Treatment Outcomes of Multiple Canal vs Single Canal Benign Paroxysmal Positional Vertigo (BPPV); A Prospective Comparative Study

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ABSTRACT

Background: Multiple canal BPPV is a less explored entity and studies regarding the same is very less. In this study we are exploring the treatment responses of multiple canal BPPV compared to single canal BPPV. This is a prospective comparative study where patients with BPPV is evaluated in a teritiary care centre in Calicut, Kerala

Aims and Objectives:

- To find response for canalolith repositioning manoeuvre in Multiple canal BPPV in comparison with Single canal BPPV
- To compare the number of treatment sessions in Multiple canal BPPV & Single canal BPPV

Methods: 50 patients with single canal BPPV and 50 patients with multiple canal BPPV were evaluated in our centre by position test from April 2023 to September 2023. Dix Hallpike test for posterior semicircular canal, roll over test for lateral semicircular canal and head hanging test for anterior semicircular canal was done . In patients with multiple canal BPPV most affected canal was identified and repositioning manoeuvre was done to the most affected side . Epley's manoeuvre was done for posterior semicircular canal, Log roll manoeuvre done for lateral semicircular canal & Yacouvino manoeuvre for anterior semicircular canal .In patients with single canal BPPV affected canal was identified and repositioning manoeuvre was done . Patients were asked to review in ENT OPD every 2 days to look for symptom resolution. If symptomatic, position test was repeated. Patient had to review till symptoms resolved.

Results and Analysis: Age of participants were between 20 to 81 years, with a mean age of 54.3 years. There was no significant difference in sex distribution of two groups. History of trauma was more frequent in patients with Multiple Canal BPPV as compared to Single canal BPPV. Half of those with Multiple Canal BPPV had at least one comorbidity as compared to 26% of those with Single Canal BPPV. It was found that in multiple canal BPPV the most common combination of canals was ipsilateral PSCC and LSCC (40%), followed by bilateral PSCC (32%). In single canal BPPV, Posterior semicircular canal was most commonly affected followed by horizontal canal. No patients had anterior canal BPPV. Nearly half of (46.0%) those with Single Canal BPPV has symptom resolved by the first visit. About 60% of those with Multiple canal BPPV had symptom resolution by second visit. Overall, by the second visit, 96% of those with Single Canal BPPV had resolution of symptoms, whereas in case of Multiple Canal BPPV, this was 60%.In our study also patients with multiple canal BPPV had response to repositioning manoeuvres, but they needed a slightly longer treatment course compared to single canal BPPV.

Conclusion: Treatment response of multiple canal BPPV is comparable to single canal BPPV. But patients are required to have frequent follow ups to identify the most affected canal and to do the repositioning manoeuvres to most affected canal. Most of the patients with multiple canal BPPV required 2 or more visits for symptom resolution. But majority of patients with single canal BPPV had symptom resolution by second visit. Patients with comorbidities (e.g.: Diabetes Mellitus, Hypertension, CAD) are more prone to multiple canal BPPV.

Keywords: Multiple Canal BPPV, Single Canal BPPV, Canalolith Repositioning Maneuver, Treatment Response

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INTRODUCTION

Benign Paroxysmal Positional Vertigo (BPPV) is indeed one of the most common vestibular disorders, affecting the inner ear's balance system. It is characterized by brief episodes of intense dizziness triggered by specific head movements and can be associated with nausea and vomiting. BPPV is diagnosed in a substantial proportion of patients presenting with vertigo symptoms. Specifically, it is diagnosed in 17%. The lifetime prevalence of BPPV is 2.4%.[1]

A concise and accurate breakdown of the BPPV is:

Benign - not a serious or progressive condition. It is generally not associated with life- threatening complications.

Paroxysmal - Describes the sudden and unpredictable nature of the vertigo episodes

Positional - Indicates that the symptoms of BPPV are triggered or provoked by changes in head position. Specific head movements or orientations can lead to vertigo in individuals with BPPV.

Vertigo - Refers to the primary symptom of BPPV, which is a spinning or whirling sensation

There are two main theories regarding the pathogenesis of Benign Paroxysmal Positional Vertigo (BPPV), known as Canalolithiasis and Cupulolithiasis. These theories help to explain how the displacement of otoconia from utricle to semicircular canals can lead to the characteristic symptoms of BPPV. In canalolithiasis dislodged otoconia are thought to float freely within the endolymph of semicircular canals. In Cupulolithiasis, degenerative otoconia are thought to adhere or stick to the cupula. Both Canalolithiasis and Cupulolithiasis lead to inappropriate stimulation of the vestibular system when the head is moved, resulting in the characteristic symptoms ofBPPV.

