

**THE EFFECTIVENESS OF SURESMILE TECHNOLOGY TO ACHIEVE  
PREDICTED TREATMENT OUTCOME**

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## **Abstract**

**INTRODUCTION:** The present study evaluated the effectiveness of SureSmile technology when used as an adjunctive tool in orthodontic treatment. The study was designed to evaluate the effectiveness of SureSmile archwires to produce the final tooth position prescribed by the SureSmile virtual treatment plan. **METHODS:** Digital models of the SureSmile virtual treatment plan and final treatment outcome were digitally superimposed to determine areas of discrepancy. Discrepancy less than 0.5 mm with respect to mesial-distal, facial-lingual, vertical dimensions, and discrepancy less than 2 degrees for crown torque, crown tip, and crown rotation were considered to be clinically acceptable. **RESULTS:** Discrepancy was within clinically acceptable limits with respect to the mesial-distal dimension for all teeth except upper 2<sup>nd</sup> molars and upper lateral incisors. In the facial-lingual dimension, clinically acceptable results were observed for upper canines and lateral incisors, lower 1<sup>st</sup> molars, lower 1<sup>st</sup> and 2<sup>nd</sup> premolars, and lower canines. Discrepancy in the vertical dimension was minimal with only lower 2<sup>nd</sup> molars exceeding clinically acceptable limits. Discrepancy exceeded clinically acceptable levels for crown torque, crown tip, and crown rotation with the exception of crown torque on lower 2<sup>nd</sup> premolars and crown tip on lower 1<sup>st</sup> molars and lower 2<sup>nd</sup> premolars. **CONCLUSION:** The effectiveness of SureSmile treatment to achieve predicted final tooth position is highly variable for tooth type and dimension of movement.

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## **Introduction**

Advances in three-dimensional (3D) imaging techniques and CAD/CAM technology have catalyzed new approaches to dental treatment. In orthodontics, advances in 3D imaging have led to the development of digital model systems. Digital systems allow linear measurements, space analysis, and tooth size measurements.<sup>1</sup> Numerous studies have shown digital models to be equally effective for routine orthodontic diagnosis and treatment planning and equivalent levels of accuracy compared to plaster models.<sup>2,3,4</sup> Recently, digital model analysis software has been utilized to evaluate 3D tooth movement. Using mathematical superimposition of pre and post-treatment records, it has become possible to quantitatively describe treatment changes<sup>5</sup> and thus aid in precise virtual treatment planning.<sup>6,7</sup>

Like traditional plaster models, which can be segmented and manipulated to simulate an ideal treatment outcome, digital models allow the clinician to digitally set-up a virtual treatment plan. Computer-aided manufacturing has been combined with digital model technology in several systems which utilize virtual treatment plan data to manufacture customized orthodontic appliances designed to produce the orthodontic tooth movements prescribed in the virtual treatment plan.

Invisalign (Align Technology, Santa Clara, CA) utilizes a digital model of the patient's dentition constructed from a vinyl polysiloxane (VPS) impression. Using Align's ClinCheck software, the treating doctor develops a virtual plan for the expected clinical outcome, which Align then uses to fabricate a series of plastic aligners to be worn by the patient to achieve tooth movements prescribed in the treatment plan. The Invisalign system has become an increasingly popular

choice for patients due to the comfort and esthetics of removable aligners compared to fixed appliance treatment.

Other systems have been developed which use digital models and virtual treatment planning to manufacture customized fixed appliances. For example, Insignia (Ormco, Orange, CA) allows the orthodontist to create a virtual model of the expected treatment outcome, then manufactures a fully-customized fixed appliance system including brackets, indirect bonding jigs, and archwires designed to generate the tooth movements prescribed by the virtual treatment plan.<sup>8</sup> Similar to Insignia, SureSmile (Orametrix, Richardson, TX), utilizes digital models and virtual treatment planning to manufacture customized archwires that contain prescription wire bends designed to align the patient's teeth according to the virtual treatment plan.<sup>9</sup>

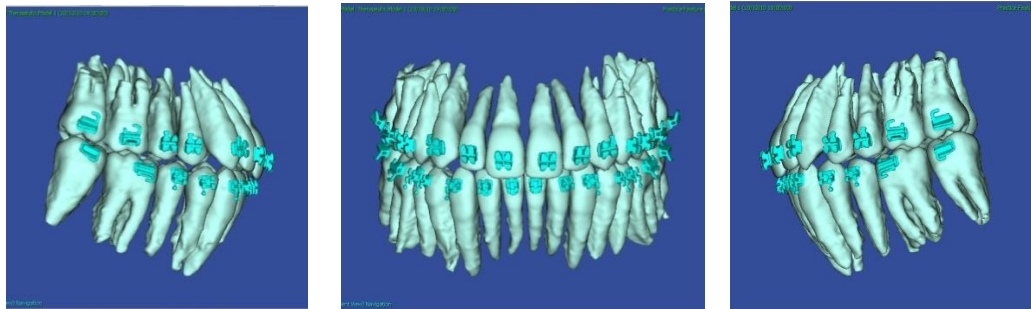
SureSmile is marketed to orthodontists as providing "powerful tools to deliver consistent, high-quality care to all patients, regardless of practice volume."<sup>10</sup> SureSmile is touted to substantially reduce common errors of fixed appliance treatment, increase clinical efficiency, reduce the number of adjustment visits required for each patient, and reduce overall treatment time. Since SureSmile utilizes standard treatment mechanics and most conventional orthodontic bracket systems, implementation of the system only requires learning to operate the software package efficiently.<sup>9</sup>

### **The SureSmile Process**

Orthodontic treatment using SureSmile technology begins similarly to conventional fixed appliance treatment. The SureSmile system utilizes conventional brackets and bands and requires no special considerations during appliance placement. Patients begin the SureSmile process any time after appliance placement with the creation of a digital model of the patient's dentition.

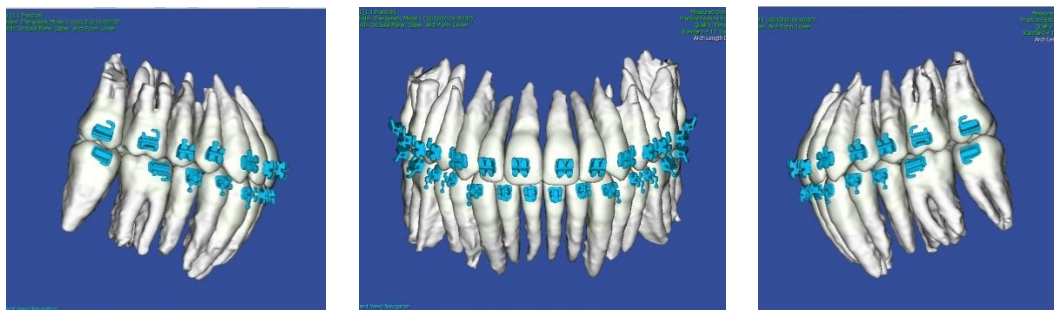


Data obtained from cone beam CT imaging or SureSmile's intra-oral optical scanner, the OraScanner, is used to construct a 3D model of the patient's dentition and location of the orthodontic bracket on each individual tooth, called the therapeutic model (Figure 1).



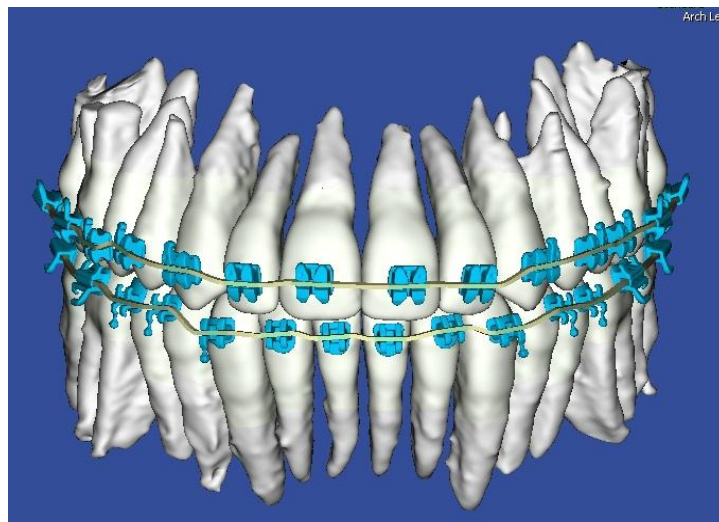
**Figure 1.** SureSmile therapeutic model

The orthodontist uses the therapeutic model to simulate the final position of each individual tooth and create a virtual plan of the expected treatment outcome (Figure 2).



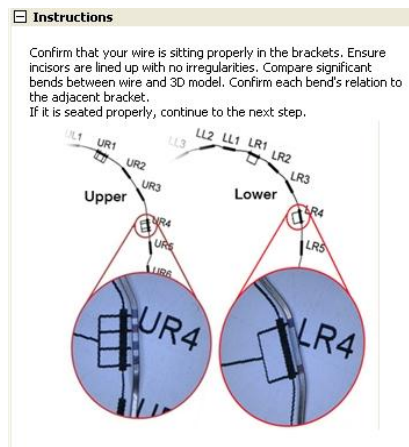
**Figure 2.** SureSmile virtual treatment plan

Based on the position of the bracket slot on each individual tooth, the SureSmile software calculates the archwire bends necessary to move the patient's teeth to the final position dictated by the virtual treatment plan (Figure 3). After approval by the treating orthodontist, SureSmile uses robotic technology to fabricate an archwire with the necessary geometry to complete orthodontic treatment.



