#### UNIVERSITY OF THE **PACIFIC** Arthur A. Dugoni School of Dentistry

# Three-Dimensional Condylar changes in the Surgery First Approach: a comparison of Fixed Orthodontics vs. Invisalign Therapy

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#### BACKGROUND

During the 1960s, traditional Orthognathic Surgery was almost exclusively done with out prior orthodontic treatment. This was known as the "Surgery First Approach". This approach led to realizations that mandibular set back was limited by overjet between the maxillary and mandibular incisors. Later in the 1970s the "Orthodontic Approach" became the standard for orthognathic surgeries which encompassed orthodontic treatment before surgery. This helped to improve alignment of dental occlusion, incisor decompensation, tooth rotation, and arch coordination. More recently a "Face First" approach has been adopted where the chief complaint is taken care of immediately by improving the facial soft tissue. This approach is a modernized "Surgery First Approach". It allows for the elimination of the presurgical orthodontic phase. It allows for all dental including incisor decompensation, movements, alignment, and surgical relapse, to be corrected in the post-surgical phase with orthodontics.

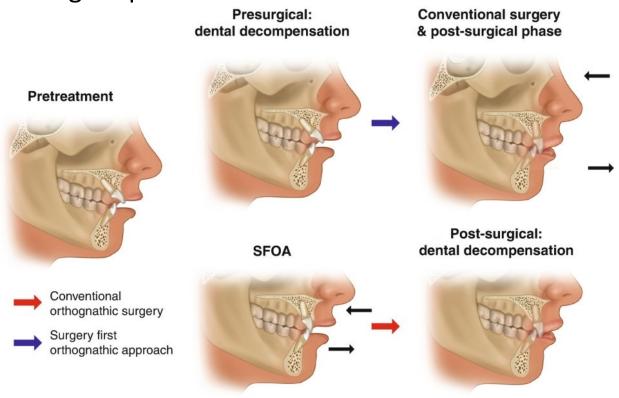
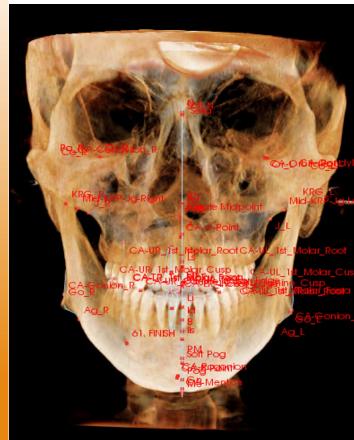


Figure A. Showing difference between Surgery first approach and traditional approach.

#### **OBJECTIVES**

To analyze condylar resorption, remodeling, and positional changes in Surgery First Approach (SFA) patients and assess correlations with cephalometric changes. The null hypothesis is that there are no significant differences in condylar changes between fixed orthodontics and Invisalign therapy post-SFA.



This retrospective observationa longitudinal study (IRB2021-70) involves two groups. Group Fixed includes 28 patients (20 males, 8 females, ages 17-25; males average age 22Y 4M, females 26Y 6M). Group Invisalign consists of 18 patients (11 males, 7 females, ages 18-48; males average age 10Y 10M, females 22Y 3M). All underwent mandibular setback

Figure 1- 3D auto-tracing

and maxillary advancement, evaluated at three points: T1 (pre-surgery), T2 (post-surgery), T3 (after orthodontic treatment). Imaging used InVivo and 3D Slicer with AI auto-tracing and specialized configuration, checking data against three planes: Frontal, Frankfort Horizontal, and Midsagittal. Inclusion criteria: adult Class III dental patients post-orthognathic surgery. Exclusion criteria: patients with condylar disorders or resorption.