According to the involved canal/s BPPV can be classified into: posterior canal BPPV which accounts for 75-80% of cases, lateral canal BPPV includes 15- 25 %, anterior canal BPPV which is rare and only represent 1-2% of cases and multiple canals BPPV accounts for 6-20% of cases.[2]

Diagnosis of BPPV typically involves clinical assessment, including specialized positional tests like the Dix-Hallpike manoeuvre for posterior canal, supine roll test for lateral canal & supine head hanging test for anterior canal to provoke characteristic vertigo and nystagmus.

If BPPV is diagnosed, treatment aims to reposition the dislodged otoconia in the semicircular canals to alleviate symptoms. It comprises of various repositioning manoeuvres.

Surgical intervention for BPPV is rare and typically reserved for cases where other treatments have failed, and the condition is significantly impacting the patient's quality of life.

Multiple canal BPPV can manifest as either bilateral (involving the same canal on both sides) or multiple canal involvement (simultaneously affecting different canals on the same or both sides of the inner ear), leading to more complex and challenging presentations of the condition.[3]

In this study we are studying the response for canalolith repositioning manoeuvres in Multiple canal BPPV in comparison with Single canal BPPV and to compare the number of treatment sessions in Multiple canal BPPV and Single canal BPPV

AIMS AND OBJECTIVES

- To find response for canalolith repositioning manoeuvre in Multiple canal BPPV in comparison with Single canal BPPV
- To compare the number of treatment sessions in Multiple canal BPPV & Single canal BPPV

MATERIAL AND METHODS

Study Area: Department of ENT, Malabar Institute of Medical Sciences, Calicut, Kerala

Study Population: Adults in the age group of 18-81 years with BPPV.

Study Duration: April 2023 to September 2023

Study Design: Prospective comparative study

Sample Size: Expected Difference between proportions

Expected response to canalolith repositioning manoeuvre in first visit in single canal BPPV patients= 60%

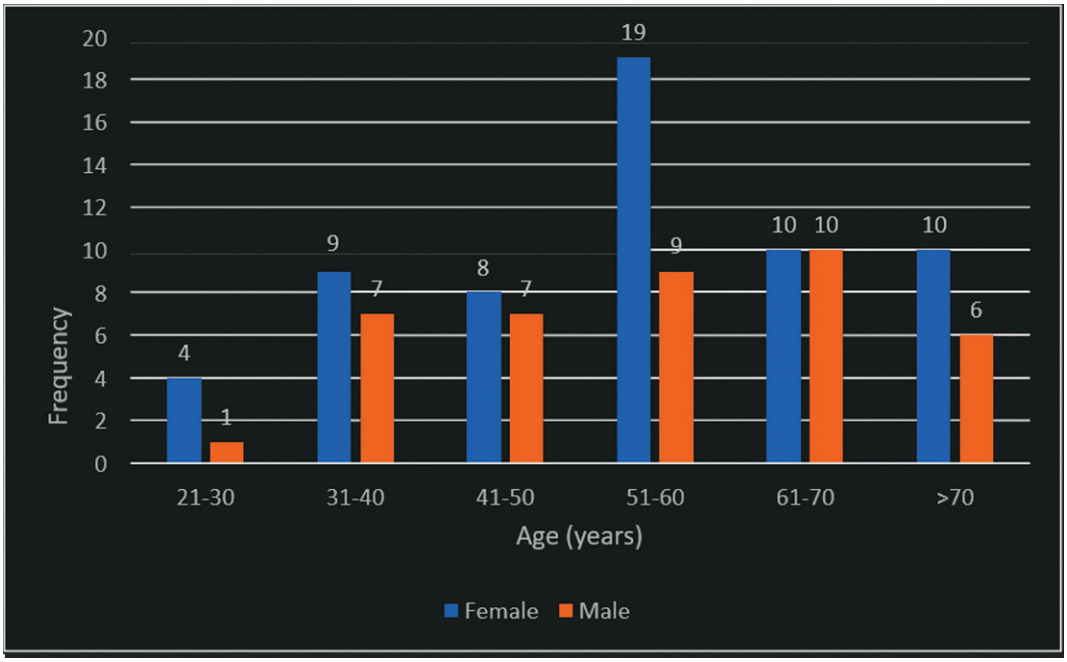

Figure 1. Age and Sex distribution of patients

Table 1. Distribution of sample according to symptoms

		Sex		Total
		Female	Male	
Age	21-30	4	1	5
	31-40	9	7	16
	41-50	8	7	15
	51-60	19	9	28
	61-70	10	10	20
	>70	10	6	16
Total		60	40	100