**Figure 3.** SureSmile prescription archwire

SureSmile custom archwires are placed in the patient's braces according to a specific orientation specified by the archwire prescription (Figure 4). Orthodontic treatment is monitored by the orthodontist and often includes use of auxiliary mechanics such as elastic chains and inter-arch elastics. The SureSmile archwire is designed to contain all necessary wire bends to align the patient's teeth according to the SureSmile virtual treatment plan.



**Figure 4.** Archwire insertion instructions

## Review of Current Literature

Current publications regarding the use of SureSmile include mainly case reports and editorial commentaries published by orthodontists using the technology.<sup>11,10</sup> Published case reports suggest shorter treatment times and more precise appliance control than manual wire bending.<sup>12</sup> According to an editorial published by the Chief Clinical Officer of Orametrix, Inc., greater clinical efficiency, reduced errors of treatment planning, and enhanced patient communication can be expected.<sup>11</sup> Editorial commentary even promotes reduced stress for the clinician due to the predictability of the SureSmile process.<sup>12</sup> However, case reports also describe a substantial increase in clinic overhead due to fees associated with utilization of SureSmile technology.<sup>12</sup>

At the present time, very few studies designed to evaluate the efficiency and effectiveness of SureSmile treatment have been published. In a 2010 report, Saxe *et. al.*<sup>13</sup> compare clinical outcomes of cases treated using SureSmile with cases treated using conventional fixed appliances. The study included 62 consecutively treated cases, of which 38 were treated using SureSmile and 24 treated using conventional fixed appliances; however, the patient selection methods and distribution among treating orthodontists is unknown. Final treatment outcomes were evaluated using the American Board of Orthodontics Objective Grading System (OGS), a tool developed to objectively evaluate the quality of orthodontic treatment. When compared to conventional fixed appliances, Saxe *et. al.* found a 4.4 point reduction in final OGS scores for cases treated with SureSmile compared to traditional mechanics (26.3 vs. 30.7). Significantly lower OGS scores, which indicate a higher quality final treatment outcome, were observed in OGS categories including maxillary rotations, maxillary marginal ridges, and maxillary buccal-lingual inclination. In addition, cases treated using SureSmile were found to have lower OGS scores for right side overjet and left side interproximal contacts; however, the authors offer no

explanation for this unilateral observation. Furthermore, a significant 5.3 month reduction in total treatment time was observed for cases treated with SureSmile<sup>13</sup>.

Most recently, a similar study published by Alford *et. al.*<sup>14</sup> found that treatment time when using SureSmile was significantly reduced by approximately 7 months. A strong trend of lower OGS scores for cases treated using SureSmile was observed; however, in contrast to the reports by Saxe *et. al.*, this finding did not reach statistical significance. Cases finished with SureSmile did show significantly reduced OGS scores for alignment and rotations, as well as reduced OGS scores for interproximal contacts. However, in comparison to conventional fixed appliances, cases treated using SureSmile demonstrated increased OGS scores for root angulation. The authors suggest that although SureSmile is effective at tipping crowns, root alignment with SureSmile is less favorable than treatment completed with conventional fixed appliances.

Although recently published studies suggest that utilization of SureSmile during comprehensive orthodontic treatment can reduce treatment time with results equivalent to conventional fixed appliance treatment, no objective studies have validated the manufacturer's claims of more precise appliance control and greater treatment accuracy.

Other orthodontic systems which utilize digital models to manufacture fully customized orthodontic appliances according to a prescription based on a virtual treatment plan, such as the Invisalign system, have been more extensively studied. In a 2009 study, Kravitz, *et. al.* investigated the efficacy of tooth movement using the Invisalign system.<sup>15</sup> The study compared the amount of tooth movement predicted by the ClinCheck virtual treatment plan to the actual amount of tooth movement achieved by Invisalign treatment. Analysis was completed using ToothMeasure, a software application developed by Align, which allowed superimposition of predicted final tooth position as prescribed by the ClinCheck setup, to the actual post-treatment

results. The authors found that the most accurate tooth movement was lingual constriction, which produced 41% of the movement predicted by the ClinCheck, and the tooth movement with the least accuracy was extrusion showing, on average, 29.6% of expected movement.<sup>15</sup> Outcome assessment of cases treated with Invisalign compared to traditional fixed appliance treatment report less favorable clinical outcomes for Invisalign treatment. Based on the American Board of Orthodontics OGS, cases treated with Invisalign averaged 13 more OGS points than cases completed with fixed appliances and subsequently a 27% lower passing rate for the American Board of Orthodontics clinical examination.<sup>16</sup>

## **The Present Work**

The present work evaluated the effectiveness of SureSmile technology when used as an adjunctive tool in fixed orthodontic treatment. Specifically, the current study was designed to evaluate the effectiveness of SureSmile archwires to produce the final tooth position prescribed by the SureSmile virtual treatment plan. Using digital model software to superimpose models, tooth movement was quantified. In the present study, a digital model of the SureSmile treatment plan was superimposed on a digital model of the patient's final treatment outcome. Predicted final tooth position was compared with the actual final tooth position. Comparison utilized eModel Compare software, (developed by Geodigm Corporation, Chanhassen, MN) to determine areas of tooth position discrepancy.

## **Specific Aims**

The aims of this study were:

1. to evaluate SureSmile treatment effectiveness to achieve final tooth positions that are within 0.5 mm mesial-distally, facial-lingually, and vertically of the final tooth position predicted in the SureSmile virtual treatment plan,
2. to evaluate SureSmile treatment effectiveness to achieve buccal-lingual crown torque, mesial-distal crown tip, and crown rotation of final tooth position that are within 2 degrees of the final tooth position predicted by the SureSmile virtual treatment plan, and,
3. to determine, by calculation, average mean positional difference between final tooth position predicted by the SureSmile plan and final treatment outcome, overall patterns of discrepancy and the specific teeth and dimensions of tooth movement where greatest discrepancies existed.



## **Hypotheses**

The hypotheses were:

1. Discrepancy between predicted final tooth position, based on the SureSmile treatment plan, and actual final tooth position obtained following orthodontic treatment is less than 0.5 mm in the mesial-distal, facial-lingual or vertical dimension.
2. Discrepancy of buccal-lingual crown torque, mesial-distal crown tip, and crown rotation between predicted final tooth position, based on the SureSmile treatment plan, and actual final tooth position obtained following orthodontic treatment is less than 2 degrees.

## **Materials and Methods**

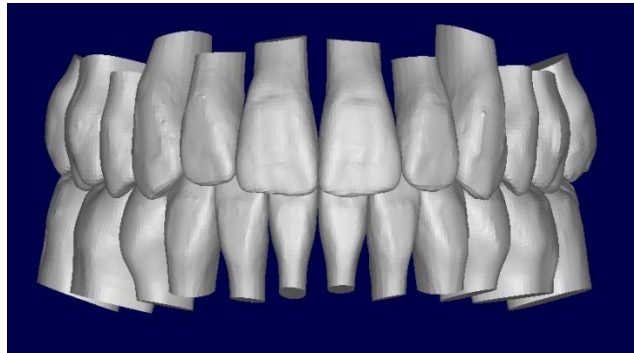
Orthodontic treatment was completed by two private practice orthodontists trained by Orametrix in the use of SureSmile. A total of 23 completed cases were collected. Twelve cases collected from office 1, and 11 cases were collected from office 2. Patients were initially selected for SureSmile treatment based on treatment protocols established in each orthodontic office.

SureSmile archwires were fabricated according to the digital setup designed by the respective treating clinician. The final SureSmile archwires for all patients were produced by Orametrix.

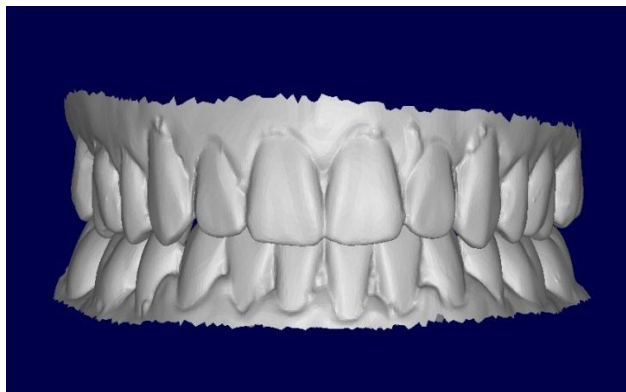
The time of placement and length of time spent in the final wire was determined according to the clinical judgment of the treating orthodontist.

Each orthodontist was instructed to collect post treatment records for patients consecutively treated using SureSmile. Cases included extraction and non-extraction treatment plans. Initial severity of malocclusion was not considered. Final records included alginate impressions taken at the time of appliance removal, which were subsequently used to fabricate plaster models. Final records were obtained from 23 patients.

