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Comparative Evaluation of Proximal Amalgam Restoration Contact Tightness Between Tofflemaire and Sectional Matrices Through Radiograph – A Randomized Controlled Trial

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ABSTRACT
Background: It is difficult to achieve correct proximal contacts with straight posterior amalgam fillings due to the body's anatomical structures. This is due to the fact that amalgam cannot be "condensed" which means the material does not shrink while the teeth are not moving. Research has tried to improve materials and methods to solve these issues. The primary objective for this investigation will be to assess and evaluate the Proximal contact strength for two different types of matrix band systems utilized with class II amalgam fillings.
Methodology
One did a random allocation of all 66 patients who were diagnosed with class II caries into two groups. Group A comprised 33 who had a Tofflemire matrix system while Group B had 33 who had a Triodent matrix system. Assessment of the contact of the fusion over the amalgam proximal contact was done v X-ray examinations were done at 0, 1, 3, and 6 months. In addition, radiographic examinations of the overhanging edges were also performed and data collected were analyzed in a systematic manner.
Results
The Triodent matrix system group demonstrated greater Proximal contact tightness than the control group (p=0.050). There was no statistically significant difference in the proximal contact tightness from the start of study to the follow-ups at 1, 3, and 6 months. A s-ray examination showed no peripheral extension in both groups.
In conclusion:
The level of proximal contacts achieved with the segment matrix system together with class II amalgam fillings was significantly higher than that achieved using the Tofflemire matrix band system. At the 6-month follow-up, the level of proximal contact tightness attained at the start was maintained throughout the study.

Keywords: Class II amalgam restoration; Direct amalgam restorations; Sectional matrix system.

INTRODUCTION

Adhering to proper proximal touch principles is critical for dental tooth mechanics to operate efficiently. Due to the lack of proper proximal occlusion, sore gums, periodontal disease, food impaction, tooth mobility, and other issues arise. A considerable amount of force is required to floss the interproximal contact area. If interproximal contact is too intimate, the attachment apparatus might be damaged or repositioned. While you floss, you apply force to the region where two teeth touch, which is also called the interproximal contact area. This region sustains significant plateau-like internal pressure which can be detrimental by damaging the teeth and rupturing the connective tissue [2-4]. As difficult as it is, applying tight physically correct proximal touch is challenging while filling the cavity with amalgam. The amalgam complications of not being compactable makes it very difficult for the cavity to attain a reliable seal with the cavity walls. The rubber dam's polymerization syndrome compounds issues because the tooth can move due to elastic deformation and the super elastic rubber dam border can adapt to the cavity [5-7]. These are only a few problems offered by soft polymer rubber-dam and the peculiar almond shape of the aperture's rubber edge that require resolution.

The problems described above can be solved by developing new materials in conjunction with defined geometry shape processes to get the desired results. The circular standard matrix frames have been proven to work best in modern dentistry, but their contacts and matrix contacts are not formed correctly [8]. Proximal contact tightness has been evaluated using the criteria devised by the United States Public Health System (USPHS). The tightness of the contact is measured using dental floss and the ease with which the floss passes between the teeth [9]. Contact tightness can be evaluated with the use of conventional metal blades or bits of shim stock of varying thicknesses. The first instance of blockage of the interdental proximal area was documented [10].

To determine the degree of tightness in the proximal contact, one may employ a tension recorder to insert a thin strip of metal into the gap between the teeth and retract it horizontally. The degree of tightness of the proximal contact is proportional to the frictional force opposing the retraction. From that vantage point, Dorfer et al. designed a device for vertical removal of metal strips. The tooth pressure meter is a more advanced version of this device that was previously reported in the literature to assess the extent of proximal contact tightness of class II amalgam resin fillings. It also allows one to measure the degree of tightness of the proximal contacts following restorative procedures. [11,12]
It has been shown that for two-surface class II spaces, sectional matrix systems with separation rings reliably achieve proximal contact tightness [13-15]. Using sectional matrix systems with separating rings in Class II resin amalgam restorations improved the proximal contact compared to using traditional circular matrix systems that did not employ the separating ring in improved sectional matrix systems. These results apply to two-surface repairs. Their applicability to three-surface Class II cavities, however, remains unknown. [16,17]
Also, it is still unclear how the MO and DO two surface repairs differ in establishing closed, tight proximal contacts. So, which matrix band method provides tighter contacts? The sectional or universal matrix band method? The selections in this list are complicated. There do not appear to be many recent, long-term studies available comparing the sectional and global matrix band systems.
So, the goal of the research was to determine the difference in proximal contact tightness up to 6 months post-restoration and compare it between universal and sectional matrix systems using x-ray analysis.