Fixed	T,	1	T2		T2-T1			95% CI			Inv
n=28	Mean	SD	Mean	SD	Mean	SD	SE	Lower	Upper	p-value	n=18
Ceph values											Ceph valu
SNA	80.93	3.93	82.26	4.11	1.33	3.30	0.62	0.05	2.61	0.021	SNA
SNB	82.70	5.16	79.72	4.80	-2.98	3.52	0.66	-4.35	-1.62	<.001	SNB
ANB	3.18	2.00	2.87	1.79	-0.31	3.40	0.64	-1.63	1.01	0.316	ANB
U1 to NA_T1 (°)	29.37	7.32	6.76	2.13	22.61	5.95	1.13	20.30	24.92	<.001	U1 to NA_ T1 (
U1 to SN (°)	110.29	9.22	107.45	8.12	-2.84	5.27	1.00	-4.88	-0.80	0.004	U1 to SN (°)
U1 to L1 (°)	129.67	10.02	132.02	10.52	2.35	3.83	0.72	0.87	3.84	0.002	U1 to L1 (°)
L1 to NB (°)	22.74	6.27	20.25	7.05	-2.49	3.09	0.58	-3.69	-1.29	<.001	L1 to NB (°)
MP-SN	36.01	6.97	36.52	6.22	0.50	3.35	0.63	-0.80	1.80	0.216	MP-SN
MP to L Occ Plane	23.45	5.36	22.06	4.06	-1.39	4.26	0.80	-3.04	0.26	0.048	MP to L Occ P
FMA(MP-FH)	31.14	5.44	32.35	4.84	1.21	2.87	0.54	0.09	2.32	0.017	FMA(MP-FH)
B pt to MSP	4.33	3.12	1.94	1.41	-2.39	2.69	0.51	-3.43	-1.34	<.001	B pt to MSP
B pt to FP	4.39	4.42	6.35	4.44	1.96	5.59	1.06	-0.20	4.13	0.037	B pt to FP
B pt to FH	80.66	5.85	80.56	5.34	-0.10	2.68	0.51	-1.14	0.94	0.423	B pt to FH
A pt to MSP	1.13	0.70	1.21	0.87	0.08	1.01	0.19	-0.32	0.47	0.347	A pt to MSP
A pt to FP	2.67	1.67	2.68	1.67	0.01	1.71	0.32	-0.65	0.67	0.492	A pt to FP
A pt to FH	34.03	3.14	33.63	3.32	-0.40	2.13	0.40	-1.22	0.43	0.167	A pt to FH
Menton to MSP	1.99	7.15	-0.87	3.15	-2.86	8.74	1.65	-6.25	0.53	0.048	Menton to MS
Mx Height Diff	-0.43	2.57	0.24	1.86	0.67	2.68	0.51	-0.37	1.71	0.098	Mx Height Diff