Expected response to canalolith repositioning manoeuvre in first visit in multiple canal BPPV patients= 32%

Sample size calculated using the formula,

$N = (Z1-\alpha/2+Z1-\beta)2 * ((p1(1-p1)+p2(1-p2)) / (p1-p2)2$

Here Z1-α/2 is the critical value of the normal distribution at α/2 (ie; for a confidence level of 95%, α is 0.05and the critical value is 1.96), Z1-β is the critical value of the Normal distribution at β (ie; for a power of 80%, β is 0.2 and the critical value is 0.84) and p1 and p2 are the expected sample proportions of the two groups.

For this study we have to consider a sample size of 45 per each arm. Considering lost to follow up of 10 %, we will take 50 in each arm.

Inclusion Criteria: 50 patients with multiple canal BPPV & 50 patients with single canal BPPV attending outpatient department of otorhinolaryngology at Malabar Institute of Medical Sciences, Calicut was chosen for study.

Patients were selected by diagnostic criteria proposed by International Barany Society and they should fulfil all three criteria:

- Recurrent episodes of vertigo or dizziness often provoked by lying down or turning over while supine
- Coexistence of positional nystagmus due to canalolithiasis in multiple semicircular canals evoked by Dix- Hallpike Test & Roll Test
- No other vestibular diseases

Exclusion Criteria: Patients with nystagmus not concurring with diagnostic criteria of BPPV

- Patients with vestibular migraine
- Patients with central positioning nystagmus

METHOD OF MEASUREMENT OF OUTCOME OF INTEREST:

- Patients with BPPV evaluated in ENT clinic by position test
- History and associated conditions were noted
- Position test was done i.e. Dix Hallpike test for posterior semicircular canal, roll over test for lateral semicircular canal and head hanging test for anterior semicircular canal.
- In patients with multiple canal BPPV most affected canal was identified and repositioning manoeuvre was done to the most affected side

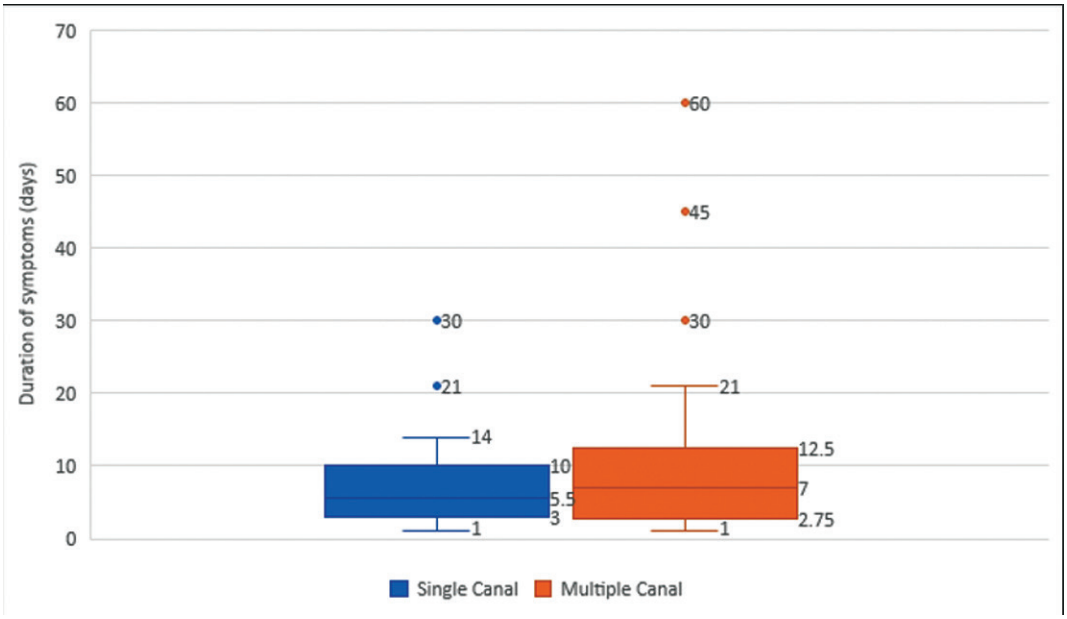

Figure 2. Comparison of duration of symptoms in Single canal and Multiple canal BPPV