MATERIALS AND METHODS

The randomized clinical study was conducted between March 2022 to January 2023. The study was feasible, as it received an approval from an ethical review board at Saveetha University in India. Patients with class II cavities were recruited for the study. Good overall health, older than 18 years, and complete osseous occluding teeth were criteria for participation. Individuals with advanced periodontal disease- referred to as periodontal gap, partial dentures, and tooth mobility grade over 1 were excluded.
Estimation of sample size was determined by a study Wirsching et al. 2011, using G*Power software version 3.1.9.2. The hypothesis adopted required at least 30 subjects for each study group. Each group must have a significance level of 0.05, power of 0.95, and it turns out that a sample size of 30 is appropriate per group. The sample group was increased from 30 to 33 after adjusting for a 10% dropout rate (60+6=66).

The repairs were done by a single individual. The mean age for the 43 cases we retrieved was 39.53 ± 9.58 years. Computer-generated random numbers provided a facade of a simple random selection. In order to conceal the method of randomization, the SNOSE, or sequentially numbered, opaque boxed method, was employed. Both the patient and operator were blinded as illustrated in Figure 1.

Procedure of treatment

Prior to the initiation of treatment, a complete medical and dental history of the selected subjects was obtained. As part of the preparatory steps for the treatment, editable patient files were created that included the patient's age, sex, and even the specific teeth they had, among other details. Those who met the study criteria were given full disclosure regarding the study's processes and expected procedures. Patients who chose to participate in the study were fully informed as to what the study entailed and provided their consent.

One individual completed 66 MO/DO class II amalgam resin fillings. For every repair, the steps taken included the use of local anaesthesia when necessary. Wood wedges, of which Hawe Neos has patents in Bioggio Switzerland, were placed between one another on the surface requiring the repair fix. The wedge from the oral side was fitted tightly into the cavity between the teeth. This guarantees that the wedges would remain fixed during the entire “pre-wedging” process which is done for the teeth to separate without harm to the papilla and zenithal gingival strip.
The crown preparation phase of the teeth was done with a high-speed handpiece (KaVo Intramatic LUX 2, 25 LN, Biberach, Germany) using diamond burs FG 108-009 (Horico). Other parts were finished with a low-speed handpiece (KaVo Intramatic LUX 2, 29 LN) together with round steel burs and hand drills to remove the carious dentine. After preparing the teeth, they were randomly assigned to one of the two study groups by a computer program doing this.
Group A:
A preformed circular matrix system (Tofflemire, Produits Dentaire SA, Vevey, Switzerland and matrix Hawe Neos 1001c, Bioggio, Switzerland, 0.05 mm thick) was placed on the tooth and secured using a Hawe Neos interdental wooden wedge (Have Neos, Bioggio, Switzerland). The polishing instrument was applied so that there was no defect along the margin of the contact area. This led to the formation of a gap. A hand tool (PFI 49, Weybridge, UK) was positioned over the contact area to secure the matrix against the tooth by the first transverse layer of amalgam resin during its polymerization (Figure 2).

