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Endo Sinus Bone Gain Following Different Approaches of Maxillary Sinus Lift: A Systematic Review

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Abstract

Posterior maxillary implant with sinus lifting is technique sensitive. Opting a precise procedure within the clinical constraints will eventually payoff. The purpose of this systematic review is to analyse a specific procedure based on notable clinical parameters apt to an individual subject. A Systematic search on PubMed databases with the MeSH terms "sinus lift, bone gain, trans-crestal, lateral "was performed. Articles were critically reviewed by the examiners basing on inclusion criteria. Letters to the editor, case reports, commentaries, and articles published in languages other than English were excluded. A total of 969 articles presenting various studies conducted in maxillary posterior region with respect to sinus lift were evident. Out of which 21 prospective studies were considered relating to the procedural and background parameters included in the study. The parameters considered were the residual bone height, type of approach and the endo sinus bone gain following a prescribed interval. Due to heterogeneity across all the studies, meta-analysis was not performed. Within the limitations of the study, the results revealed that the selection of type of approach depends on the pre residual bone height. In order to obtain maximum bone, gain lateral approach is to be preferred to other two approaches.
Keywords: implants, sinus lift, sinus agumentation, bone gain, transcrestal, lateral approach
Keywords: This study is compiled to choose a particular sinus lift approach, based on the pre-existing bone height to obtain a maximum bone gain as an end result.

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INTRODUCTION

Rehabilitation of the posterior maxilla with implants is challenging, by virtue of the available bone height, residual ridge resorption and poor bone density (247.12 ± 46.75 HU) which is 3 folds less than the density in lower mandibular region. [1] Lower initial implant stability and higher implant failure occurs as an end result. To counteract these problems, various treatment options like the use of short implants, bone grafts, sinus lift techniques, pterygoid & zygoma implants came into existence, of which the most commonly practised are the sinus lift techniques. Augmentation of sinus lift was first reported by Tatum and later modified by Boyne and James. Sinus lift procedures can increase the bone height by 3-9mm depending on whether the approach is transcrestal or lateral either with or without the use of graft. [2] maxillary sinus lift procedures has been performed using various bone grafts such as allografts, alloplast and xenografts. [3-8] The residual bone height, the use of graft and the approach to sinus (lateral or trans crestal) can indicate the amount of bone gain and implant success in future. Selection among various sinus lift techniques (direct Vs indirect or graft Vs non-graft) requires a proper diagnosis and treatment planning. This case-based selection requires a pre bone analysis using a panoramic radiograph or CBCT. However, the amount of endo sinus bone gain (ESBG) varies in different techniques of sinus lift selected based on the residual bone height (RBH). In the literature search, there exist lacunae of evidence regarding the relation of RBH and ESBG in various maxillary sinus lift approaches. This present study is therefore designed to systematically review the techniques of sinus lift and relate them to the amount of endo sinus bone gain.

Objective

The primary objective of this systematic review is to analyse and estimate the amount of endo sinus bone gain following different approaches of sinus lift based on the residual bone height present at the time of surgery.

METHODOLOGY

This systematic review was conducted in accordance with the PRISMA guidelines [9] and following the model proposed in the literature [10]

Search Strategy:

An extensive online search of literature was conducted using PubMed, Cochrane library, Scopus databases between the years 2009 and 2018, by entering the MeSH terms "sinus lift, dental implant, transcrestal , lateral sinus lift, bone gain" in single & in combinations. The bibliographies of few relevant publications were also scrutinised. The titles and abstracts were analysed to set an inclusion criteria for the study.

Selection of Studies:

Clinical studies were chosen after reviewing titles and abstracts. Only prospective studies were included. The participants, intervention, comparison, outcome and the time point were determined to formulate a specific question. Participants were patients who underwent maxillary sinus lift surgery through any of the listed techniques, concomitant with implant placement. The intervention was different techniques of maxillary sinus lift surgery selected based on residual bone height. The comparison was between the different approaches (lateral or transcrestal , with or without graft) of sinus lift. The outcomes analysed were the amount of endo sinus bone gain in different techniques of sinus lift. The time frame for the outcome measurement was scheduled to be more than 6 months.