Table 2. Comparison of Sex distribution in two groups

		Group		Total
		Single Canal	Multiple Canal	
Sex	Female	29 (58.0%)	31 (62.0%)	60 (60.0%)
	Male	21 (42.0%)	19 (38.0%)	40 (40.0%)
Total		50 (100%)	50 (100%)	100 (100%)

Pearson Chi-Square=0.167; df=1; p=0.683

Table 3. Comparison of history of fever in Single canal and Multiple canal BPPV

		Group		Total
		Single Canal	Multiple Canal	
History of Fever	Yes	2 (4.0%)	0 (0.0%)	2 (2.0%)
	No	48 (96.0%)	50 (100%)	98 (98.0%)
Total		50 (100%)	50 (100%)	100 (100%)

Two patients had history of fever; both had Single canal BPPV.

- Epley's manoeuvre was done for posterior semicircular canal, Log roll manoeuvre done for lateral semicircular canal & Yacouvino manoeuvre for anterior semicircular canal
- In patients with single canal BPPV affected canal was identified and repositioning manoeuvre was done
- Patients were asked to review in ENT OPD every 2 days to look for symptom resolution.
- If symptomatic, position test was repeated.
- In multiple canal BPPV most affected canal was treated.
- Patient had to review till symptoms resolve

Data Collection Methods

Data of 50 patients with single canal BPPV & 50 patients with multiple canal BPPV attending ENT OPD from April 2023 to September 2023 were collected using proforma method.

Statistical Methods

Statistical analyses were be performed using the Statistical Package for the Social Sciences (SPSS version 26.0) and graphs were depicted using Microsoft excel or openoffice Spreadsheet. Normality of distribution of all data was assessed using histograms and Kolmogorov–Smirnov/ Shapiro-Wilk test. Continuous variables were summarized as Mean ± Standard deviation or median with interquartile range. Categorical variables between groups were summarized in terms of frequency with % and was tested using Chi Square/ Fischer's exact test. Continuous measurements between groups were tested using independent sample t test/ Mann Whitney U test. For all test p value < 0.05 was considered as statistically significant.

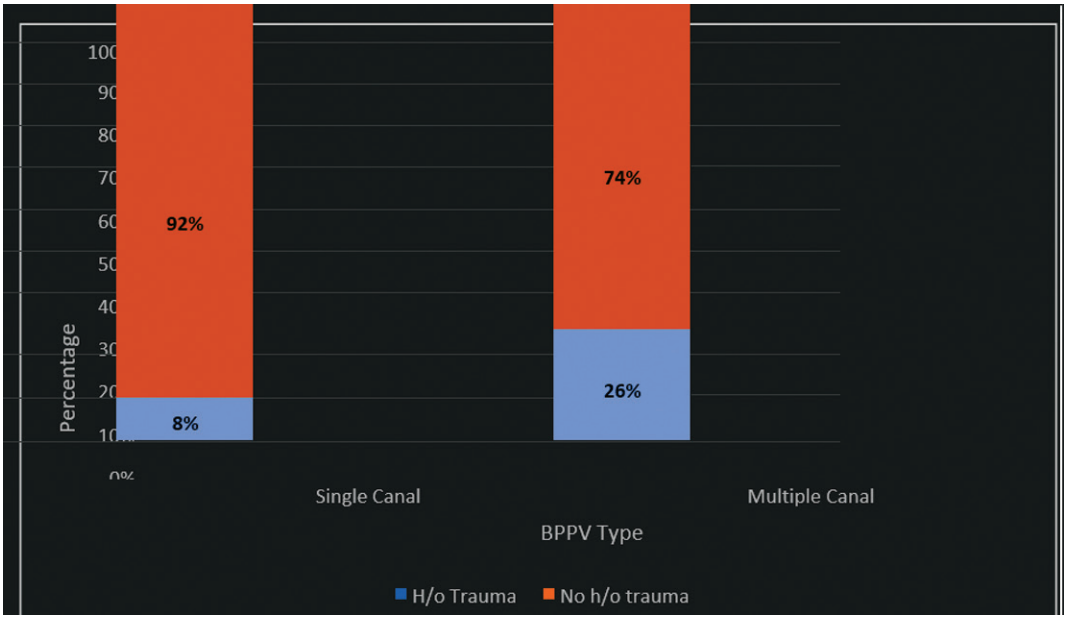

Figure 3. Comparison of history of trauma in Single canal and Multiple canal BPPV