Group B:
I utilized a Bi-Tine ring type I and a 0.04 mm thick sectioned dead soft standard matrix (Triodent, Dentsply Caulk, Milford, DE). The Bi-Tine Ring Type I was created using the Bi-Tine Ring Type I. A wooden wedge (Hawe Neos, Bioggio, Switzerland) was used for holding the sections grid in position, after which the separation ring was placed on top of it. The matrix was polished using a hand tool PF1 49 against the tooth's next proximal side. Both of these steps are evident in Figure 3.

Cavities were filled using a self-etch glue method (Single Bond Universal) and a nano cluster composite (Filtek Z350). The tip that was used to pour the amalgam resin was already loaded, so it was possible to add the resin for the 12 mm thick layers in a stepwise fashion. Addition of each layer was fixed with a polymerisation machine (Optilux 401, Demetron, Kerr, USA, light strength 800 mW/cm2) for 20 seconds per side facing the tooth. After the matrix was placed, restorations were fixed from buccal and lingual sides for 20 seconds, during which the matrix was removed. Finishing of restorations was done using fine grit diamond burs (FG 249-F012 and FG 277-F023, Horico) and a Shofu cleaning kit. Teeth were verified for the fit and used articulate paper (Bausch Articulate Paper, 40 mm) for verification.
The overhang of the repairs along with vertical fringe overhang overhangs were evaluated using radiography. In addition, all FDI values pertaining to the proximal contact were inserted together with the corresponding form. An external co-investigator rendered all perpendicular block amalgam reconstructions at baseline, one month, three month, and at six month intervals.

Analysis of Data
Once again, gender and age were analyzed as categorical and continuous variables respectively. Custom Python code was employed to determine the averages and frequencies associated with the variables. The approximation of the contact proximal tightness on both sides and the chis quas were used to compare the study and control groups. Analysis of the data was performed using the IBM SPSS Statistics package, version 20 for Windows. The significance level set for the study was 5% (±=0.05), which constitutes the threshold for importance.

RESULTS
Table 1 displays the earlier comparison of both groups pertaining to proximal contact tightness. More restorations in Group A (63%) had normal contact, while the majority of repairs in Group B had slightly too strong contractile control at the outset. This difference was deemed statistically significant by the Chi-square test.
Progression over time for both groups is presented in Table 2, which contains two sets of results for contact tightness at baseline, one month, three months, and six months. Most of the values from both groups at the given times indicated a state of stasis or movement toward an expected shift. A mathematical analysis of the numbers from the start of the study to one month later showed acceptance of the null hypothesis for both groups. Of importance, by the six-month follow-up, neither Group A nor Group B's repair numbers were trending downward.
As a secondary objective, the study sought to assess marginal overhang radiographically, and both groups did not demonstrate any signs of marginal overhang.

DISCUSSION
In clinical research, dental floss has been applied to determine the character of proximal contacts. The floss is threaded through the interproximal contact area and then assessed as tight, loose, or just right. Other researchers have also managed this using radiography [18,19].

These studies might lack some sensitivity when it comes to accurately measuring the force applied. There are sensors that can accurately capture far more subtle forces being applied.

The first one was developed by Loomans et al. [14] from the Netherlands' University of Technology in Delft. However, this was discovered by researchers from the University of Tokushima in Korea [20]. Their equipment works with a macroscale examination of the force applied in a perpendicular direction. Nevertheless, these instruments are not available in shops. This means we needed to see what happened when we used the normal way of flossing.

This hypothesis an randomized parallel clinical trial aims to evaluate the difference in restoring apex proximal contacts associated with class II amalgam resin techniques using circular matrix system with strong wedging and hand-instrumented pressure versus sectional matrix system with separation ring.