Table 2- Results T2 vs T3 (Post Surgery to Final) - Student`s t-test

Fixed	T2	2	T	3	Т3	-T2		959	6 CI		Inv	T2		TŔ	3	T3	-T2		959	6 CI	
n=28	Mean	SD	Mean	SD	Mean	SD	SE	Lower	Upper	p-value	n=18	Mean	SD	Mean	SD	Mean	SD	SE	Lower	Upper	p-value
Ceph values											Ceph values										
SNA	82.26	4.11	81.16	3.86	-1.09	2.66	0.50	-2.12	-0.06	0.019	SNA	82.10	3.68	81.35	3.77	-0.76	1.57	0.37	-1.54	0.03	0.028
SNB	79.72	4.80	80.21	4.53	0.49	2.48	0.47	-0.47	1.45	0.153	SNB	80.21	3.94	81.68	3.40	1.47	1.38	0.33	0.78	2.15	0.000
ANB	2.87	1.79	2.53	1.52	-0.35	1.87	0.35	-1.07	0.38	0.169	ANB	2.15	1.78	1.65	1.50	-0.51	1.73	0.41	-1.37	0.36	0.117
U1 to NA_T1 (°)	6.76	2.13	7.44	2.48	-17.76	5.92	1.12	-20.05	-15.46	0.000	U1 to NA_ T1 (°)	6.88	1.67	8.23	1.85	-18.37	5.89	1.39	-21.30	-15.44	0.000
U1 to SN (°)	107.45	8.12	107.91	8.47	0.46	6.04	1.14	-1.88	2.81	0.344	U1 to SN (°)	108.70	8.21	106.36	8.65	-2.34	7.40	1.74	-6.02	1.34	0.098
U1 to L1 (°)	132.02	10.52	127.82	8.09	-4.20	11.11	2.10	-8.51	0.11	0.028	U1 to L1 (°)	133.88	10.46	133.92	9.45	0.04	8.18	1.93	-4.03	4.11	0.492
L1 to NB (°)	20.25	7.05	24.47	5.25	4.23	7.24	1.37	1.42	7.04	0.002	L1 to NB (°)	17.64	6.02	21.41	5.27	3.77	5.43	1.28	1.07	6.47	0.005
MP-SN	36.52	6.22	37.34	6.68	0.83	3.46	0.65	-0.51	2.17	0.107	MP-SN	35.34	6.08	34.72	5.95	-0.62	2.33	0.55	-1.78	0.54	0.138
MP to L Occ Plane	22.06	4.06	24.86	4.54	2.81	3.21	0.61	1.56	4.05	0.000	MP to L Occ Plane	21.42	3.62	24.49	4.21	3.08	4.46	1.05	0.86	5.30	0.005
FMA(MP-FH)	32.35	4.84	33.17	6.07	0.82	2.46	0.46	-0.14	1.77	0.045	FMA(MP-FH)	31.25	5.18	30.54	5.43	-0.71	1.50	0.35	-1.46	0.04	0.031
B pt to MSP	1.94	1.41	2.38	2.06	0.44	2.06	0.39	-0.36	1.24	0.135	B pt to MSP	1.92	2.01	2.27	1.69	0.36	2.02	0.48	-0.65	1.36	0.233
B pt to FP	6.35	4.44	5.63	4.16	-0.72	2.54	0.48	-1.71	0.26	0.072	B pt to FP	5.87	3.47	4.62	3.09	-1.26	2.76	0.65	-2.63	0.12	0.035
B pt to FH	80.56	5.34	78.41	4.87	-2.15	4.71	0.89	-3.97	-0.32	0.011	B pt to FH	77.22	5.42	75.58	5.18	-1.65	1.61	0.38	-2.45	-0.84	0.000
A pt to MSP	1.21	0.87	1.22	1.00	0.01	0.66	0.13	-0.25	0.27	0.467	A pt_to MSP	1.23	0.95	1.63	1.08	0.40	0.86	0.20	-0.03	0.83	0.034
A pt to FP	2.68	1.67	2.93	1.79	0.26	1.00	0.19	-0.13	0.65	0.093	A pt to FP	2.27	1.92	2.59	2.28	0.32	1.64	0.39	-0.50	1.14	0.210
A pt to FH	33.63	3.32	32.99	3.31	-0.65	1.66	0.31	-1.29	0.00	0.024	A pt to FH	33.81	3.66	32.83	3.28	-0.98	2.16	0.51	-2.06	0.09	0.035
Menton to MSP	-0.87	3.15	-0.27	3.71	0.60	4.20	0.79	-1.03	2.22	0.230	Menton to MSP	-0.90	2.23	-1.30	2.27	-0.40	3.01	0.71	-1.90	1.10	0.291
Mx Height Diff	0.24	1.86	0.23	1.80	-0.01	1.76	0.33	-0.69	0.67	0.486	Mx Height Diff	0.14	1.07	0.28	1.26	0.14	1.44	0.34	-0.58	0.85	0.347

#### **METHODS**

## **RESULTS AND DISCUSSION**

Table 3- Showing results of T1 Vs T2 Differences between Fixed and Invisalign. Significant differences were seen in the SNB between the two.

	FIXED	n = 28	INV	= 18	TŹ	H1	Fix -	Inv	
Inv	T2-T1		T2-	-T1			959	6 CI	
n=18	Mean	SD	Mean	SD	Mean	SD	Lower	Upper	p-valu
Ceph values									
SNA	1.33	3.30	-0.02	2.93	1.35	0.96	-0.58	3.28	0.08
SNB	-2.98	3.52	-5.12	1.62	2.14	0.89	0.35	3.92	0.01
ANB	-0.31	3.40	-1.25	3.22	0.94	1.01	-1.09	2.97	0.17
U1 to NA(°)	-2.84	5.27	-4.20	4.31	0.03	1.40	-2.80	2.85	0.49
U1 to SN (°)	-2.49	3.09	-4.22	2.37	1.38	1.32	-1.29	4.05	0.15
U1 to L1 (°)	-1.39	4.26	1.48	3.94	0.88	1.17	-1.48	3.23	0.22
L1 to NB (°)	2.35	3.83	-2.38	2.71	-0.11	0.89	-1.91	1.68	0.44
MP-SN	0.50	3.35	1.62	3.07	-1.11	0.98	-3.09	0.86	0.13
MP to L Occ Plane	10.22	51.65	-2.29	4.92	0.90	1.37	-1.86	3.65	0.25
FMA(MP-FH)	1.21	2.87	1.63	3.33	-0.42	0.92	-2.29	1.44	0.32
B pt_to MSP	0.08	1.01	-0.98	2.92	-1.41	0.84	-3.11	0.28	0.05
B pt to FP	0.01	1.71	0.35	6.93	1.61	1.86	-2.13	5.36	0.19
B pt to FH	-0.40	2.13	-1.87	5.51	1.77	1.21	-0.67	4.22	0.07
A pt to MSP	-0.07	1.65	0.13	0.82	-0.05	0.28	-0.63	0.52	0.42
A pt to FP	-0.76	6.73	0.00	1.68	0.01	0.51	-1.02	1.04	0.49
A pt to FH	0.14	2.87	0.34	2.05	-0.73	0.63	-2.01	0.54	0.12
Menton to MSP	-0.97	3.38	0.68	4.25	-3.54	2.22	-8.01	0.93	0.05
Mx Height Diff	0.67	2.68	-0.04	1.90	0.71	0.73	-0.76	2.18	0.16