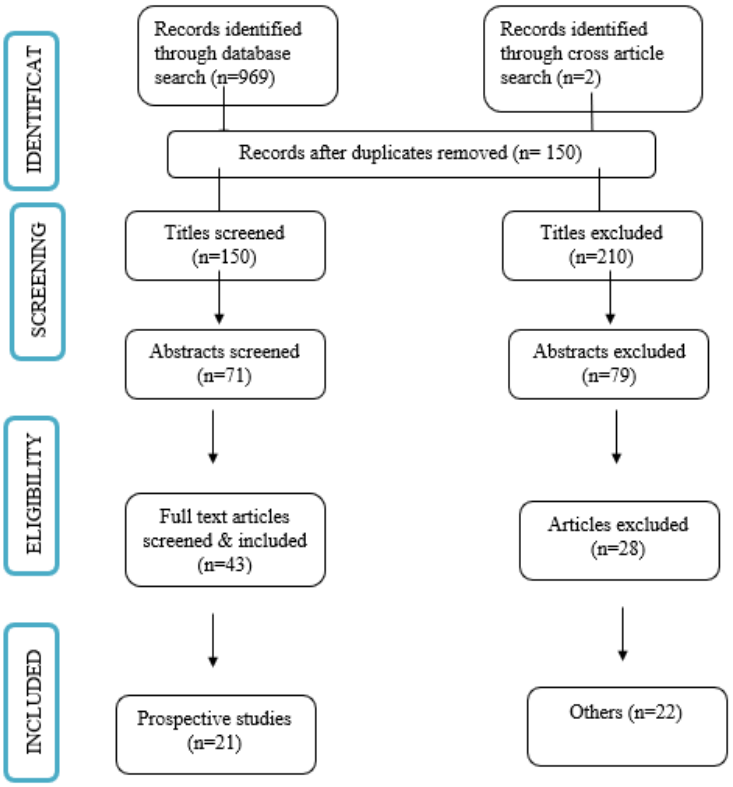
Inclusion Criteria:

Articles in English language, clinical trials, in vivo studies on human, sinus augmentation using either lateral or transcrestal approach associated with implant placement, a minimum follow-up period of 6 months.

Exclusion Criteria:

Articles including case series, pilot studies, case reports, literature and systemic reviews, ex-vivo, in-vitro and animal studies were excluded.

Data Analysis:



l the 21 prospective studies were reviewed and following data was extracted from each article: author name, type of study, number of subjects, number of implants, implant dimensions, diagnostic aid, technique of sinus lift, residual bone height, follow up period, endo sinus bone gain. The data obtained was processed for quantitative assessment. Due to heterogeneity across all the studies, meta-analysis was not performed.