It has been suggested that the right arrangement and proximal contour with adequate touch enable avoidance of blockage, tooth migration, periodontal disease, and secondary carious lesions. We decided to work with sectional pre-curved matrices and circular pre-contoured matrices because contoured matrix bands do enhance the shape help better restore and

improve the proximal portion. Using straight standard matrix bands would not alter the outcome of the work we intend to study [1,2,21,22].
If there was an adjacent filling some parts of the edge overhang with an adjoining border roughness would need smoothing. Ideally, and for clinical compliance, the restorations should proximately, though not be over adjusted, which is contrary to the initial alteration rule.
There was also a difference which was detectable statistically and was different for two groups for each of those. So off course touch of the sectional matrix band was stronger than with the tofflemire matrix system (Figure 4). Results confirm what Loomans et al. found in 2006 [14], who claimed that posterior class II amalgam fillings with more proximal contact were performed when separating rings and sectional matrices were used instead of a circular matrix system.
The "sectional matrix" system outperformed the "circumferential matrix" system in cases with two surface holes. In the case of three surface holes however, there was no statistically significant difference. Eva Weissching et al. 2011 [23].
In this study, both groups did not have any overhangs. The reason could be related to the way the matrix band and wedge were applied and not due to other reasons. Chuang et al. [24] argued that the interproximal marginal overhangs were the result of the concave shape of the surface, because the band and ring system application didn't work because it wasn't done correctly.
In this study, after six months, an observation was made regarding the alteration of the contact point after a therapeutic procedure. The follow up with the dentist was regularly after six months. At this visit, the contact tightness was tested to ensure no new work done would alter the tightness being assessed. Additionally, it probably seems reasonable to assume that most of the significant changes regarding the contact tightness would occur immediately after the repair is implemented.
There were no alterations to the strength of the proximal touch from the start of the study to six months later. In contrast, Loomans et al.'s 2007 study found that for posterior amalgam resin repairs, distal links often become weaker than baseline six months post treatment, despite being stronger prior to treatment. Most researchers still agree that after six months, the situation hasn't changed significantly proximal contacts [25].
Despite other dentists placing amalgams on certain load-bearing areas, some do not place amalgam in Class II preparations at all. In clinical circumstances, there is no rationale for the use of a proximal separation ring in amalgam fillings. If one were to use a ring for an amalgam restoration mistakenly, there is the likelihood of considerable movement of the tooth. This puts the newly restored teeth at significant risk of fracturing the amalgam onto which the ring and matrix system are removed. These rings have some issues and should only be applied in the case of amputated teeth.
In considering Class II amalgam fillings, proximal regions of wear merit attention as well. Proximal wear has a gradual but constant increase when the teeth shift towards the center. During these biological processes, the amalgam's retention in the inter-dental spaces alters. It remains unknown whether this proximal wear is influenced by various surgical techniques [25].
As noted by Demarco et al., there was a lack of adequate healing of amalgam-proximal contacts at 2 and 4 year follow-up intervals, indicating that amalgam repairs of the proximal area require prolonged maintenance [26,27].
There appears to be a gap in the literature regarding ongoing randomized controlled studies analyzing the difference in looseness of proximal contact from the universal versus sectional matrix systems. Variations in materials, especially those pertaining to the adhesives and other components, influence the durability of the repairs in actual practice. To determine the efficacy of these repairs, additional long-term clinical trials along with randomized controlled trials need to be conducted.

CONCLUSION

This data suggests that with the given limitations, the amalgam restorations done with sectional matrix system as compared to matrix band showed significantly improved proximal contacts. Proximal contact tightness did not change at the 6 month follow up. Both groups showed no marginal overhang.

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TABLES

Criteria		Groups		Total	Chi square	Df	p value
		1	2				
Normal contact	N	17	5	22	12.997	2	.002
	%	63.0	18.5	40.7			
Contact slightly too strong	N	9	22	31			
	%	33.3	81.5	57.4			
Somewhat weak contact	N	1	0	1			
	%	3.7	0.0	1.9			
Total	N	27	27	54			
	%	100.0	100.0	100.0			

Table 1: Comparison of the proximal contact tightness (Radiography) between group A & B at baseline.