Table 4. Comparison of history of trauma in Single canal and Multiple canal BPPV

		Group		Total
		Single Canal	Multiple Canal	
History of Trauma	Yes	4 (8.0%)	13 (26.0%)	17 (17.0%)
	No	46 (92.0%)	37 (74.0%)	83 (83.0%)
Total		50 (100%)	50 (100%)	100 (100%)

Pearson Chi-Square=5.741; df=1; p=0.017

Ethical Consideration

Patients was informed about the study and written consent was obtained. The study includes only routine investigations done for any case of BPPV and so no additional cost for participants. There was no risk involved for the subject and also no research related injury.

RESULTS

The study had 100 patients – 50 with Single Canal BPPV and 50 with Multiple CanalBPPV

Demographic profile of patients

Age of participants raised from 20 to 81 years, with a mean age of participants was 54.3 [SD = 15.36] years. There was no significant difference in the age of the two groups [53.8 (SD=13.79) v/s 54.7 (SD=15.03) years, p=0751] **(Figure 1).**

Sixty of the 100 patients were female. There is no significant difference in sex distribution of two groups. [p=0.683] **(Table 2).**

Symptom Profile of Patients in Two Groups

Duration of symptoms ranged from 1 day to 2 months with a median duration of 7 days (IQR=7). The median duration was shorter in Single canal group compared to the multiple canal group, though not statistically significant [5.5 days (IQR=7) v/s 7 days (IQR=9.75), p=0.827] **(Table 1 and Figure 2).**

Two patients had history of fever; both had Single canal BPPV **(Table 3).**

Seventeen patients had history of trauma. History of trauma was more frequent in patients with Multiple Canal BPPV as compared to Single canal BPPV. [26% v/s 8.0%, p=0.017] **(Figure 3 and Table 4).**

There was no significant association between individual comorbidities such as DM, hypertension, CAD or Dyslipidaemia with type of BPPV **(Figure 4 and Table 5).**

There was one case each of post renal transplant, seronegative arthritis, Rheumatic heart disease (Mitral stenosis) and sudden Sensorineural hearing loss. All of them had multiple canal BPPV.

Half of those with Multiple Canal BPPV had at least one comorbidity as compared to 26% of those with Single Canal BPPV. This difference in proportion was statistically significant. (p=0.013) **(Figure 5 and |Table 6).**

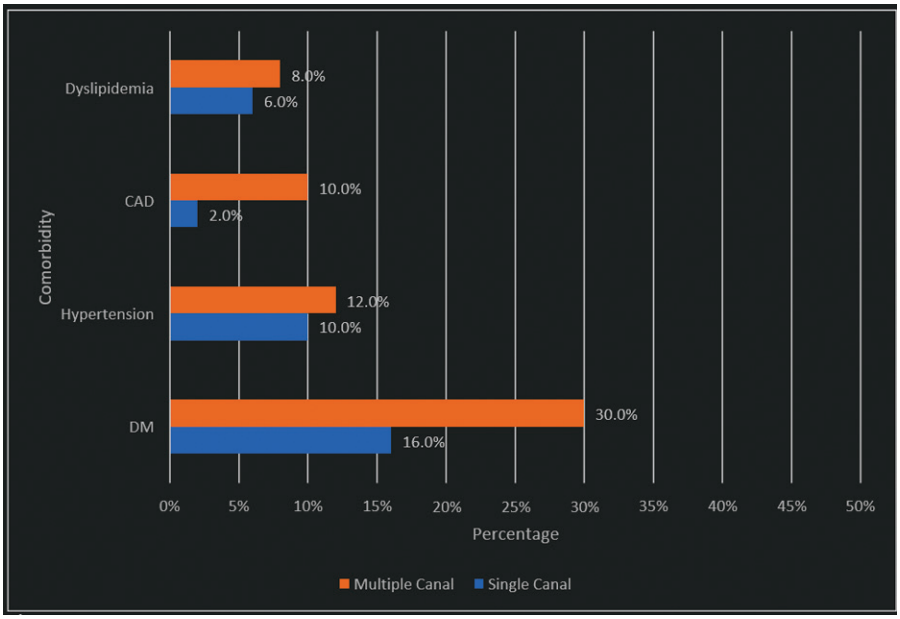

Figure 4. Comparison of common Comorbidities in Single canal and Multiple canal BPPV