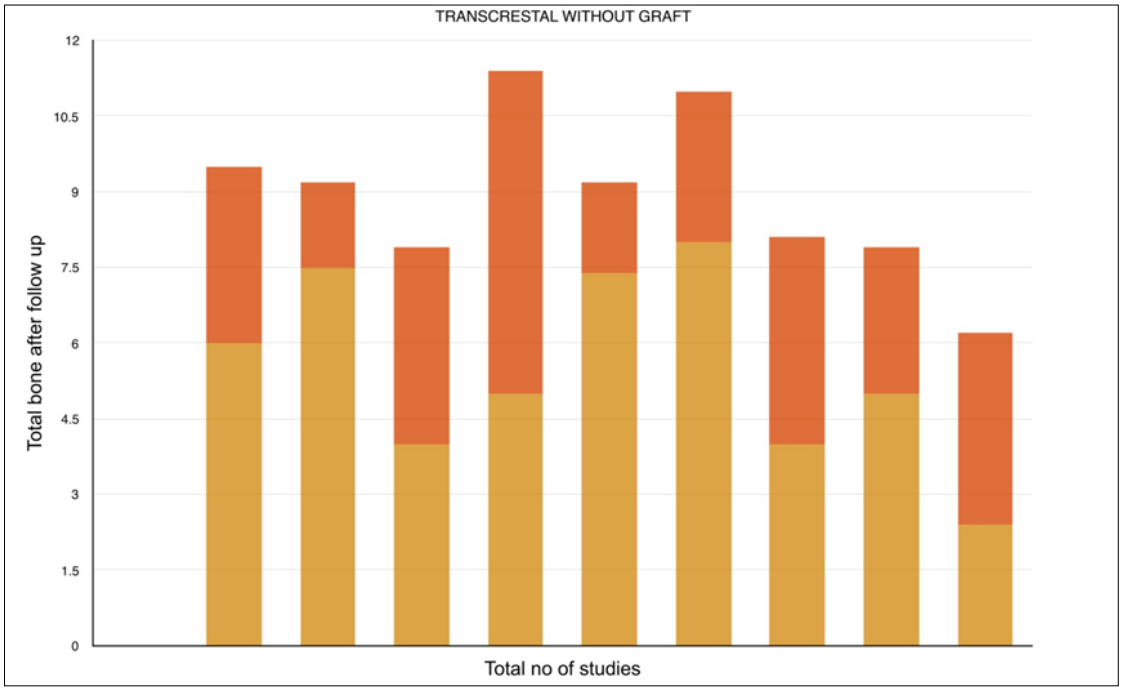
RESULTS

A total of 16 prospective studies and 1,183 implants were analysed for endo sinus bone gain under three groups. The groups were categorised based on the technique used, the transcrestal approach without graft, the transcrestal approach with graft, and the lateral approach respectively. The results were discussed separately for individual group.

In review of all these studies transcrestal approach without graft, where mean residual bone height was 5.4 mm showed maximum and minimum bone gain of 6.4±1.6 mm and 1.7 mm respectively. The mean endo sinus bone gain was 3.4mm. (Table – 1, Graph - 1)

Table 1: Summary of published articles using transcrestal approach of sinus augmentation

Name of the author	Type of study	No of subjects	No of implants placed	Implant dimensions	Dignostic aid	Residula bone height	Technique of sinus lift	Follow up period	Endo sinus bone gain
Zitzmann and Scharer (1998)	Prospective	30	79	L- 8.5mm,10 mm	CT, OPG	> 6 mm	Trans crestal without graft	2.5 years	3.5 mm
Pjetursson (2009)	Prospective RCT	181	252	L- 8.5mm	IOPA	7.5mm	Trans crestal without graft	3 years	1.7mm
Rabah nedir (2012)	Prospective RCT	22	37	L-8.0 mm D-4.8mm	IOPA	≤ 4.0mm	Trans crestal without graft	1 year	3.9 ±1.0 mm
Alessandro Pozzi (2013)	Prospective cohort	66	136	L-10,15mm D-4,4.3,5mm	IOPA	≤ 5.0mm	Trans crestal without graft	3 years	6.4±1.6mm
Artiza (2014)	Prospective	36	36	L-8,10mm	IOPA	7.4 ±0.4mm	Trans crestal without graft	2.0 years	1.8±0.3mm
Rabah nedir (2015)	Prospective	17	23	L-10.0mm	OPG	≤8.0mm	Trans crestal without graft	10 years	3.0±1.4mm
Rabah nedir (2015)	Prospective RCT	12	37	L-8.0 mm D-4.8mm	IOPA	≤ 4.0mm	Trans crestal without graft	3 years	4.1±1.0mm
T.Bensaha (2015)	Prospective RCT	20	20	L-10,11.5,13mm D- 3.5,4,4.5mm	OPG,CT	≤ 5.0mm	Trans crestal without graft	1 year	2.9±0.32mm
Rabah nebir (2016)	Prospective RCT	12	37	L-8mm D-4.8mm	IOPA	2.4±0.9mm	Trans crestal without graft	5 years	3.8±1.0mm