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Change in score	Baseline to one month N (%)		Baseline to three months N (%)		Baseline to six months N (%)	
	Group A	Group B	Group A	Group B	Group A	Group B
No change	27 (100.0)	27 (100.0)	26 (96.3)	26 (96.3)	24 (88.9)	25 (92.6)
Positive rank	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	2 (7.4)	1 (3.7)
Negative rank	0 (0.0)	0 (0.0)	1 (3.7)	1 (3.7)	1 (3.7)	1 (3.7)
Total	27 (100.0)	27 (100.0)	27 (100.0)	27 (100.0)	27 (100.0)	27 (100.0)
Chi square	-		0.000		0.354	
P value	-		1.000		0.838	

Table 2: Change in the proximal contact tightness in the Groups from Baseline to one month, three months, and Six months follow up

FIGURES

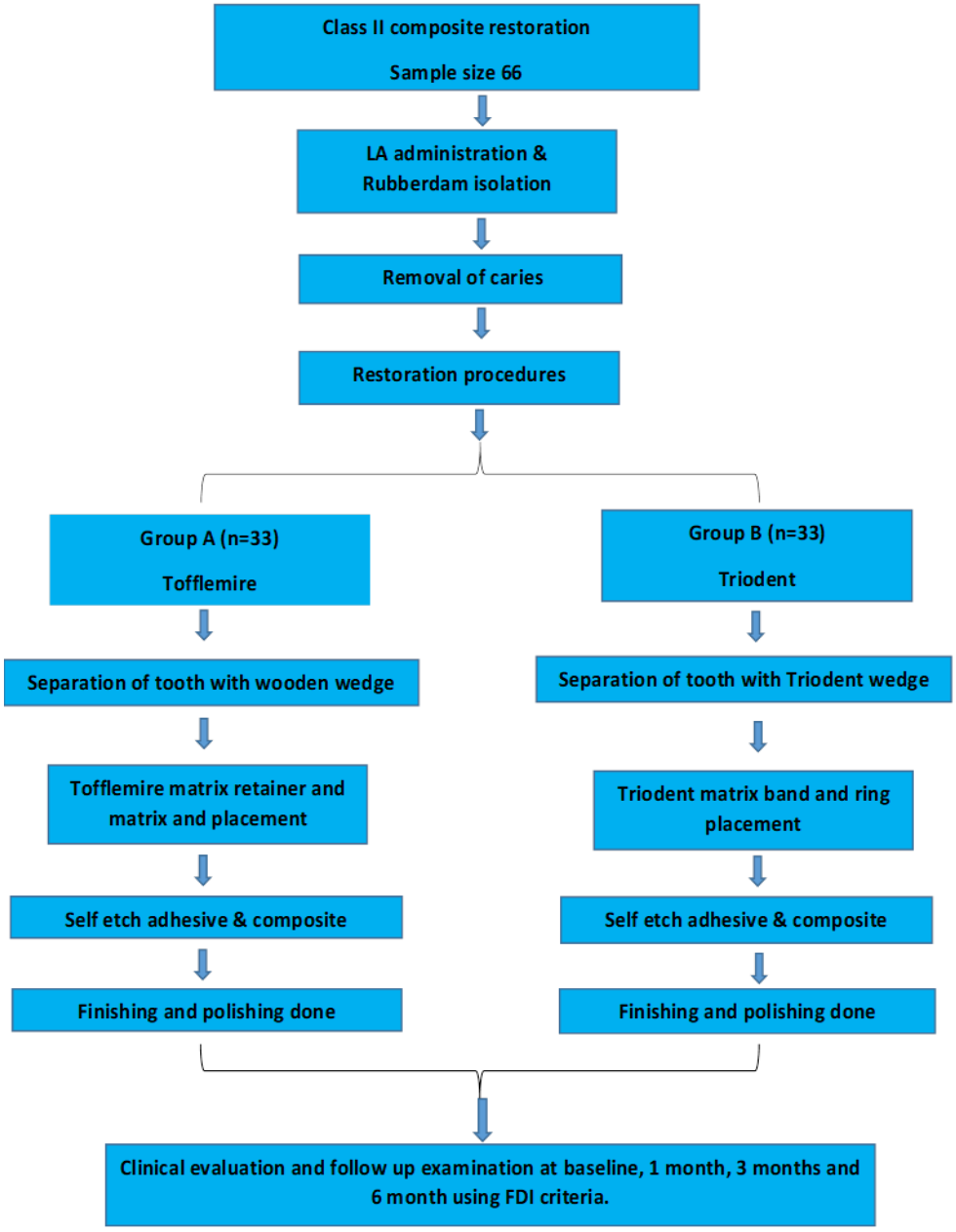

Figure 1: Methodology Flowchart

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Figure 2: A- Preoperative photograph, B- Tofflemire matrix system, C-Postoperative photograph.

