clinician or trained staff when the patient's posturing is appropriate for capture. The underlying algorithm uses these facial markers to standardize smile posture across photographs for a given patient, and the app additionally provides built-in adjustments for lighting[19]. The result is a standardized image set acquired under guided conditions, rather than one dependent on the operator's manual camera settings, positioning judgment, and lighting control *(figure 1)*.

The iTero Lumina™ intraoral scanner utilizes the iTero Multi-Direct Capture™ (MDC) technology, an architecture featuring six cameras and five projectors at the wand tip that generates a wider field of view while maintaining a wand half the size of the previous generation[20,21]. Beyond capturing the three-dimensional model used for treatment planning, the scanner's texture mapping technology captures high-fidelity color information during the scan, projecting photorealistic surface color and texture onto the digital model[20] *(figure 2)*. The texture mapping process in the iTero Lumina™ scanner begins during the intraoral 3D scan, in which hundreds of individual color images are captured simultaneously to the 3D surface topographical data collection. These images are acquired at very short working distances, resulting in high object-space resolution.

For each region of the scan, a subset of the most suitable images is selected for texture mapping. The algorithm for image selection is based on optimal distance, viewing angle, and image quality from the available captures covering that region.

Once the images are selected, they are accurately projected onto the 3D mesh. The camera pose relative to the mesh is estimated using the positions of neighboring structured-light frames, which are captured within approximately 15 milliseconds of the color images. Camera position is derived by interpolating between structured-light poses and incorporating motion estimation, enabling precise alignment between image data and surface geometry.

After projection, overlapping images are blended to form a seamless texture map. This blending compensates for radiometric differences caused by variations in illumination, angle, and distance, and reduces the impact of specular reflections.

The resulting texture-mapped mesh provides high-quality visual detail across all viewing directions. The final image presented to the user is a rendering of this textured 3D surface from any desired viewpoint, enabling visualization of the textured 3D model from angles that are limited with conventional external DSLR photography[22].

Together, these two tools consolidate what was previously a multi-instrument, multi-step photographic workflow into an integrated digital process. The scan simultaneously captures the 3D model and the intraoral images; the app captures the extraoral photographs with guided quality assurance. All images flow directly into the patient record, rather than passing through the manual transfer, renaming, upload, and quality-check steps that characterize the conventional DSLR workflow.

Measurable gain: multi-site observations

Smile Doctors, one of the largest orthodontic support organizations in the United States, deployed iTero Lumina™ scanners and the Invisalign® Practice App workflow across 11 clinic locations spanning five regional teams in Virginia, Texas, Minnesota, and Georgia, beginning September 2024.

Practice productivity was assessed as NPE slots per production day,

Figure 2: Representative illustration of intraoral photographs and their corresponding IOS images. The top row shows the standard five-view intraoral photographic series captured with a DSLR camera. The bottom row presents the corresponding set of intraoral scan images of the same views, rendered from the texture-mapped three-dimensional model.

comparing a DSLR baseline period (trailing 12-month average ending July 2024) with the aggregated post-iTero Lumina™ period (September 2024 through March 2025). Across the 11 available locations, mean NPE slots per production day increased from 12.98 at baseline to 15.00 after implementation, an absolute gain of 2.02 NPE slots per production day and a relative increase of 15.3%. Eight of 11 locations (72.7%) improved. At the team level, descriptive gains were observed in Northern Virginia (+33.4%), Winchester-Front Royal (+29.7%), and Harker Heights-Copperas Cove (+7.9%), while Shoreview-Maplewood (-1.3%) and Woodstock-Canton (-2.2%) were essentially flat to slightly lower. Neither of these two decreases reached statistical significance in the per-location analysis, so both locations are best characterized as essentially unchanged rather than as true declines. According to Dr. Zachary Casagrande, Clinical Director of Aligners for Smile Doctors, the minor shortfalls at these locations reflected local operational factors, for example staff vacation or scheduling circumstances outside the scan process rather than any difficulty adopting the scanner or application. He further noted that the iTero Lumina™ scanner with IPA process is more efficient than the DSLR workflow.

Because locations were nested within doctor/team clusters, the primary inferential analysis used a mixed-effects model with location nested within team. In this model, the post-iTero Lumina™ period was associated with an increase of 2.024 NPE slots per production day (SE 0.881; $p = 0.0222$). The 95% confidence interval for the treatment effect was 0.298 to 3.751 NPE slots per production day, and the standardized effect size was large (Cohen $d = 0.98$). The intraclass correlation coefficient was 90.6%, indicating substantial clustering by team and location and supporting the use of a hierarchical model. Exploratory aggregated doctor-level analyses showed heterogeneous effects across clusters. Adcox demonstrated a statistically significant improvement (+0.85 NPE slots per production day; $p = 0.0050$), while Casagrande (+5.58; $p = 0.0551$) and DeArment/Lill (+2.27; $p = 0.0620$) showed positive directional effects that approached significance. Wang (-0.18; $p = 0.7003$) and Kar/Sweeney (-0.18; $p = 0.8292$) did not show improvement.

Taken together, these results indicate that the transition from DSLR photography to the iTero Lumina™ scanner plus Invisalign® Practice App workflow was associated with an increase in NPE capacity across the Smile Doctors pilot network.