Table 5. Comparison of common Comorbidities in Single canal and Multiple canal BPPV

Comorbidities		Group: Single Canal	Group: Multiple Canal	Total	p-value
DM	Yes	8 (16.0%)	15 (30.0%)	23 (23.0%)	0.154
	No	42 (82.0%)	35 (70.0%)	77 (77.0%)	
Hyperten-sion	Yes	5 (10.0%)	6 (12.0%)	11 (11.0%)	0.749
	No	45 (90.0%)	44 (88.0%)	89 (89.0%)	
CAD	Yes	1 (2.0%)	5 (10.0%)	6 (6.0%)	0.206
	No	49 (98.0%)	45 (90.0%)	94 (94.0%)	
Dyslipidae-mia	Yes	3 (6.0%)	4 (8.0%)	7 (7.0%)	0.695
	No	47 (94.0%)	46 (92.0%)	93 (93.0%)	
Total		50 (100%)	50 (100%)	100 (100%)	

EXAMINATION FINDINGS

Findings on first visit

All patients had intact TM on ear examination.

In the Single Canal group, all except four had unilateral torsional nystagmus, the remaining had unilateral horizontal nystagmus; none had combination of horizontal and torsional nystagmus. Of the 30 with bilateral nystagmus, 16 had bilateral torsional nystagmus, five had bilateral horizontal- torsional nystagmus, and seven had horizontal-torsional nystagmus on side with torsional or horizontal nystagmus on the other **(Table 7).**

Among the 50 cases with Multiple canal BPPV, the most common combination of canals was ipsilateral PSCC and LSCC (40%), followed by bilateral PSCC (32%). Five cases had PSCC and LSCC involvement on both sides. Only one case had a combination of contralateral LSCC and PSCC. Overall, all except one case of Multiple canal BPPV had PSCC involvement at least on one side; 34 cases had LSCC involvement at least on one side **(Table 8).**

Among the 50 with Single Canal BPPV, 46 cases had PSCC involvement while the remaining four had LSCC involvement **(Table 9 and Figure 6).**

The most affected canal was Right PSCC followed by Left PSCC in both groups. Thiswas similar in both groups, with no significant difference in distribution. [p=0.689]

Correspondingly, the most commonly elicited position test was Right PRM followed by Left PRM in both groups. This was similar in both groups, with no significant difference in distribution. [p=0.841] **(Table 10).**

FINDINGS AT REVISITS

Nearly half (46.0%) those with Single Canal BPPV has symptom resolved by the first visit. About 60% of those with Multiple canal BPPV had symptom resolution by second visit. Overall, by the second visit, 96% of those with Single Canal BPPV had resolution of symptoms, whereas in case of Multiple Canal BPPV, this was 60%; this difference in proportion was statistically significant. (p<0.001). None of those with single canal BPPV needed more than three visits, while among those with Multiple canal BPPV; there were four cases who needed more than three visits for resolution of symptoms **(Table 11 and Figure 7).**

Overall, 43 (76.8%) of those with Right PSCC involvement and 31 (81.5%) of those with Left PSCC had symptom resolution by second visit. There was

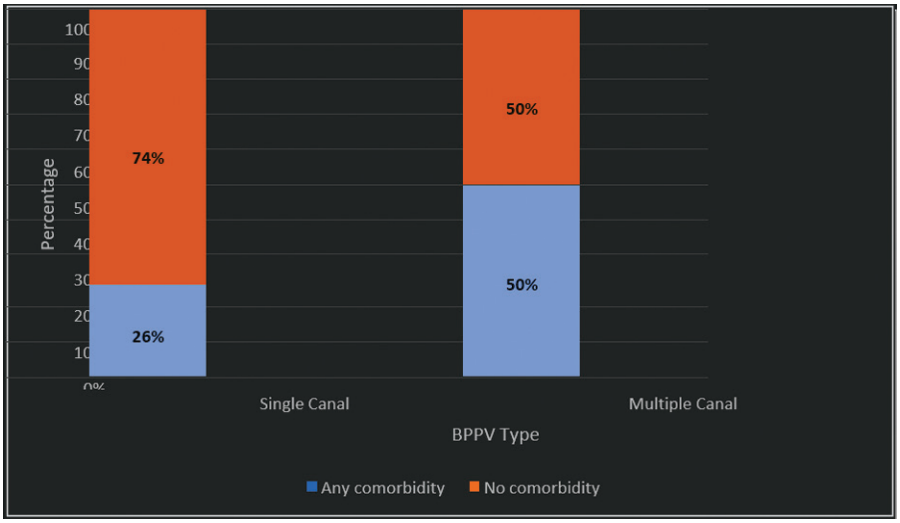

Figure 5. Comparison of presence of any Comorbidities in Single canal and Multiple canal BPPV