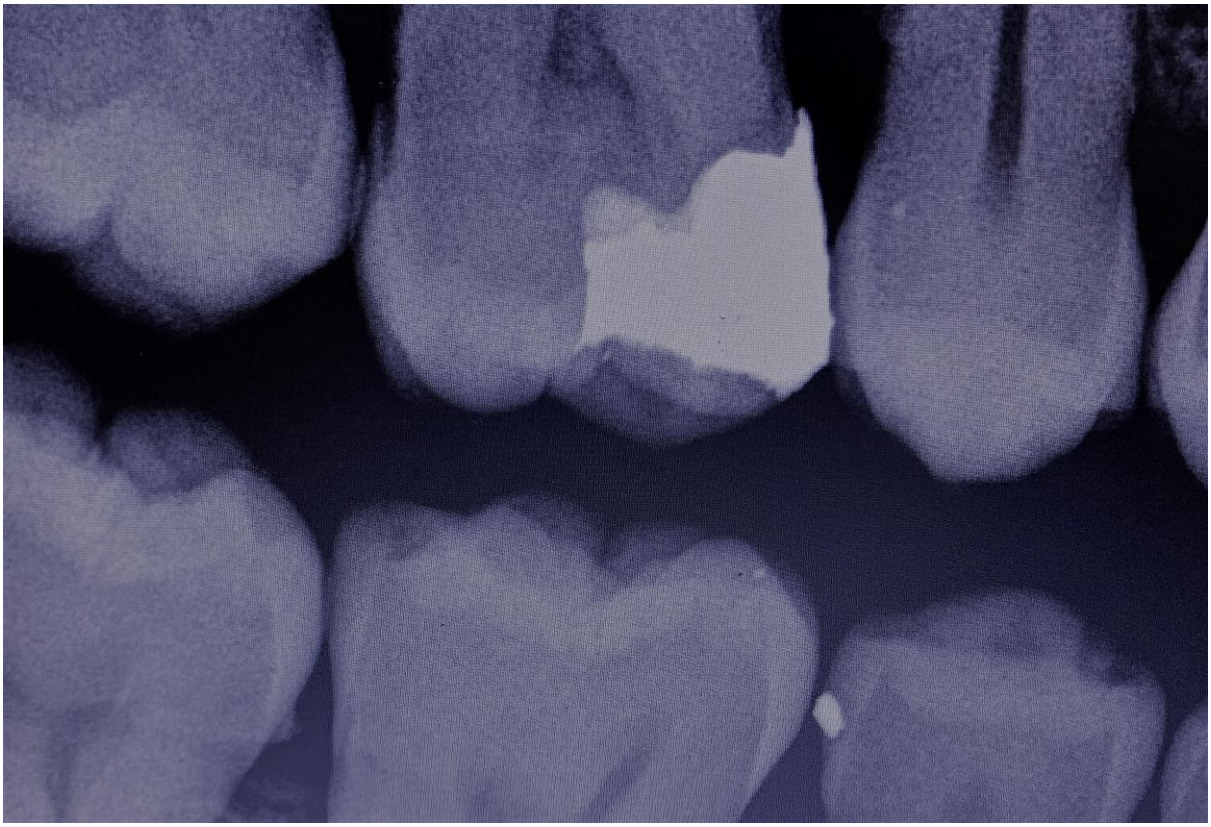

Figure 3: A- Preoperative photograph, B- Triodent matrix system, C-Postoperative photograph.

