Table S1. Study characteristics.

Author (Year)	Study Type	Group Design and Sample Size	Gender	Age	Dental Condition	Vit D	Treatment Duration	Appliance Type	Appliance Position
Al-Attar and Abid, (2022)	RCT	ND3G (n=15), CG (n=15)	Not specified	18–30 yrs	Mandibular anterior crowding (LII 3–6mm)	Yes	18 weeks	FOT	Md anterior
Al-Hasani (2011)	Prospective cohort study	3 groups (n=5 each, 3 doses of calcitriol, 15/25/40 pg)	Not specified	17–28 yrs	Class I/II, premolar extraction	Yes	3 weeks	FOT	Mx canine
Aman (2018)	Retrospective cohort study	160 patients	104F/56M	Mean 34 yrs	Maxillary anterior, aligner therapy	No	2.19 yrs	CAT (Invisalign)	Mx anterior
Aras (2018)	Clinical study	DQ (n=16), TO (n=16)	DQ: 12F/4M; TO: 10F/6M	14.9–15.0 yrs	Angle Class I, crowding (4–10 mm)	No	9 months	FOT (SL) vs FOT (CO)	Mx anterior
Azizi (2022)	Retrospective cohort study	80 patients (stratified by Vit D levels)	Not specified	12–30 yrs	Maxillary anterior (fixed treatment)	Yes	2 yrs	FOT	Mx anterior
de Almeida (2018)	RCT	CIA (n=12), Continuous arch (n=16)	CIA: 8M/4F; CA: 8M/8F	CIA: 15.1 yrs; CA: 22.1 yrs	Deep bite or AOB, <3mm crowding	No	6 months	FOT	Mx anterior
Fontana (2012)	Prospective cohort study	160 low-EARR, 179 high-EARR, 38 untreated	154M/185F	Mean 14.9 yrs	Class II Div 1, no trauma	Yes	7 months	FOT	Mx central incisor
Han (2005)	Clinical study	9 patients, split-mouth	5F/4M	12.7–20 yrs	Maxillary 1st premolars, intrusion/extrusion	No	8 weeks	FOT	Mx premolars
Iosub Ciur (2016)	Clinical study	4 patients, split-mouth (CBCT)	3M/1F	~18 yrs	Canine distalization (post-extraction)	Yes	3 months	FOT	Single canine (Mx/Md)
Jacobs (2014)	Retrospective cohort study	SL (n=139), Non-SL (n=74)	SL: 83F/56M; Non-SL: 51F/23M	Mean 12.4 yrs	Upper/lower incisors	No	21 months	FOT (SL) vs FOT (CO)	Anterior (Mx/Md)
Leite (2012)	Prospective cohort study	Self-ligating (n=11), Conventional (n=8)	SL: 5F/6M; Conv: 6F/2M	11–30 yrs	Class I with 3–5 mm crowding	No	6 months	FOT (SL) vs FOT (CO)	Upper and lower anterior
Liu (2012)	Case based comparative clinical study	Damon (n=15), Conventional (n=15)	Not specified	Not reported	Class I/II crowding, extraction	No	Not specified	FOT (SL) vs FOT (CO)	Mx/Md incisors
Pandis (2008)	Retrospective cohort study	Damon2 (n=48), Microarch (n=48)	67F/29M	Mean 13.2 yrs	Maxillary anterior, no trauma	No	26.4 months	FOT (SL) vs FOT (CO)	Mx anterior
Scott (2008)	RCT	Damon3 (n=32), Synthesis (n=28)	31M/31F	Mean 16.27 yrs	Mandibular crowding (5–12 mm), extraction	No	9 months	FOT (SL) vs FOT (CO)	Md anterior
Tehranchi (2017)	Cross-sectional study	34 patients (4 Vit D levels)	23.5% male	12–23 yrs	Maxillary incisors, no trauma	Yes	Avg. 3.91 yrs	FOT (Roth)	Mx anterior
Varughese (2019)	RCT	15 patients (split-mouth)	Not specified	15–30 yrs	Maxillary canine distalization	Yes	3 months	FOT (MBT)	Mx canine