Table 4- Showing results of T2 vs T3 differences between Fixed and Invisalign. FMA increased in fixed group and decreased in the Invisalian group

	FIXED	n = 28	INV	= 18		T3-	<b>T2 Fi</b>	x - Inv	
	T3·	T3	-T2			959			
	Mean	SD	Mean	SD	Mean	SE	Lower	Upper	p-value
Ceph values									
SNA	-1.09	2.66	-0.76	1.57	-0.34	0.69	-1.74	1.06	0.314
SNB	0.49	2.48	1.47	1.38	-0.98	0.64	-2.27	0.31	0.067
ANB	-0.35	1.87	-0.51	1.73	0.16	0.55	-0.95	1.27	0.387
U1 to NA(°)	1.56	6.34	-1.59	7.42	3.15	2.05	-0.98	7.27	0.066
U1 to SN (°)	0.46	6.04	-2.34	7.40	2.81	1.99	-1.21	6.83	0.083
U1 to L1 (°)	-4.20	11.11	0.04	8.18	-4.24	3.05	-10.38	1.89	0.085
L1 to NB (°)	4.23	7.24	3.77	5.43	0.46	1.99	-3.56	4.48	0.410
MP-SN	0.83	3.46	-0.62	2.33	1.45	0.93	-0.42	3.32	0.063
MP to L Occ Plane	2.81	3.21	3.08	4.46	-0.27	1.13	-2.55	2.01	0.406
FMA(MP-FH)	0.82	2.46	-0.71	1.50	1.53	0.65	0.22	2.83	0.011
B pt to MSP	0.44	2.06	0.36	2.02	0.08	0.62	-1.16	1.33	0.447
B pt to FP	-0.72	2.54	-1.26	2.76	0.53	0.79	-1.07	2.13	0.253
B pt to FH	-2.15	4.71	-1.65	1.61	-0.50	1.15	-2.83	1.82	0.333
A pt to MSP	0.01	0.66	0.40	0.86	-0.39	0.23	-0.84	0.07	0.047
A pt to FP	0.26	1.00	0.32	1.64	-0.06	0.39	-0.85	0.72	0.437
A pt to FH	-0.65	1.66	-0.98	2.16	0.34	0.56	-0.80	1.47	0.277
Menton to MSP	0.60	4.20	-0.40	3.01	0.99	1.14	-1.31	3.30	0.195
Mx Height Diff	-0.01	1.76	0.14	1.44	-0.15	0.50	-1.15	0.85	0.384

Figure 2- Summary of results for the skeletal bone bases between groups and time points.

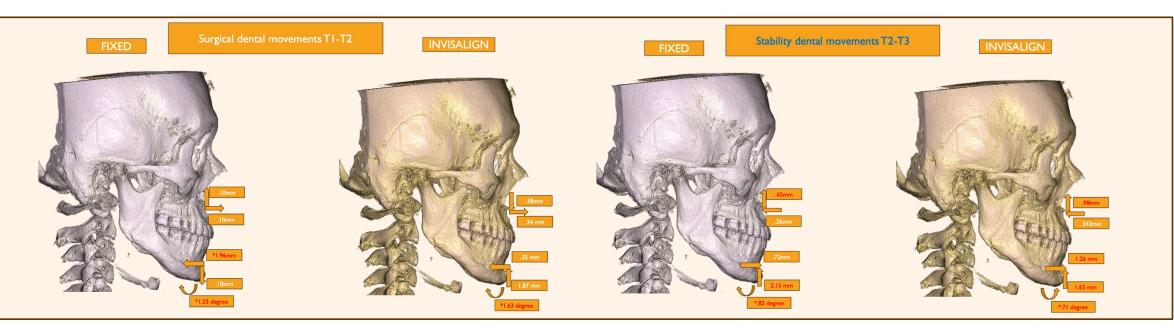


Figure 3- Summary of results for the dental movements between groups and time points.