Table 6. Comparison of presence of any Comorbidities in Single canal and Multiple canal BPPV

Comorbidities		Group		Total
		Single Canal	Multiple Canal	
Any comorbidity	Present	13 (26.0%)	25 (50.0%)	38 (38.0%)
	Absent	37 (74.0%)	25 (50.0%)	62 (62.0%)
Total		50 (100%)	50 (100%)	100 (100%)

Pearson Chi-Square=6.112; df=1; p=0.013

no significant difference in this proportion between these canals. (p=0.596). When analysed separately for single canal and multiple canal groups, there continued to be no difference in symptom resolution at 2nd visit for different canals. [Right PSCC: 92.6% v/s 100%, p=0.215; Left PSCC: 62.1% v/s 61.1%, p=0.944] **(Table 12).**

Right PSCC continued to be the most affected canal through the initial follow-up visits. On the fourth visit, only two patients in the multiple canal group had symptoms; in both cases, canal involved was left PSCC **(Table 13 and Figure 8).**

Correspondingly, the most commonly done CRM in the initial visits was Right PRM followed by Left PRM. In the third and fourth visits, there were three and two cases respectively in the Multiple canal group in whom Left PRM was done. These procedures correspond to the canal involved in each visit **(Table 14).**

10 patients had symptoms at the 3rd month review: three in single canal BPPV group and seven in the multiple canal group. This difference is not statistically significant [p=0.182] **(Table 15 and Figure 9).**

DISCUSSION

BPPV is the most common cause of vertigo. Given its high incidence, BPPV has been the subject of numerous research papers and medical literature. However, it is indeed less common for papers to specifically analyse cases in which multiple semicircular canals are simultaneously affected by BPPV. Previous studies showed that prevalence of multiple canal involvement was 6.8-20 % of total BPPV cases.[9]

In this study we are finding response for canalolith repositioning manoeuvres in Multiple canal BPPV in comparison with Single canal BPPV and to compare the number of treatment sessions in Multiple canal BPPV & Single canal BPPV.

The study had 50 patients with single canal BPPV & 50 patients with multiple canal BPPV who came to ENT OPD.

Demographic profile of patients:

Age of participants are between 20 to 81 years, with a mean age of 54.3 years. There was no significant difference in the age of the two groups.

Sixty of the 100 patients were female. There is no significant difference in sex distribution of two groups.

In the study, Benign Paroxysmal Positional Vertigo with Simultaneous Involvement of Multiple Semicircular Canals by Dae Bo Shim, it did not show a significant difference between patients with single and multiple canal BPPV in terms of age or sex.

Symptom profile of patients in two groups:

The median duration of symptoms was shorter in Single canal group compared to the multiple canal group. History of trauma was more frequent in patients with Multiple Canal BPPV as compared to Single canal BPPV. The greatest difference between multiple canal and single-canal cases is likely their aetiology. In

Table 7. Comparison of Nystagmus elicited in Single canal and Multiple canal BPPV

Groups		Right		Left		Total
Single Canal	Horizontal	2		2		4
	Torsional	26		20		46
Multiple Canal		Horizontal Torsional	Horizontal	Torsional	Nil	
Left	Horizontal Torsional	5	1	1	6	13
	Horizontal	1	1	1	0	3
	Torsional	4	0	16	0	20
	Nil	14	0	0	0	14
	Total	24	2	18	6	50

Table 8. Combinations of canals involved in Multiple canal BPPV (n=50)

Combinations of Canals	Frequency	Percentage
Ipsilateral LSCC and PSCC	20	40.0
Contralateral LSCC and PSCC	1	2.0
Bilateral PSCC	16	32.0
Bilateral LSCC	1	2.0
Bilateral LSCC and PSCC	5	10.0
Bilateral PSCC with Unilateral LSCC	5	10.0
Bilateral LSCC with Unilateral PSCC	2	4.0
TOTAL	50	100

Table 9. Comparison of most affected Canal in Single canal and Multiple canal BPPV