Final models were digitized as stereolithography (.stl) files using a 3Shape R700 model scanner and *ScanIt Orthodontics* software (3Shape A/S, Copenhagen Denmark). The SureSmile virtual treatment plans, from which the final archwires were fabricated, were exported from the SureSmile software as .stl files. SureSmile plan models were exported segmented as individual teeth. Final models and corresponding SureSmile plan for each individual arch were converted to eModels using eModel 9.0 digital model software (Geodigm Corporation, Chanhassen MN) for further analysis (Figures 5 and 6).



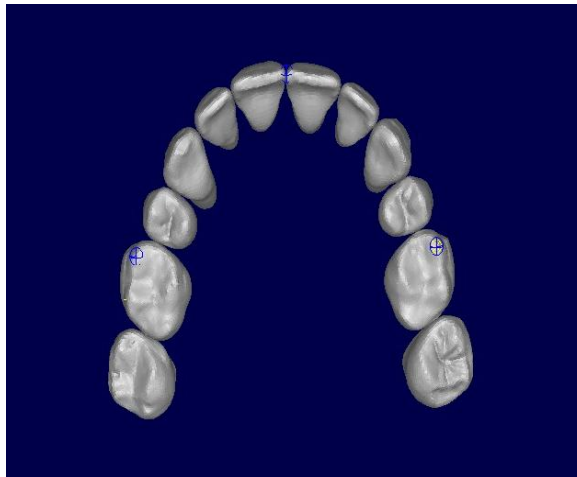
**Figure 5.** Example of SureSmile virtual treatment plan eModel.



**Figure 6.** Example of final treatment outcome eModel.

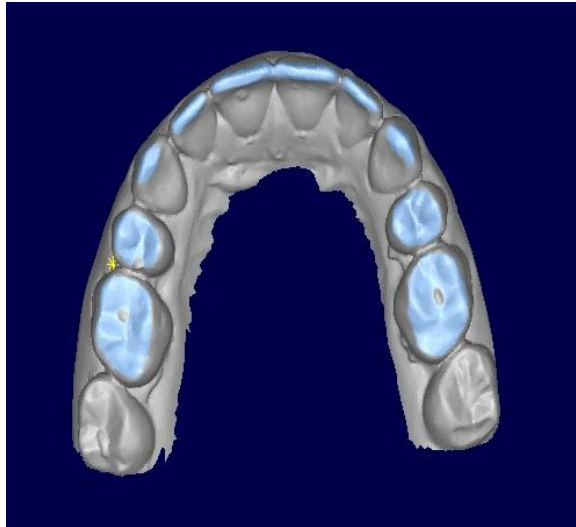
## Arch Registration

The final model for each individual arch was superimposed on the SureSmile plan model utilizing best fit surface based registration. Initial registration was completed by three point match based on the mesial-buccal cusps of 1<sup>st</sup> molars and the incisal contact point between central incisors (Figure 7).



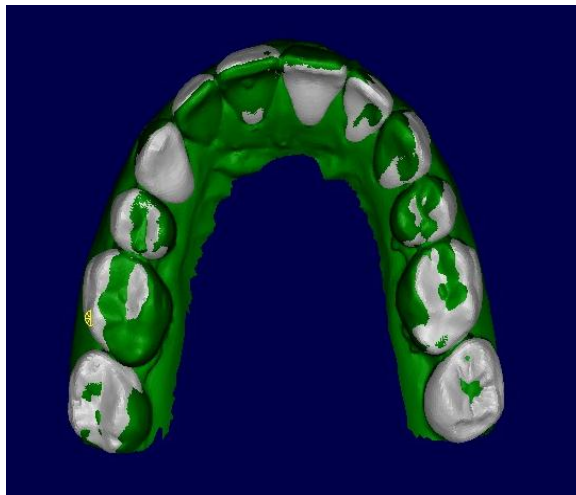
**Figure 7.** Selection of points for initial three-point match registration.

Arch registration was refined using an iterative closest point algorithm to align the SureSmile plan and final model according to the best fit for each individual arch. Alignment was based on defined fit regions of the occlusal surfaces of 1<sup>st</sup> molars and premolars, incisal tip of canines, and incisal edges of central and lateral incisors. This region was chosen to represent the average occlusal plane for each respective arch. Positive defects on the model surface were excluded from the fit region (Figure 8).



**Figure 8.** Selection of fit regions containing occlusal surfaces of 1<sup>st</sup> molars and premolars, incisal tip of canines, and incisal edges of central and lateral incisors. Positive surface defects were excluded from fit regions.

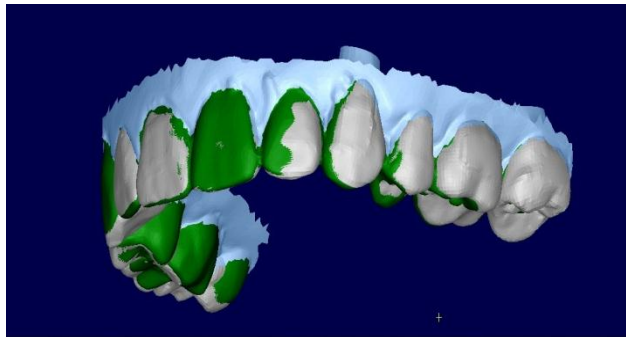
Alignment of the final to the plan model was completed by 30 transformations of the iterative closest point algorithm (Figure 9).



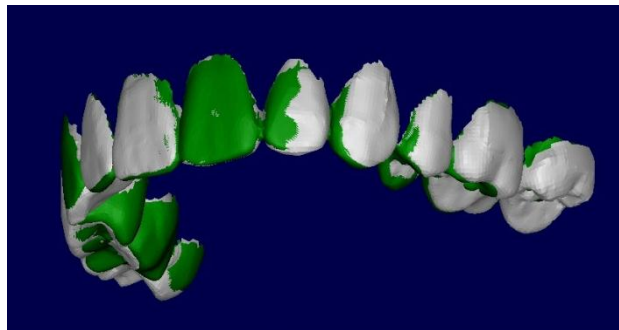
**Figure 9.** Best-fit registration of final model (green) on SureSmile plan (white).

### **Tooth Position Analysis**

To ensure that tooth position analysis was based solely on tooth surface features, interproximal papillae and model base apical to the gingival margin were removed from both SureSmile plan and final models (Figures 10, 11).

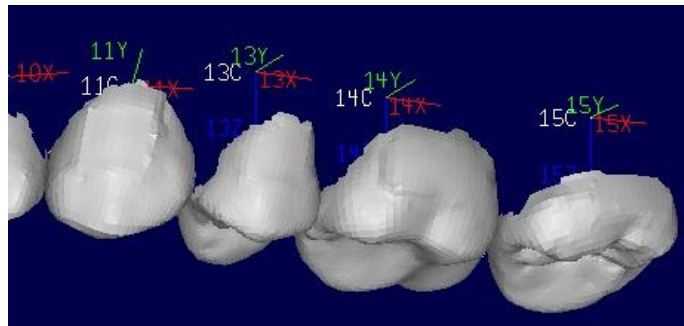


**Figure 10.** Selection of apical areas for removal.

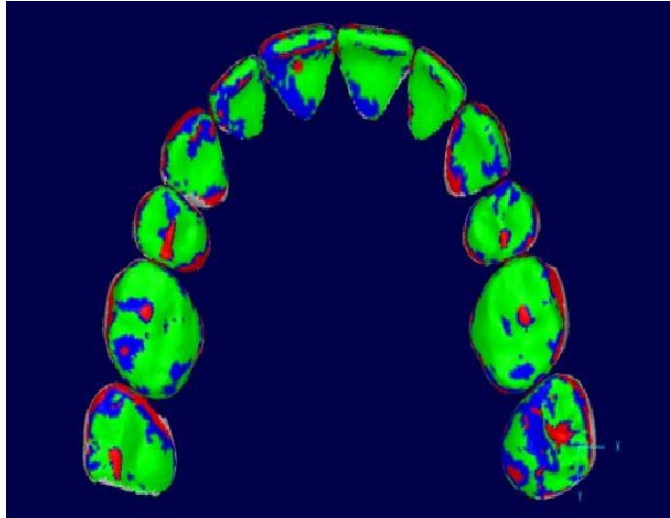


**Figure 11.** Trimmed model with area apical to the final model gingival margin removed from both final (green) and plan (white) models.

Differences in individual tooth position between SureSmile plan and post-treatment tooth position recorded in the final model were determined utilizing eModel Compare software (v8.1, Geodigm Corporation, Chanhassen MN). eModel Compare software allowed surface feature-based superimposition of individual teeth contained in the SureSmile plan on the corresponding tooth in the final model by iterative closest point matching. The direction and magnitude of transformation to achieve best-fit was calculated to determine the discrepancy between the expected tooth position dictated by the SureSmile plan and actual final treatment outcome. Transformation with respect to six dimensions of tooth movement, including bodily movement mesial-distally, facial-lingually, and occlusal-gingivally; crown rotation; mesial-distal crown tip; and facial-lingual crown torque, was calculated in reference to a coordinate system approximating the center of resistance for each individual tooth (Figure 12). Transformations were completed by the software's autosuperimposition function and best-fit for each tooth was visually verified by the operator (Figure 13). All data collection was completed by a single operator. Bonded retainers, positive defects on the model surface, and gingival embrasure areas were excluded from superimposition fit.