Wang (2020)	RCT	Investigational (n=28), Invisalign (n=15)	86% F, 14% M	Mean 31 yrs	Class I/II mild-moderate, <6mm crowding	No	15 months	CAT	Upper/lower anterior
Withayanukonkij (2023)	RCT	CA (n=20), FM (n=20)	CA: 8M/ 12F; FM: 7M/13F	~21.7 yrs	Anterior open bite, mild-moderate	No	6 months	CAT vs FOT	Mx first molars
Yi (2018)	Retrospective cohort study	CAT (n=40), FOT (n=40)	CAT: 31F/ 9M; FOT: 29F/11M	Mean 22.54 yrs	Non-extraction mild crowding	No	21 months	CAT vs FOT	Upper/lower anterior

CAT: clear aligner therapy, CG: control group, CIA: Connecticut intrusion arch, DQ: distal quadrant, EARR: External apical root resorption, FOT (MBT): fixed orthodontic treatment using mclaughlin–bennett–trevisi system, FOT (Roth): fixed orthodontic treatment using roth prescription, FOT(CO): fixed orthodontic treatment conventional, FOT(SL): fixed orthodontic treatment self-ligating, FOT: fixed orthodontic treatment, Md: mandible, Mx: maxilla, ND: normal dose, SL: self-ligating, CBCT: cone beam computed tomography, CA: clear aligner, TO: torque-oriented, RCT: randomized controlled trial

Table S2. Root resorption without Vit D related studies.

Author (Year)	Appliance type	Appliance position	Root resorption (mm or %)	p value
Aras (2018)	FOT	Maxillary anterior	FOT (SL) central incisors 9.73%, lateral incisors 9.63% FOT (CO) central incisors 10.02%, lateral incisors 8.89%	>0.05
de Almeida (2018)	FOT	Maxillary anterior	CIA: 0.76 mm; Continuous: 0.59 mm	>0.05
Han (2005)	FOT	Maxillary premolars	Intrusion: 5.75%; Extrusion: 1.28%	<0.01
Jacobs (2014)	FOT	Anterior (maxilla/ mandible)	SL: 3.0%; Non-SL: 4.5%	0.33
Leite (2012)	FOT	Upper and lower anterior	Maxillary central incisor SL: 0.34 mm; Conv: 0.33 mm Maxillary lateral incisor SL: 0.43 mm; Conv: 0.44 mm Mandibular central incisor SL: 0.39 mm; Conv: 0.31 mm Mandibular lateral incisor SL: 0.23 mm; Conv: 0.40 mm	>0.05
Liu (2012)	FOT	Maxillary and mandibular incisors	Maxillary central incisor Damon: 2.05 mm; Conv: 2.08 mm Maxillary lateral incisor Damon: 1.77 mm; Conv: 1.91 mm Mandibular central incisor Damon: 2.06 mm; Conv: 1.98 mm Mandibular lateral incisor Damon: 1.94 mm; Conv: 1.84 mm	0.973
Pandis (2008)	FOT	Maxillary anterior	median of 1.05 mm (5th-95th percentile: 0.18-3.06 mm)	>0.05
Scott (2008)	FOT	Mandibular anterior	mandibular right central incisor Damon: 2.26 mm; Synthesis Conv: 1.21 mm;	>0.05
Aman (2018)	CAT	Maxillary anterior	central incisors 0.53 ± 0.59 mm lateral incisors 0.49 ± 0.57 mm Change in root length (%): 3.6–4.3%	>0.05
Wang (2020)	CAT	Upper/low-er anterior	Investigation: 0.11-0.23 mm; Control: 0.04-0.09 mm	>0.05
Withayanukonkij (2023)	CAT	Maxillary first molars	FM: 0.38-0.47 mm; CA: 0.04-0.09 mm	<0.05
Yi (2018)	CAT	Upper/low-er anterior	CAT: 5.13 ± 2.81%; FOT: 6.97 ± 3.67%	<0.001

CA: clear aligner, CIA: Connecticut intrusion arch, SL: self-ligating, FM: fixed mechanotherapy, FOT(CO): fixed orthodontic treatment conventional, FOT(SL): fixed orthodontic treatment self-ligating, FOT: fixed orthodontic treatment