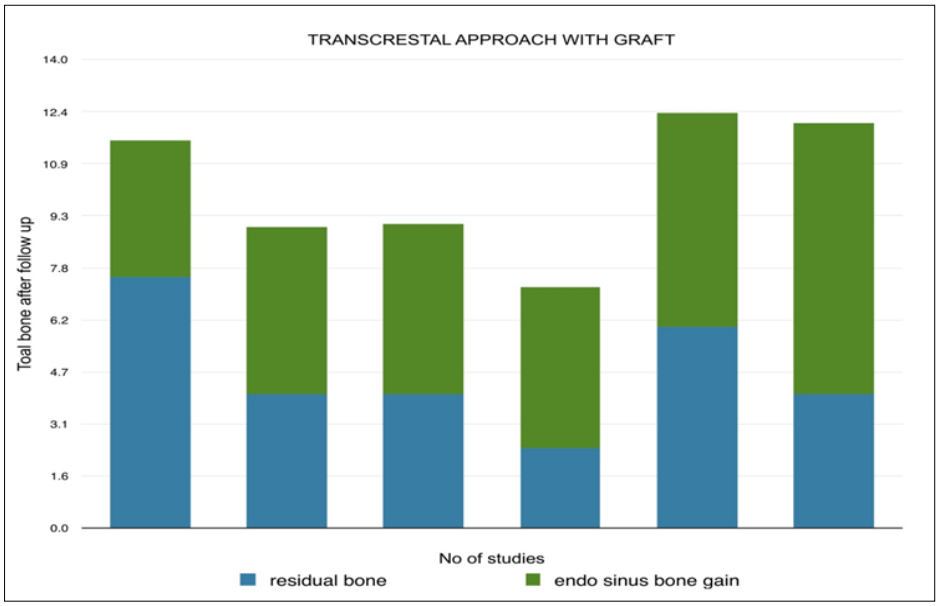


Graph 1: Comparison of pre- and post-operative bone in transcrestal approach of sinus augmentation.

Whereas average bone gain in transcrestal approach with graft was 5.5 mm with pre residual bone height being 4.6mm. The maximum and minimum bone gain was 8.1±3.4mm and 4.1 mm respectively. (Table – 2, Graph - 2)

Table 2: Summary of published articles using bone grafts via transcrestal approach of sinus augmentation

Name of the author	Type of study	No of subjects	No of implants placed	Implant dimensions	Dignostic aid	Residula bone height	Technique of sinus lift	Follow up period	Endo sinus bone gain
Pjetursson (2009)	Prospective RCT	181	252	L-8.5 mm	IOPA	7.5 mm	Transcrestal with graft	3 years	4.1 mm
Rabah nedir (2012)	Prospective RCT	22	37	L-8.0 mm D-4.8mm	IOPA	≤ 4.0mm	Trans crestal with graft	1 year	5.0 ±1.3 mm
Rabah nedir (2015)	Prospective RCT	12	37	L-8.0 mm D-4.8mm	IOPA	≤ 4.0mm	Trans crestal with graft	3 years	5.1± 1.2 mm
Rabah nebir (2016)	Prospective RCT	12	37	L-8mm D-4.8mm	IOPA	2.4±0.9mm	Trans crestal with graft	5 years	4.8±1.2mm
Laith (2017)	Prospective	24	24	L- 8.5mm,10 mm	CBCT	≤6.0mm	Trans crestal with graft (baloon lift)	6months	6.48mm
J.lopez (2018)	Prospective	27	27	L-11,13,15 mm D-4mm	OPG,CT	≤ 4.0mm	Trans crestal with graft (baloon lift)	6months	8.10±3.45mm