**Figure 12.** Location of coordinate system approximating the center of resistance for each individual tooth.



**Figure 13.** Verification of individual tooth feature-based superimposition of SureSmile plan on final model. green: less than 0.1 mm difference, blue: 0.1 to 0.2 mm difference, red: greater than 0.2 mm difference.



## Statistics

For statistical analysis and descriptive comparison, right and left analogous teeth within each arch were combined to create a single tooth pair group for further analysis.

To determine if predicted final tooth position, as prescribed by the SureSmile virtual treatment plan, was obtained during orthodontic treatment with a clinically acceptable level accuracy, threshold values for equivalence were defined as 0.5 mm for mesial-distal, facial-lingual, and vertical discrepancies, and 2 degrees for crown torque, crown tip, and crown rotation.

Discrepancy calculations contain both positive and negative values for each dimension. In order to eliminate the possibility that summation of positive and negative discrepancy values in a given dimension would give illusion of clinical accuracy, absolute values of each individual discrepancy were calculated. One-sided test of equivalence was completed on the absolute value of each discrepancy measurement for each tooth pair with respect to six dimensions of tooth movement. Statistical analysis was completed utilizing mean absolute discrepancy at a significance level of  $\alpha=0.05$ . P-values of less than 0.05 indicate absolute mean discrepancy within the defined limits of clinical acceptability.

## Results

To exclude the possibility of alignment bias during the whole arch registration process, mean discrepancy values for each dimension were compared between all teeth right of the midline to all teeth left of the midline. Measurements were completed independently for upper and lower arches and are shown in Tables 1 and 2. Right and left side comparison demonstrated approximately equal distribution of values for each dimension. Mean values were found to be equivalent for teeth on the right and left side in the rotation dimension of the upper arch and vertical dimension of the lower arch ( $p < 0.05$ ). Although statistically significant differences were noted for all dimensions except crown rotation in the upper arch and vertical dimension in the lower arch, mean differences were not considered clinically significant for the purposes of this study.

Dimension	Upper Right		Upper Left		Diff	p-value
	Mean	SD	Mean	SD		
Mesial-Distal	0.23	0.41	0.32	0.44	0.01	0.9286*
Facial-Lingual	-0.28	0.56	-0.28	0.60	-0.09	0.0581*
Vertical	-0.04	0.34	-0.13	0.35	0.01	0.9766*
Torque	0.66	3.72	0.69	3.47	0.34	0.2838*
Tip	-0.52	2.76	-0.86	2.69	-0.03	0.9331*
Rotation	0.64	3.51	0.62	4.06	0.08	0.038

**Table 1.** Mean discrepancy upper arch right vs. left side.  
Statistically significant difference (alpha 0.05) indicated by \*.

Dimension	Lower Left		Lower Right		Diff	p-value
	Mean	SD	Mean	SD		
Mesial-Distal	0.05	0.36	0.07	0.44	0.06	0.3417*
Facial-Lingual	-0.13	0.51	-0.19	0.58	-0.02	0.6889*
Vertical	0.02	0.39	-0.09	0.38	-0.07	0.8609*
Torque	0.80	3.63	0.66	3.52	0.13	0.6696*
Tip	0.43	2.74	0.30	2.70	0.14	0.7221*
Rotation	1.00	3.31	1.07	3.33	0.11	0.010

**Table 2.** Mean discrepancy lower arch right vs. left side. Statistically significant difference (alpha 0.05) indicated by \*.

Mean discrepancy values for each dimension of tooth movement were compared for cases treated at two independent orthodontic offices (Table 3). Mean values for the rotation dimension were found to be equivalent ( $p < 0.05$ ) between cases collected from the two independent orthodontic offices. Although statistically significant differences were noted for all dimensions except crown rotation, mean differences were not considered clinically significant for the purposes of this study.

Dimension	Office 1			Office 2			Diff	p-value
	N	Mean	St Dev	N	Mean	St Dev		
Mesial-Distal	323	0.09	0.45	294	0.24	0.39	0.06	0.3417*
Facial-Lingual	323	-0.21	0.59	294	-0.24	0.53	-0.02	0.6889*
Vertical	323	-0.06	0.35	294	-0.06	0.39	-0.07	0.8609*
Torque	323	0.22	3.53	294	1.23	3.56	0.13	0.6696*
Tip	323	-0.11	2.95	294	-0.19	2.56	0.14	0.7221*
Rotation	323	0.66	3.31	294	1.03	3.81	0.11	0.010

**Table 3.** Comparison of inter-office mean discrepancy values. Statistically significant difference (alpha 0.05) indicated by \*. office 1: n=12 cases, office 2: n=11 cases

For further analysis, analogous right and left teeth for each individual arch were combined into a single group for analysis as shown in Table 4. Variation in sample size for each tooth pair reflects two cases which were missing upper and lower 1<sup>st</sup> premolars, two cases missing upper 1<sup>st</sup> premolars, and one case missing a lower central incisor. A total of twelve upper and two lower 2<sup>nd</sup> molars were missing, unerupted, or not included in the SureSmile virtual treatment plan.

<b>tooth pairs</b>	<b>n=</b>
upper 2 <sup>nd</sup> molars	34
upper 1 <sup>st</sup> molars	46
upper 2 <sup>nd</sup> premolars	46
upper 1 <sup>st</sup> premolars	38
upper canines	46
upper lateral incisors	46
upper central incisors	46
lower 2 <sup>nd</sup> molars	44
lower 1 <sup>st</sup> molars	46
lower 2 <sup>nd</sup> premolars	46
lower 1 <sup>st</sup> premolars	42
lower canines	46
lower lateral incisors	46
lower central incisors	45

**Table 4.** Grouping and sample size for each tooth pair

To eliminate the a potential influence of summation of positive and negative discrepancy values for each dimension giving the illusion of accuracy, the absolute discrepancy was determined by calculating the absolute value of each individual discrepancy measurement. Average absolute discrepancy values for each tooth pair are shown in Table 5. The absolute discrepancy values indicate the magnitude of discrepancy between the final tooth position and the SureSmile plan; however, absolute discrepancy does not indicate the direction in which final tooth position deviates from the SureSmile plan.

#### Upper Arch Absolute Discrepancy

tooth pair	M-D (mm)	Fa-Li (mm)	Vertical (mm)	Torque ( ° )	Tip ( ° )	Rotation ( ° )
2nd molars	0.56 +/- 0.38	0.72 +/- 0.60	0.40 +/- 0.34	4.91 +/- 3.40	3.09 +/- 2.91	3.88 +/- 3.39
1st molars	0.37 +/- 0.24	0.54 +/- 0.39	0.14 +/- 0.11	1.71 +/- 1.29	2.11 +/- 1.61	4.79 +/- 2.94
2nd premolars	0.39 +/- 0.29	0.56 +/- 0.45	0.20 +/- 0.18	2.32 +/- 2.07	1.87 +/- 1.46	2.18 +/- 2.26
1st premolars	0.33 +/- 0.28	0.52 +/- 0.43	0.27 +/- 0.23	2.39 +/- 1.84	2.04 +/- 1.49	1.77 +/- 1.42
canines	0.40 +/- 0.37	0.36 +/- 0.22	0.36 +/- 0.31	2.00 +/- 1.70	2.18 +/- 1.63	2.76 +/- 2.26
lateral incisors	0.48 +/- 0.35	0.38 +/- 0.26	0.26 +/- 0.23	2.72 +/- 1.90	2.37 +/- 1.72	2.90 +/- 2.12
central incisors	0.28 +/- 0.27	0.44 +/- 0.41	0.23 +/- 0.18	3.53 +/- 3.12	1.71 +/- 1.49	1.96 +/- 1.61

#### Lower Arch Absolute Discrepancy

tooth pair	M-D (mm)	Fa-Li (mm)	Vertical (mm)	Torque ( ° )	Tip ( ° )	Rotation ( ° )
2nd molars	0.37 +/- 0.26	0.49 +/- 0.39	0.43 +/- 0.55	3.60 +/- 3.46	2.64 +/- 2.05	3.72 +/- 3.13
1st molars	0.35 +/- 0.23	0.33 +/- 0.40	0.12 +/- 0.09	2.13 +/- 1.61	1.45 +/- 1.02	3.10 +/- 2.31
2nd premolars	0.27 +/- 0.23	0.38 +/- 0.41	0.18 +/- 0.14	1.65 +/- 1.33	1.55 +/- 1.10	2.80 +/- 2.15
1st premolars	0.32 +/- 0.23	0.31 +/- 0.28	0.23 +/- 0.24	2.40 +/- 2.05	2.04 +/- 1.44	2.33 +/- 3.13
canines	0.35 +/- 0.24	0.37 +/- 0.26	0.24 +/- 0.23	2.34 +/- 1.82	2.62 +/- 2.01	1.91 +/- 1.49
lateral incisors	0.33 +/- 0.21	0.58 +/- 0.36	0.28 +/- 0.26	3.57 +/- 2.46	2.67 +/- 1.82	2.15 +/- 1.65
central incisors	0.29 +/- 0.25	0.58 +/- 0.34	0.28 +/- 0.25	3.44 +/- 2.81	2.14 +/- 1.68	1.94 +/- 1.52

**Table 5.** Absolute tooth position discrepancy for upper and lower arches. Values and standard deviation indicate discrepancy between predicted final tooth position based on the SureSmile plan and final tooth position observed following treatment. M-D (mesial-distal), Fa-Li (facial-lingual).