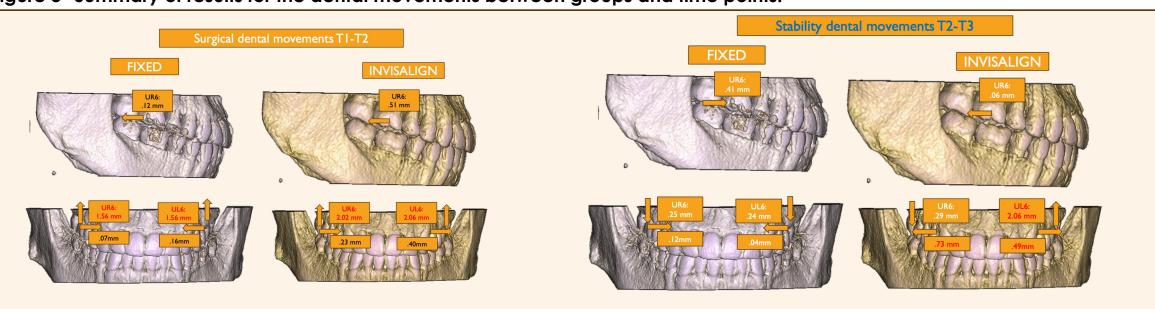
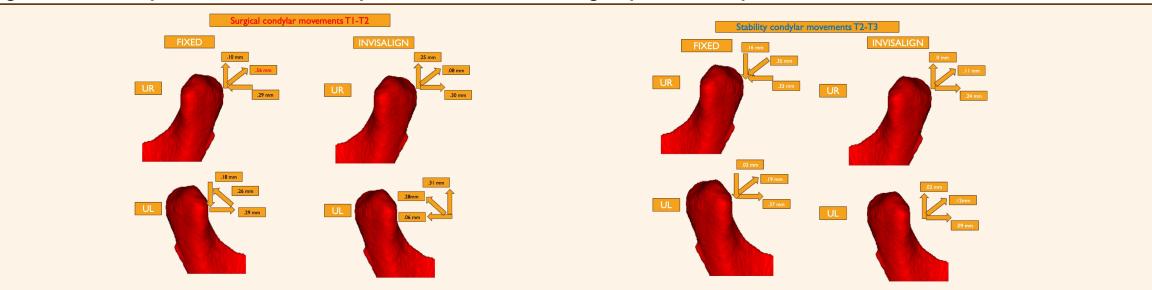
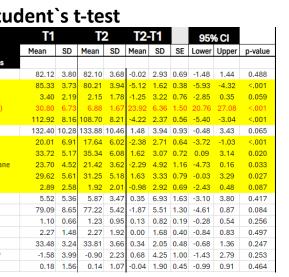


Figure 4- Summary of results for the condyle movements between groups and time points.







Instrumentation Laboratory

Table 5- Shows there was no significant diferences between the 2groups for condylar changes between T2 and T3

	FIXED	n = 28	INV	=18	T3-T2 Fix - Inv						
	T3-	<b>T2</b>	T3	-T2			959				
	Mean	SD	Mean	SD	Mean	SE	Lower	Upper	p-value		
Condylar Width	-0.56	2.66	-0.23	2.29	-0.33	0.76	-1.87	1.20	0.332		
Cd_R to MSP	-0.35	1.51	-0.11	1.22	-0.24	0.42	-1.10	0.61	0.285		
Cd_R to FP	-0.33	3.61	-0.24	1.52	-0.09	0.90	-1.91	1.72	0.459		
Cd_ R to FH	0.16	0.90	0.00	0.57	0.17	0.24	-0.31	0.65	0.241		
Cd_L to MSP	-0.19	2.10	-0.12	1.72	-0.07	0.59	-1.27	1.12	0.452		
Cd_L to FP	-0.37	2.59	-0.09	1.45	-0.28	0.67	-1.63	1.07	0.338		
Cd_L to FH	0.02	1.31	-0.02	0.47	0.03	0.32	-0.62	0.69	0.457		

## CONCLUSION

Most skeletal variables showed no statistically significant differences between the groups post-surgery and after treatment completion. No condylar changes were observed in the SFA between the fixed and Invisalign groups. The null hypothesis is accepted, indicating no significant differences in condylar changes between the two treatment modalities.

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