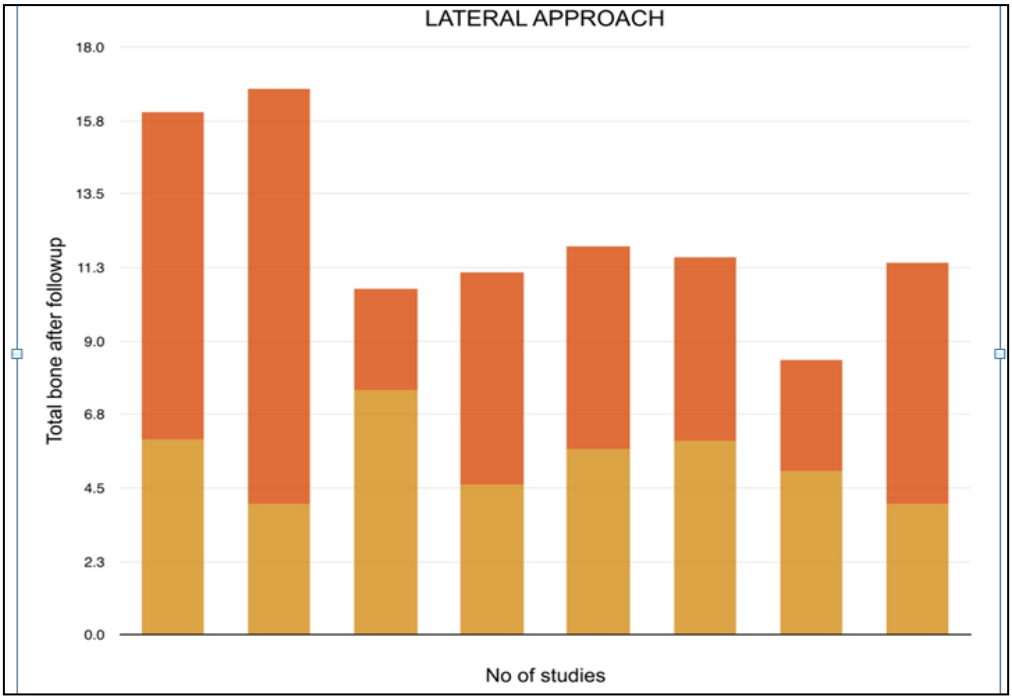


Graph 2: Comparison of pre and post-operative bone in transcrestal approach of sinus augmentation using bone grafts

On the other hand, the lateral approach resulted in average endo sinus bone gain of 6.4 mm with a mean pre residual bone height of 5.2 mm. The maximum and minimum bone gain was 12.7mm and 2.7±0.5 mm respectively. (Table – 3, Graph – 3)

Table 3: Summary of published articles using lateral approach of sinus augmentation

Name of the author	Type of study	No of subjects	No of implants placed	Implant dimensions	Dignostic aid	Residula bone height	Technique of sinus lift	Follow up period	Endo sinus bone gain
Zitzmann and Scharer (1998)	Prospective	30	79	L- 8.5mm,10 mm	CT, OPG	4-6 mm	1 step lateral approach	2.5 years	10 mm
Zitzmann and Scharer (1998)	Prospective	30	79	L- 8.5mm,10 mm	CT, OPG	<4 mm	2 step lateral approach	2.5 years	12.7 mm
Chen (2007)	Prospective	47	75	L-12,13,15 mm	CBCT,OPG	7.5±2.1 mm	Lateral approach	2 years	2.7 ± 0.5 mm
Thor (2007)	Prospective	20	44	L-9,11,13,15 mm D-4.5,5 mm	OPG	4.6 mm	Lateral approach	1 year	6.5 mm
Giovanni cricchio (2010)	Prospective RCT	84	239	L-11.5,13,15 mm	CT	5.7±2.3mm	Lateral approach	6 years	5.2 ± 2.2 mm
Bassi (2015)	Prospective	20	45	L- 13 mm D-4.3 mm	CBCT	5.94 mm	Lateral approach	3.5 years	5.63 mm
T.Bensaha (2015)	Prospective RCT	20	20	L-10,11.5,13mm D- 3.5,4,4.5mm	OPG,CT	≤ 5.0mm	Lateral approach	1 year	2.7 ± 0.7mm
Falah (2016)	Prospective	18	72	L-11,13 mm	CBCT	> 4 mm	Lateral approach	1 year	6.14± 1.34 mm



Graph 3: Comparison of pre and post-operative bone in lateral approach of sinus augmentation

DISCUSSION

Maxillary sinus pneumatisation and bone resorption following tooth loss always necessitates a sinus lift for the placement of dental implant. Maxillary sinus lift is a versatile procedure, done either using osteotomes or balloon lift or piezoelectric or endoscopic technique, however the outcome depends on the clinician approach to the sinus i.e; either via trans crestal or lateral window approach. The crucial parameter deciding the type of approach is the residual bone height present at the time of surgery.[11] Misch *et al.,* recommended the use of transcrestal approach in case of RBH ≥ 6mm and lateral window approach in cases less than 6mm.[12] The first invasive surgery via transalveolar approach using socket former was reported by Tatum in 1986.[13] Summer improvised Tatum's technique using osteotomes and devised new techniques of future site development, bone added osteotome sinus floor elevation, and osteotome sinus floor elevation.[14] Systematic reviews of different techniques showed that the type of approach influences the implant survival and bone gain.[15-19] A meta-analysis by Emmerich et al on sinus-lift techniques performed with osteotomes reported a value of 90.9% 24 months after loading.[15] Tan *et al.,* in a 2008 review of transalveolar approaches, showed a mean implant survival of 92.8% with 3 years follow-up.[16] The results of the meta-analysis done by Mingdong Yan *et al.,* suggested that the overall amounts of endo-sinus bone gain in transcrestal approach at 12 months and 36 months were lower in the non-graft group compared to graft group, with difference of 1.10 mm at 12 months and 0.74 mm at 36 months was noted.[17] Systemic reviews conducted on maxillary sinus lift indicated more bone gain of 6.2mm in lateral approach than transcrestal.[18,19]