To determine if final tooth position met the selected threshold for clinically acceptable discrepancy, 95% confidence intervals for each tooth pair with respect to each dimension of tooth movement were calculated. For the present study, the threshold for clinical significance was set at  $\pm 0.5$  mm for mesial-distal, facial-lingual, and vertical discrepancies; and  $\pm 2$  degrees for torque, tip, and rotational discrepancies. 95% confidence intervals and respective p-values are shown in Table 6 and Figures 14 and 15.

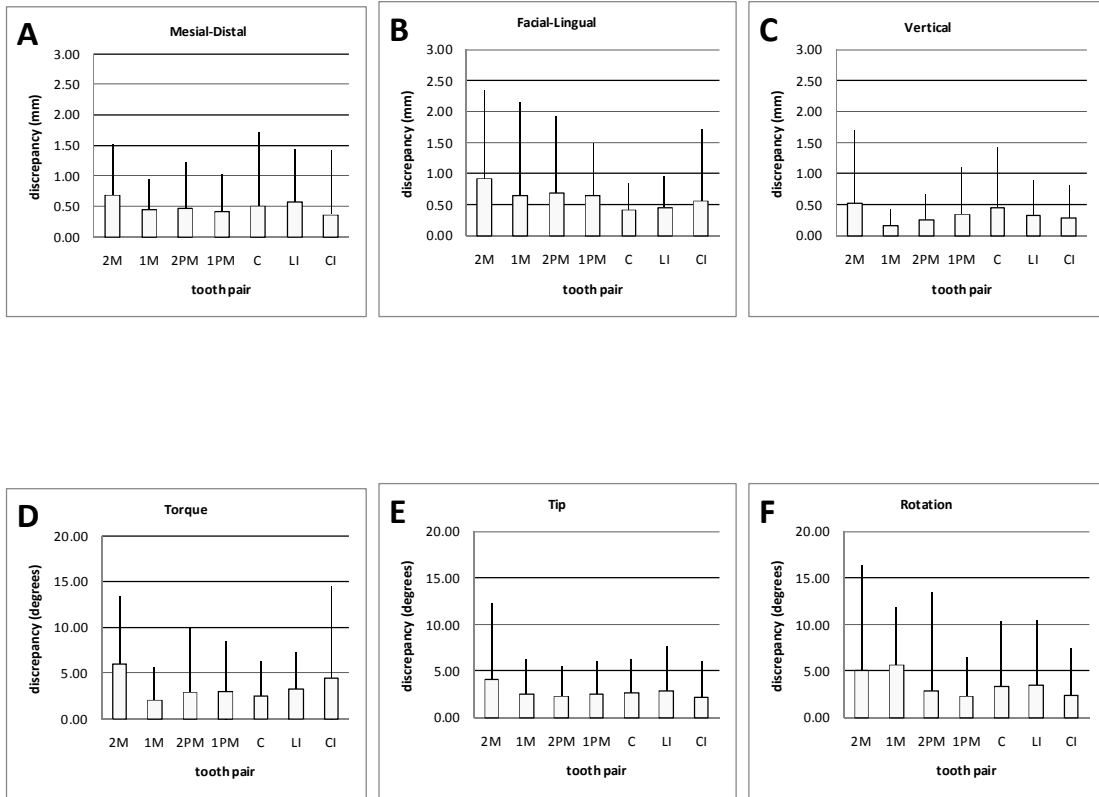
#### Upper Arch Absolute Discrepancy 95% Confidence Interval and p-value

tooth pair	M-D (mm)		Fa-Li (mm)		Vertical (mm)		Torque (°)		Tip (°)		Rotation (°)	
	CI	p =	CI	p =	CI	p =	CI	p =	CI	p =	CI	p =
2nd molars	0.69	0.831	0.92	0.982	0.52	0.050*	6.06	1.000	4.06	0.982	5.02	0.999
1st molars	0.44	0.004*	0.65	0.753	0.17	<0.001*	2.08	0.065	2.57	0.676	5.64	1.000
2nd premolars	0.47	0.005*	0.69	0.822	0.25	<0.001*	2.92	0.853	2.29	0.273	2.83	0.700
1st premolars	0.42	0.003*	0.65	0.594	0.34	<0.001*	2.98	0.902	2.52	0.569	2.22	0.163
canines	0.51	0.037*	0.42	<0.001*	0.45	<0.001*	2.50	0.507	2.65	0.772	3.41	0.986
lateral incisors	0.58	0.317	0.45	<0.001*	0.32	<0.001*	3.27	0.993	2.87	0.926	3.51	0.997
central incisors	0.35	<0.001*	0.56	0.169	0.29	<0.001*	4.43	0.999	2.14	0.097	2.42	0.435

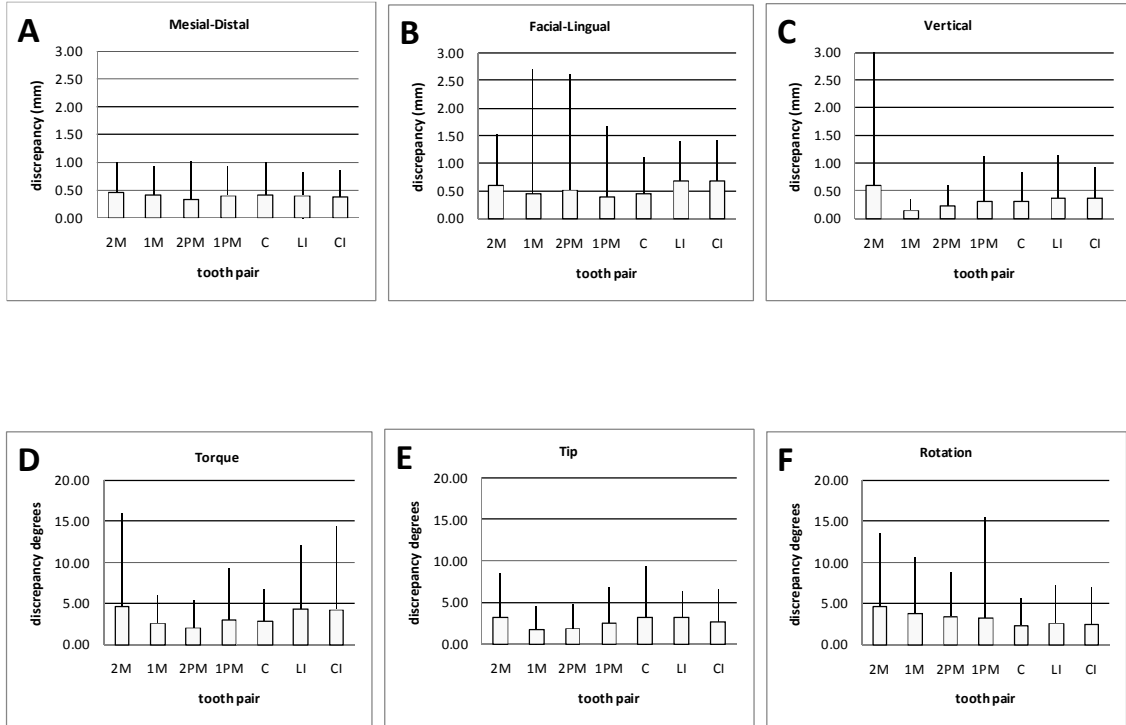
#### Lower Arch Absolute Discrepancy 95% Confidence Interval and p-value

tooth pair	M-D (mm)		Fa-Li (mm)		Vertical (mm)		Torque (°)		Tip (°)		Rotation (°)	
	CI	p =	CI	p =	CI	p =	CI	p =	CI	p =	CI	p =
2nd molars	0.447	<0.001*	0.601	0.411	0.597	0.215	4.621	0.998	3.248	0.979	4.648	1.000
1st molars	0.412	<0.001*	0.449	0.004*	0.143	<0.001*	2.590	0.702	1.746	<0.001*	3.769	1.000
2nd premolars	0.337	<0.001*	0.503	0.031*	0.222	<0.001*	2.031	0.039*	1.864	0.004*	3.427	0.993
1st premolars	0.390	<0.001*	0.391	<0.001*	0.303	<0.001*	3.020	0.893	2.477	0.572	3.272	0.749
canines	0.414	<0.001*	0.447	<0.001*	0.309	<0.001*	2.865	0.893	3.204	0.979	2.341	0.343
lateral incisors	0.395	<0.001*	0.682	0.932	0.359	<0.001*	4.281	1.000	3.197	0.992	2.626	0.726
central incisors	0.367	<0.001*	0.682	0.948	0.357	<0.001*	4.257	0.999	2.630	0.707	2.388	0.404

**Table 6.** Absolute discrepancy 95% confidence intervals and p-values for each tooth pair. Values indicate discrepancy between final observed tooth position and the SureSmile plan. p-value of less than 0.05 indicates final tooth position is within clinically acceptable limits and is indicated by \*. M-D (mesial-distal), Fa-Li (facial-lingual).