Implications and next steps

In an environment of rising overhead and constrained margins[4,5,23], the Smile Doctors data suggest that transitioning from the DSLR workflow to a guided-app and scanner-based imaging workflow was associated with a measurable increase in NPE capacity. In the pilot, this workflow change was implemented without additional staff or extended operating hours, while supporting a more integrated digital documentation workflow. For practices operating the parallel-chair model[1,2], these observations point to a potential workflow optimization opportunity; operational outcomes may differ among practices.

These findings should be interpreted within the context of a real-world, single-arm pre-post pilot evaluation. As such, they provide practice-based observations regarding the integrated workflow that warrant further validation. Future prospective studies should expand the analysis across additional sites, include comparator groups, and incorporate formal time-and-motion and economic assessments to confirm the magnitude of the workflow impact and better quantify its patient- and practice-level value.

Funding and support: Research supported by the Align Technology Collaborative Research Program.

This research was supported by Align Technology, Inc. In the form of technical support and statistical analysis support.

Disclaimer: Results are based on a retrospective pilot evaluation conducted within selected Smile Doctors locations. Outcomes may not be representative of all practices. Individual results may vary.

1. Levin RP. How orthodontic practices leak revenue and miss growth targets. Orthodontic Products. 2025. Available at:https://orthodonticproductsonline.com/practice-management/business-development/how-orthodontic-practices-leak-revenue-and-miss-growth-targets/
2. Levin RP. 7 questions and answers to increase practice profitability. Orthodontic Products. 2023. Available at: https://orthodonticproductsonline.com/practice-management/business-development/7-questions-and-answers-to-increase-practice-profitability/
3. Kravitz ND, Vogels DS III, Vogels PB. 2023 JCO orthodontic practice study. Part 1: Trends. J Clin Orthod. 2023;57(10):567–584.
4. Levin RP. Findings from the 2024 orthodontic practice survey. Orthodontic Products. 2025. Available at: https://orthodonticproductsonline.com/practice-management/business-development/findings-from-the-2024-orthodontic-practice-survey/
5. Levin RP. 2022 orthodontic practice performance survey. Orthodontic Products. 2023. Available at: https://orthodonticproductsonline.com/practice-management/business-development/2022-orthodontic-practice-performance-survey/
6. Cunha TMA, Barbosa IS, Palma KK. Orthodontic digital workflow: devices and clinical applications. Dental Press J Orthod. 2021;26(6):e21spe6.
7. Cattaneo PM, Cornelis MA. Digital workflows in orthodontic postgraduate training. Semin Orthod. 2023;29(1):4–10.
8. Galante DL. History and current use of clinical photography in orthodontics. J Calif Dent Assoc. 2009;37(3):173–174.
9. Pani S. A review on clinical digital photography. Int J Appl Res. 2017;3(7):10–17.
10. Wander P, Ireland RS. Dental photography in record keeping and litigation. Br Dent J. 2014;217(3):133–137.
11. Alam MK, et al. Impact of portraiture photography on orthodontic treatment: a systematic review and meta-analysis. Cureus. 2023;15(10):e48054.
12. American Board of Orthodontics. ABO case report assembly notebook: ideal photographs and radiographs. 2016.
13. Goodchild JH, Donaldson M. Getting the right shots! Tips and tricks for consistent photographic excellence. Dent Today. 2013;32(1):112–118.
14. Suárez-Solís B, Suárez-Fernández C, Suárez-Solís J, et al. Clinical photography in orthodontic practice: insights from a nationwide survey in Spain. J Clin Med. 2025;14(6):1984.
15. McKeown HF, Murray AM, Sandler PJ. How to avoid common errors in clinical photography. J Orthod. 2005;32(1):43–54.
16. Sandler J, et al. Quality of clinical photographs taken by orthodontists, professional photographers, and orthodontic auxiliaries. Am J Orthod Dentofacial Orthop. 2009;135(5):657–662.
17. Shahrul AI, et al. Technique for orthodontic clinical photographs using a smartphone. Int J Dent. 2022;2022:2811684.
18. Stieber JC, Nelson T, Huebner CE. Considerations for use of dental photography and electronic media in dental education and clinical practice. J Dent Educ. 2015;79(4):432–438
19. Adel SM, Bichu YM, Pandian SM, Sabouni W, Shah C, Vaiid N. Clinical audit of an artificial intelligence (AI) empowered smile simulation system: a prospective clinical trial. Sci Rep. 2024;14(1):19385.
20. Align Technology. Align Technology announces new iTero Lumina™ intraoral scanner. Press Release. 2024.
21. Boschken D. iTero Lumina™ scanner - a new technology in intraoral scanners transforming practices and people's smiles. White Paper. 2024;1–4.
22. iTero Lumina™ Texture Mapping- Mode of Operation. Memo to file at Align Technology, as of March 30, 2026
23. Levin RP. 2021 orthodontic practice performance survey. Orthodontic Products. 2022. Available at: https://orthodonticproductsonline.com/practice-management/business-development/2021-orthodontic-practice-performance-survey/

The opinions expressed in this publication are those of the author and may not reflect those of Align Technology, Inc. The authors were paid an honorarium by Align Technology, Inc. in connection with this publication.

align education