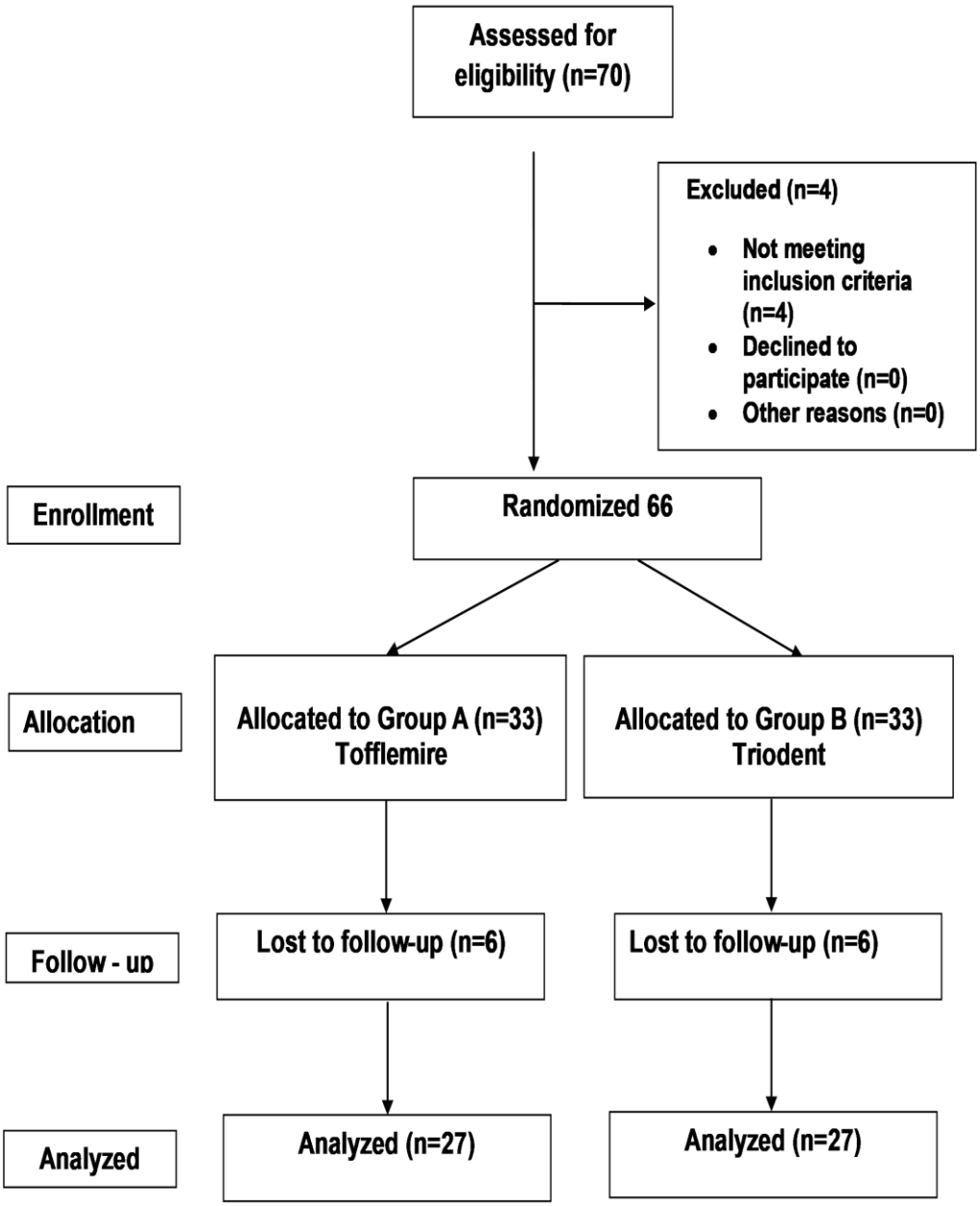

Figure 4: Participants flowchart