**Figure 14. A-F.** Upper arch 95% confidence intervals for absolute tooth position discrepancy. Boxes indicate 95% confidence intervals, solid vertical lines indicate range of individual discrepancy measurements. Values indicate discrepancy between the final tooth position and the SureSmile plan for each tooth pair. A. mesial-distal discrepancy, B. facial-lingual discrepancy, C. vertical discrepancy, D. torque discrepancy, E. tip discrepancy, F. rotational discrepancy.



**Figure 15. A-F.** Lower arch 95% confidence intervals for absolute tooth position discrepancy. Boxes indicate 95% confidence intervals, solid vertical lines indicate range of individual discrepancy measurements. Values indicate discrepancy between the final tooth position and the SureSmile plan for each tooth pair. A. mesial-distal discrepancy, B. facial-lingual discrepancy, C. vertical discrepancy, D. torque discrepancy, E. tip discrepancy, F. rotational discrepancy.



Although absolute discrepancy values are the best indication of the relative magnitude of discrepancy for each dimension, they do not indicate the direction of the discrepancy. To determine the direction of discrepancy, mean discrepancy values for each dimension were calculated for each tooth pair and are shown in Table 9. Relative to the SureSmile plan, positive discrepancy values indicate the final tooth position was located mesially, facially, occlusally/incisally and the final tooth position had increased buccal crown torque, increased mesial crown tip, and increased mesial-lingual rotation when compared to the SureSmile plan. Sign convention for discrepancy values are summarized in Table 8.

<b>dimension</b>	<b>+ value</b>	<b>- value</b>
<b>M-D (mm)</b>	more mesial	more distal
<b>Fa-Li (mm)</b>	more facial	more lingual
<b>Vertical (mm)</b>	more occlusal/incisal	more gingival
<b>Torque (°)</b>	more buccal crown torque	more lingual crown torque
<b>Tip (°)</b>	more mesial crown tip	more distal crown tip
<b>Rotation (°)</b>	facial surface rotated more mesially	facial surface rotated more distally

**Table 8.** Sign convention for discrepancy values with respect to six dimensions of tooth movement. M-D (mesial-distal), Fa-Li (facial-lingual).

### Upper Arch Mean Discrepancy

tooth pair	M-D (mm)	Fa-Li (mm)	Vertical (mm)	Torque (°)	Tip (°)	Rotation (°)
<b>2nd molars</b>	0.49 +/- 0.46	-0.43 +/- 0.84	0.02 +/- 0.53	4.57 +/- 3.86	-2.51 +/- 3.43	2.91 +/- 4.27
<b>1st molars</b>	0.23 +/- 0.38	-0.41 +/- 0.53	-0.07 +/- 0.16	1.08 +/- 1.86	-1.42 +/- 2.25	4.68 +/- 3.11
<b>2nd premolars</b>	0.19 +/- 0.44	-0.52 +/- 0.50	-0.03 +/- 0.27	1.07 +/- 2.94	-0.11 +/- 2.38	0.29 +/- 3.14
<b>1st premolars</b>	0.19 +/- 0.39	-0.49 +/- 0.46	-0.21 +/- 0.29	0.06 +/- 3.04	0.22 +/- 2.54	-0.26 +/- 2.27
<b>canines</b>	0.30 +/- 0.46	-0.23 +/- 0.36	-0.30 +/- 0.36	-0.16 +/- 2.64	-0.46 +/- 2.70	-0.17 +/- 3.58
<b>lateral incisors</b>	0.41 +/- 0.43	-0.12 +/- 0.44	-0.13 +/- 0.32	0.22 +/- 3.33	-0.77 +/- 2.85	-1.69 +/- 3.19
<b>central incisors</b>	0.16 +/- 0.35	0.14 +/- 0.59	0.14 +/- 0.26	-1.21 +/- 4.58	-0.10 +/- 2.28	-0.92 +/- 2.38

### Lower Arch Mean Discrepancy

tooth pair	M-D (mm)	Fa-Li (mm)	Vertical (mm)	Torque (°)	Tip (°)	Rotation (°)
<b>2nd molars</b>	0.04 +/- 0.45	0.25 +/- 0.57	0.09 +/- 0.70	0.59 +/- 4.99	1.41 +/- 3.05	1.95 +/- 4.49
<b>1st molars</b>	0.13 +/- 0.40	-0.17 +/- 0.49	0.04 +/- 0.14	1.25 +/- 2.37	0.22 +/- 1.77	2.79 +/- 2.69
<b>2nd premolars</b>	0.05 +/- 0.36	-0.12 +/- 0.55	-0.09 +/- 0.21	-0.33 +/- 2.11	0.22 +/- 1.90	1.17 +/- 3.36
<b>1st premolars</b>	0.03 +/- 0.40	-0.12 +/- 0.40	-0.15 +/- 0.30	-0.53 +/- 3.13	0.05 +/- 2.52	1.32 +/- 3.68
<b>canines</b>	0.19 +/- 0.38	-0.20 +/- 0.41	-0.12 +/- 0.31	0.28 +/- 2.97	-0.50 +/- 3.29	-0.60 +/- 2.36
<b>lateral incisors</b>	-0.04 +/- 0.40	-0.39 +/- 0.56	-0.04 +/- 0.39	2.02 +/- 3.86	1.06 +/- 3.08	0.71 +/- 2.63
<b>central incisors</b>	0.01 +/- 0.39	-0.38 +/- 0.56	0.01 +/- 0.38	1.73 +/- 4.11	0.10 +/- 2.74	-0.05 +/- 2.48

**Table 9.** Mean discrepancy values for each tooth pair. Values indicate final observed tooth position relative to the SureSmile plan. Positive values indicate increased mesial, facial, or occlusal position; increased buccal crown torque, mesial crown tip, and mesial-lingual crown rotation of final tooth position relative to SureSmile plan. M-D (mesial-distal), Fa-Li (facial-lingual).

For each tooth pair, 95% confidence intervals for mean discrepancy were calculated for each dimension (Table 10 and Figures 16 and 17).

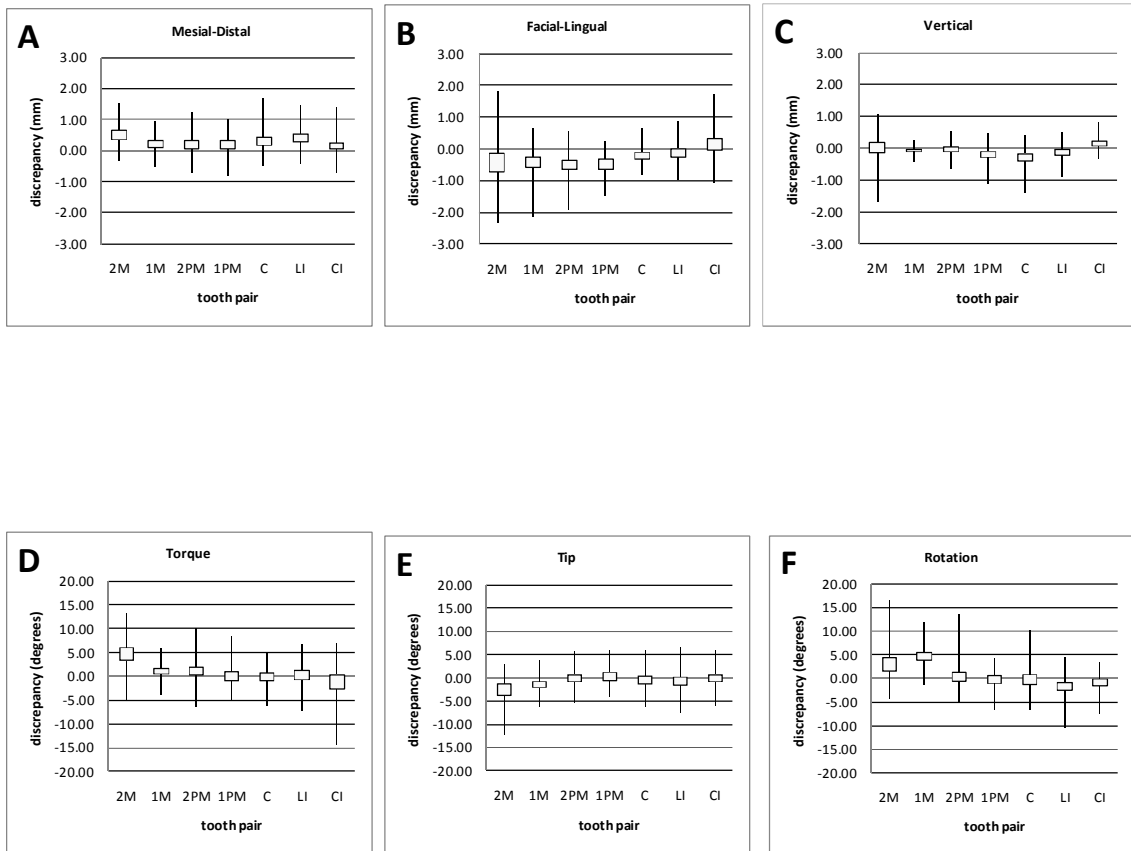
#### Upper Arch 95% Confidence Interval Mean Discrepancy

tooth pair	M-D (mm)		Fa-Li (mm)		Vertical (mm)		Torque (°)		Tip (°)		Rotation (°)	
	low	high	low	high	low	high	low	high	low	high	low	high
2nd molars	0.34	0.65	-0.71	-0.15	-0.16	0.19	3.28	5.87	-3.67	-1.36	1.47	4.35
1st molars	0.11	0.34	-0.56	-0.25	-0.12	-0.02	0.54	1.61	-2.07	-0.77	3.78	5.58
2nd premolars	0.06	0.31	-0.66	-0.37	-0.11	0.05	0.22	1.92	-0.80	0.58	-0.61	1.20
1st premolars	0.06	0.31	-0.63	-0.34	-0.30	-0.11	-0.91	1.03	-0.59	1.03	-0.98	0.46
canines	0.17	0.43	-0.33	-0.12	-0.41	-0.20	-0.92	0.60	-1.24	0.32	-1.21	0.86
lateral incisors	0.28	0.53	-0.25	0.01	-0.22	-0.03	-0.74	1.18	-1.59	0.05	-2.61	-0.76
central incisors	0.06	0.26	-0.03	0.31	0.06	0.21	-2.53	0.11	-0.76	0.56	-1.60	-0.23