Prospective Clinical Studies

Alessandro Pozzi *et al.,* in 2013 conducted a prospective study on 66 patients using CAD/ CAM guided surgical template via transcrestal approach. The posterior maxillary residual bone height was 6.7±1.6 mm, over a follow up period of 3 years gained 6.4±1.6 mm of bone. [20] The radiographic results of this investigation are similar to those reported by Bernardello and colleagues in a retrospective study with an average residual bone height of 3.46 ± 0.91 mm and a radiographic bone gain of 6.48 ± 2.38 mm.[21] In a study conducted by Artiza *et al.,* In 2014 using OSFE without grafting, the mean bone gain of 1.8± 0.3mm was noted after a follow up of 2 years.[22]

Laith *et al.,* performed a prospective clinical study on 24 patients using transcrestal osteotome antral membrane elevation where Oxidised Regenerated Cellulose and Osteon II were used as the graft material to fill the surgical void. The amount of bone gain was evaluated radiologically after a year. The mean bone gain in ORC and Osteon II group was 5.94 mm and 7.02mm respectively. [23]

In 2018, J.Lopez *et al.,* placed 27 implants in 27 patients using Minimally Invasive Antral Membrane Balloon Elevation (MIAMBE) technique via transcrestal approach. The initial sinus floor height was measured for each patient and compared with the height at 6 months post-surgery. The results displayed an average bone height gain of 8.1 ± 3.45 mm. [24]

Prospective Comparative Studies

Zitzmann & Scharer in the year 1998 conducted a study with the purpose to compare three different

methods of sinus elevation (1) the lateral antrostomy as a two-step procedure, (2) the lateral antrostomy as a one-step procedure, and (3) the osteotome technique with a crestal approach. 30 subjects were allocated into these groups based on the residual bone height (RBH ≤ 4mm – 2 step lateral, 4-6mm – 1 step lateral, ≥6mm – transcrestal). The average bone gain was comparable between 1 step and 2 step lateral approaches with values of 10 and 12.7mm respectively. However, the bone gain in osteotome technique was 3.5 mm which was quite less compared to other two techniques. The author concluded that in severely resorbed ridges, a lateral antrostomy is required for the sake of ending up with a sufficient bone height for adequate implant length.[25] Similar study conducted by T.Bensaha *et al.,*in 2015 to assess and compare the bone gain qualitatively and quantitatively in lateral and transcrestal approach. Quantitatively the bone gain was found to be significant in both approaches with not much of statistical difference. Whereas, qualitatively more dense bone was formed in sinus infiltration than in lateral approach. The author concluded the reason to be the swelling process and incomplete calcification of bone graft material during healing phase contributed to lesser bone density in lateral approach.[26]

Rabah Nedir *et al.,*has done extensive research to know the predictability of OSFE technique in atrophic ridges and to compare the bone levels around implants with or without grafting for 1, 3 and 5 years. The mean bone gain was more around implants with grafts and did not change significantly between 1 and 5 years. The author concluded that more bone was gained when grafting material is used. However, grafting was unnecessary to achieve an average bone augmentation of 3.8 mm.

The following observations were made after a summative analysis of all the studies:

1. More amount of endo sinus bone gain was observed in lateral approach followed by transcrestal approach with graft. The possible reasons could be the approach that does not disturb the structure of native one, variations in bone healing, and greater area of sinus lift.
2. Irrespective of the approach, lesser the residual bone more the bone gain is. Possibly due to more space created during the procedure which facilitates more bone formation.

CONCLUSION

To conclude, the residual bone height defines the type of approach to maxillary sinus. Choosing lateral approach brings most acceptable bone gain in patients with residual bone height > 5mm and transcrestal approach with graft is more beneficial to attain more bone gain in cases with residual bone height < 5mm. Future research directions should consider study designs grounded on longitudinal randomized controlled trials of large sample size.

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