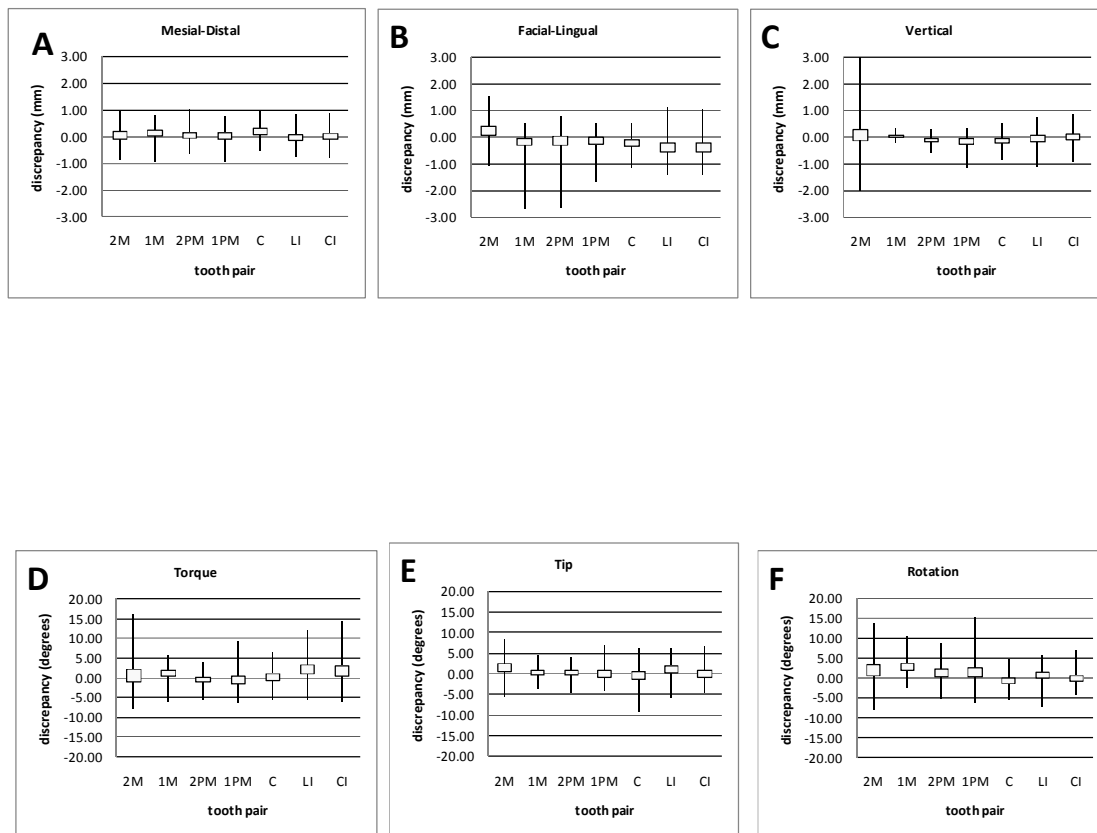
#### Lower Arch 95% Confidence Interval Mean Discrepancy

tooth pair	M-D (mm)		Fa-Li (mm)		Vertical (mm)		Torque (°)		Tip (°)		Rotation (°)	
	low	high	low	high	low	high	low	high	low	high	low	high
2nd molars	-0.10	0.17	0.08	0.42	-0.12	0.29	-0.88	2.07	0.51	2.31	0.62	3.27
1st molars	0.01	0.24	-0.31	-0.03	-0.01	0.08	0.57	1.94	-0.29	0.74	2.01	3.56
2nd premolars	-0.05	0.15	-0.28	0.04	-0.16	-0.03	-0.94	0.28	-0.33	0.77	0.20	2.14
1st premolars	-0.09	0.15	-0.24	0.00	-0.24	-0.06	-1.48	0.41	-0.71	0.81	0.21	2.43
canines	0.08	0.30	-0.32	-0.08	-0.21	-0.03	-0.58	1.14	-1.45	0.45	-1.28	0.09
lateral incisors	-0.15	0.07	-0.55	-0.22	-0.15	0.07	0.91	3.14	0.17	1.95	-0.05	1.47
central incisors	-0.10	0.12	-0.55	-0.22	-0.10	0.12	0.53	2.93	-0.70	0.90	-0.78	0.67

**Table 10.** 95% confidence intervals for mean discrepancy of each tooth pair. Values indicate final observed tooth position relative to the SureSmile plan. Positive values indicate increased mesial, facial, or occlusal position; increased buccal crown torque, mesial crown tip, and mesial-lingual crown rotation of final tooth position relative to SureSmile plan. M-D (mesial-distal), Fa-Li (facial-lingual).



**Figure 16. A-F.** Upper arch 95% confidence intervals for mean tooth position discrepancy. Boxes indicate 95% confidence intervals, solid vertical lines indicate range of individual discrepancy values. Positive values indicate increased mesial, facial, or occlusal position; increased buccal crown torque, mesial crown tip, and mesial-lingual crown rotation of final tooth position relative to SureSmile plan. A. mesial-distal discrepancy, B. facial-lingual discrepancy, C. vertical discrepancy, D. torque discrepancy, E. tip discrepancy, F. rotational discrepancy.



**Figure 17. A-F.** Lower arch 95% confidence intervals for mean tooth position discrepancy. Boxes indicate 95% confidence intervals, solid vertical lines indicate range of individual discrepancy values. Positive values indicate increased mesial, facial, or occlusal position; increased buccal crown torque, mesial crown tip, and mesial-lingual crown rotation of final tooth position relative to SureSmile plan. A. mesial-distal discrepancy, B. facial-lingual discrepancy, C. vertical discrepancy, D. torque discrepancy, E. tip discrepancy, F. rotational discrepancy.

## Summary of Results

### Mesial-Distal Discrepancy

Mesial-distal discrepancy values were found to be less than or equal to clinically significant thresholds ( $p < 0.05$ ) for upper 1<sup>st</sup> molars, upper 1<sup>st</sup> and 2<sup>nd</sup> premolars, upper canines, upper central incisors and all lower arch tooth pairs, indicating final tooth position was within 0.5 mm of the position predicted by the SureSmile plan. Discrepancy exceeded clinically significant threshold levels for upper 2<sup>nd</sup> molars ( $p = 0.83$ , mean  $0.49 \pm 0.46$ ), and upper lateral incisors ( $p = 0.37$ , mean  $0.41 \pm 0.43$ ). Mean mesial-distal discrepancy values for the upper arch and corresponding 95% confidence intervals (Figure 17.A), indicate that for all tooth pairs, the final tooth position was located mesially to the SureSmile plan. In the lower arch, all discrepancy values indicate final tooth position mesial to the SureSmile plan, except for slightly distal discrepancy seen in the lower lateral incisors ( $-0.04 \pm 0.40$  mm).

### Facial-Lingual Discrepancy

Absolute facial-lingual discrepancy was less than clinically significant threshold levels for upper canines, upper lateral incisors, lower 1<sup>st</sup> molars, lower 1<sup>st</sup> and 2<sup>nd</sup> premolars, and lower canines; thus, final tooth position within 0.5 mm of the SureSmile plan was achieved. Facial-lingual discrepancy was significantly greater than clinically significant threshold level of  $\pm 0.5$  mm for upper 2<sup>nd</sup> molars ( $p = 0.982$ , mean  $-0.43 \pm 0.84$ ), upper 1<sup>st</sup> molars ( $p = 0.753$ , mean  $-0.41 \pm 0.53$ ), upper 2<sup>nd</sup> premolars ( $p = 0.822$ , mean  $-0.52 \pm 0.50$ ), upper 1<sup>st</sup> premolars ( $p = 0.594$ , mean  $-0.49 \pm 0.46$ ), and upper central incisors ( $p = 0.169$ , mean  $0.14 \pm 0.59$ ), lower 2<sup>nd</sup> molars ( $p = 0.601$ , mean  $0.25 \pm 0.57$ ), lower lateral incisors ( $p = 0.932$ , mean  $-0.39 \pm 0.56$ ), and lower central incisors ( $p = 0.948$ , mean  $-0.38 \pm 0.56$ ). In the upper arch, mean discrepancy values indicate lingual deviation of final tooth position with respect to the SureSmile plan for all tooth pairs except central incisors ( $0.14 \pm 0.59$ ), which were positioned buccally to the SureSmile plan. Excluding

lower 2<sup>nd</sup> molars, which showed mean facial discrepancy ( $0.25\pm 0.57$  mm), final position of all tooth pairs was located lingual to the SureSmile plan. Mean discrepancy values are shown in Table 9 and 95% confidence intervals are shown in Table 10 and Figures 16.B and 17.B).

### **Vertical Discrepancy**

Absolute vertical discrepancy was found to be less ( $p < 0.05$ ) than the clinically significant discrepancy threshold for all tooth pairs except upper 2<sup>nd</sup> molars ( $p = 0.05$ , mean  $0.02\pm 0.53$ ). As shown in Figure 16.C and 17.C, mean discrepancy values indicate a strong tendency for upper premolars, canines, and lateral incisors as well as lower premolars and canines to be positioned apically to the SureSmile plan. Upper and lower 2<sup>nd</sup> molars and upper and lower central incisors were found to be positioned occlusally/incisally to the SureSmile plan.

### **Torque Discrepancy**

Torque discrepancy was determined to exceed the clinically significant threshold of 2 degrees for all tooth pairs in the upper arch ( $p > 0.05$ ) and all lower arch tooth pairs ( $p > 0.05$ ) with the exception of lower 2<sup>nd</sup> premolars ( $p = 0.039$ ). Absolute discrepancy 95% confidence intervals and corresponding p-values are shown in Table 6. The greatest mean crown torque discrepancy was observed in the upper 2<sup>nd</sup> molars ( $4.57\pm 3.86$  degrees). In the lower arch, the greatest crown torque discrepancy was seen in the lateral incisors ( $2.02\pm 3.86$  degrees). Mean torque discrepancy values for all tooth pairs are shown in Table 9.

### **Tip Discrepancy**

Absolute crown tip discrepancy was found to exceed the clinically significant threshold of 2 degrees for all tooth pairs in the upper arch ( $p > 0.05$ ). In the lower arch, absolute discrepancy for 1<sup>st</sup> molars ( $p=0.0001$ ) and 2<sup>nd</sup> premolars ( $p=0.004$ ) was within 2 degrees of the SureSmile plan. Mesial-distal tip discrepancies exceeded 2 mm for all other tooth pairs in the lower arch ( $p > 0.05$ ). However, as shown in Figure 16 and 17 panel E, the direction of crown tip discrepancy was dependent on specific tooth pairs. Upper 1<sup>st</sup> ( $-1.42 \pm 2.25$ ) and 2<sup>nd</sup> molars ( $-2.51 \pm 3.43$ ) had increased distal crown tip relative to the SureSmile plan. In contrast, lower 2<sup>nd</sup> molars ( $1.41 \pm 3.05$ ), and to lesser extent on other lower teeth, showed increased mesial crown tip than the SureSmile plan.

### **Rotation Discrepancy**

Absolute rotational discrepancy exceeded clinically significant thresholds for all tooth pairs in both the upper and lower arch. Analysis of 95% confidence intervals for mean discrepancy revealed the greatest rotational discrepancy in upper 1<sup>st</sup> molars ( $4.68 \pm 3.11$  degrees), upper 2<sup>nd</sup> molars ( $2.91 \pm 4.27$  degrees), lower 1<sup>st</sup> molars ( $2.79 \pm 2.69$  degrees) and lower 2<sup>nd</sup> molars ( $1.95 \pm 4.49$  degrees) compared to the SureSmile plan. Upper central and lateral incisors and lower canines were rotated distal-lingually in comparison to the SureSmile plan. Mean discrepancy values are shown in Table 9. 95% confidence intervals are shown in Table 10 and panel F of Figures 16 and 17.



## Discussion

This study includes the clinical outcomes from two private practice orthodontic offices. Since the cases involved in the study were treated based on the clinical judgment of each orthodontist, the study represents realistic conditions in which SureSmile technology is utilized. Furthermore, Further, patients were consecutively treated and no cases were excluded; thus, potential case selection bias was reduced.

In all dimensions, increased discrepancy between the SureSmile plan and final clinical outcome was observed in the 2<sup>nd</sup> molars. This finding is in agreement with reports of field tests of the American Board of Orthodontics clinical examination, which suggests that alignment of upper and lower 2<sup>nd</sup> molars can be problematic and - the most common deviation from ideally finished occlusion.<sup>17,18</sup>

Discrepancy between the SureSmile plan and final treatment outcome was minimal in the vertical dimension. This finding is similar to outcome assessment of cases treated with conventional fixed appliances, which have little deficiency in the vertical dimension.<sup>17</sup> In the present study, for the lower arch, molars and incisors tended to be positioned more occlusally than the SureSmile plan, while premolars and canines tended to be positioned apically. Similarly, in the upper arch the greatest vertical discrepancy was canines and premolars positioned apically to the SureSmile plan. Orthodontic treatment plans frequently involve leveling the Curve of Spee in the lower arch by relative extrusion of premolars and relative intrusion of incisors and in the upper arch by relative intrusion of premolars with extrusion of anterior teeth. The observed patterns of vertical discrepancy in the upper and lower arches can be best explained by incomplete leveling respective dental arches.

When compared to the SureSmile plan, all teeth, with the exception of upper central incisors, tended to be positioned more lingually than the SureSmile plan. The largest lingual discrepancy was found in maxillary posterior teeth and least in lower 2<sup>nd</sup> molars, which tended to be positioned slightly buccal to the SureSmile plan. The trend of lingual discrepancy, especially in posterior teeth of the upper arch, indicates a narrower final arch form than prescribed by the SureSmile plan. It is possible that transverse expansion, particularly in the upper posterior, prescribed by the SureSmile plan was not fully expressed by the SureSmile archwires.

With the exception of the central incisors, upper teeth were found to have excess buccal crown torque compared to the SureSmile plan. Increased buccal crown torque was highest in the upper 2<sup>nd</sup> molars. Studies of treatment outcomes for cases finished using conventional fixed appliance treatment have cited buccal-lingual inclination as the area of most common deficiency when scored using the American Board of Orthodontics OGS criteria.<sup>17,18</sup> When considering the observed trend for narrow transverse dimensions in the upper arch, it is possible that expansion of the upper arch prescribed by the SureSmile plan was expressed buccal crown torque rather than buccal translation. Lower central and lateral incisors were found to have excess buccal crown torque compared to the SureSmile plan.

Crown tip discrepancies were most pronounced in posterior with upper molars exhibiting excess distal crown tip and lower molars crowns tending to be tipped mesially.

Rotational discrepancy was largest in maxillary molars, showing excessive mesial-lingual rotation. Excess mesial-lingual rotation was also seen in the lower molars. Upper incisors tended to have distal-lingual crown rotation.

Although Suresmile is a tool to fabricate precision archwires, it does not eliminate the need for auxiliary mechanics. Class I mechanics, such as elastic chain, are routinely used during the orthodontic finishing to close interproximal spaces. A consequence of Class I space closure is mesial-lingual rotation of the terminal tooth connected to the elastic.

## Conclusion

The effectiveness of SureSmile treatment to achieve predicted final tooth position was highly variable for tooth type and dimension of movement. Upper and lower 2<sup>nd</sup> molars show the most frequent and largest positional discrepancy relative to the SureSmile plan.

SureSmile directed tooth movement was most effective in the vertical dimensions. As shown in the present study, mean vertical discrepancy was within 0.5 mm of predicted position for all teeth except lower 2<sup>nd</sup> molars. Mesial-distal was shown to be less than limits of clinical acceptability in the lower arch and all upper teeth except 2<sup>nd</sup> molars and lateral incisors. Facial-lingual discrepancy indicated a trend for final tooth position located lingually to the SureSmile plan, suggesting deficiency to expand or maintain transverse tooth position. Statistical comparison indicated discrepancy values in the dimensions of torque, tip, and crown rotation are greater than 2 degrees, absolute mean discrepancy values show a strong trend discrepancy of approximately 2-3 degrees.

Although we were unable to demonstrate that final tooth position predicted by the SureSmile treatment plan is consistently achieved within 0.5 mm in the mesial-distal, facial-lingual, and vertical dimensions; and that crown torque, crown tip, and crown rotation are within 2 degrees, these findings do not suggest unsatisfactory treatment results. However, knowledge of dimensions in which final tooth position is less consistent with predicted final position enables the treating clinician to build necessary compensations into the initial virtual treatment plan.

## **Future Studies**

The present study investigated the effectiveness of SureSmile orthodontic treatment utilized based on the clinical judgment of the treating orthodontist. Although this protocol represents realistic outcomes of the technology, it was impossible to determine if full expression of the SureSmile archwire had been realized at the conclusion of treatment. Future investigation using standardized protocol would reduce this potential bias.

Results reported here indicate discrepancy between planned final tooth position and actual final tooth position achieved during SureSmile orthodontic treatment. Areas of large discrepancy suggest teeth and/or tooth movements where anticipated results are less predictable and SureSmile directed tooth movement is less effective. Future study would include consideration of the initial malocclusion for each individual tooth at time SureSmile treatment was initiated. These results would help determine if discrepancy is a result of overall bodily under expression of tooth movement or deficient movement in a specific dimension.

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