		Group		Total
		Single Canal	Multiple Canal	
Most affected Canal	Right PSCC	27 (54.0%)	29 (58.0%)	56 (56.0%)
	Left PSCC	20 (40.0%)	18 (36.0%)	38 (38.0%)
	Right LSCC	1 (2.0%)	2 (4.0%)	3 (3.0%)
	Left LSCC	2 (4.0%)	1 (2.0%)	3 (3.0%)
TOTAL		50 (100%)	50 (100%)	100 (100%)

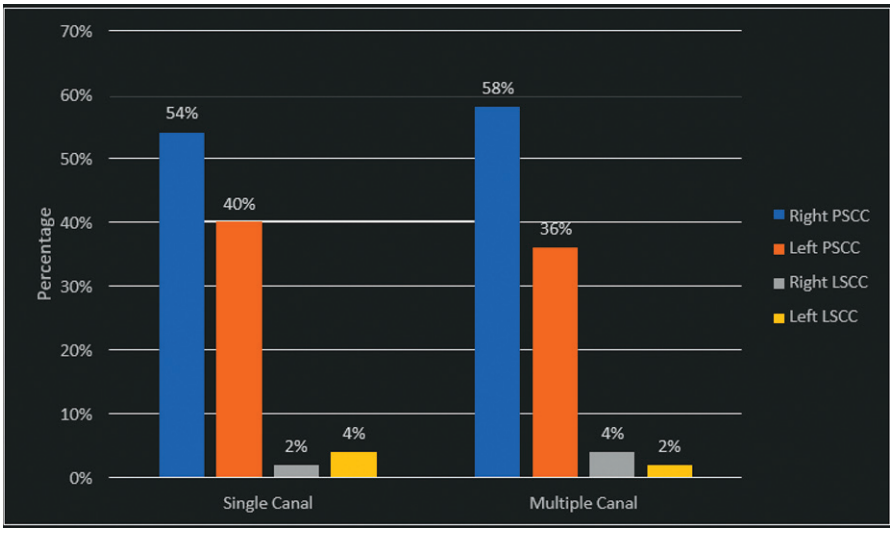

Figure 6. Comparison of most affected Canal in Single canal and Multiple canal BPPV

a study by Suarez et al.,[10] trauma is more common in multiple canal cases than in single-canal cases.

Half of those with Multiple Canal BPPV had at least one comorbidity as compared to 26% of those with Single Canal BPPV.

It is hypothesized that atherosclerotic risk factors, such as hypertension or high cholesterol, affect the blood supply to the inner ear and potentially lead to hypoxia to the cells in the utricle of the inner ear. In this hypothetical scenario, the reduced blood supply and subsequent ischemia and hypoxia could damage the supporting cells in the macula utricle. This damage may result in abnormal metabolism and degeneration of the otoconia.[11]

Canal Type Distribution

Patients were diagnosed with single canal BPPV & multiple canal BPPV using position tests; i.e. Dix- Halpike manoeuvre for posterior canal BPPV, Supine roll test for lateral canal & Head hanging test for anterior canal.

It was found that in multiple canal BPPV the most common combination of canals was ipsilateral PSCC and LSCC (40%), followed by bilateral PSCC (32%).

At present, the results for the distribution of the involved canals of multiple canal BPPV from different studies are contrasting. Lihong- Si et al.,[11] Lopez-Escamez et al.,[8] and Shim et al.,[7] also showed that ipsilateral PSCC & LSCC is the most common form of multiple canal BPPV.

Table 10. Comparison of Position testin Single canal and Multiple canal BPPV

		Group		Total
		Single Canal	Multiple Canal	
Position test	Right PRM	28 (56.0%)	29 (58.0%)	57 (57.0%)
	Left PRM	19 (38.0%)	18 (36.0%)	37 (37.0%)
	Right ROM	1 (2.0%)	2 (4.0%)	3 (3.0%)
	Left ROM	2 (4.0%)	1 (2.0%)	3 (3.0%)
TOTAL		50 (100%)	50 (100%)	100 (100%)

Table 11. Comparison of number of revisits for symptoms resolution in Single canal and Multiple canal BPPV

		Group		Total
		Single Canal	Multiple Canal	
No of visit for symptom resolution	1	23 (46.0%)	1 (2.0%)	24 (24.0%)
	2	25 (50.0%)	29 (58.0%)	54 (54.0%)
	3	2 (4.0%)	16 (32.0%)	18 (18.0%)
	4	0 (0.0%)	2 (4.0%)	2 (2.0%)
	5	0 (0.0%)	2 (4.0%)	2 (2.0%)
TOTAL		50 (100%)	50 (100%)	100 (100%)

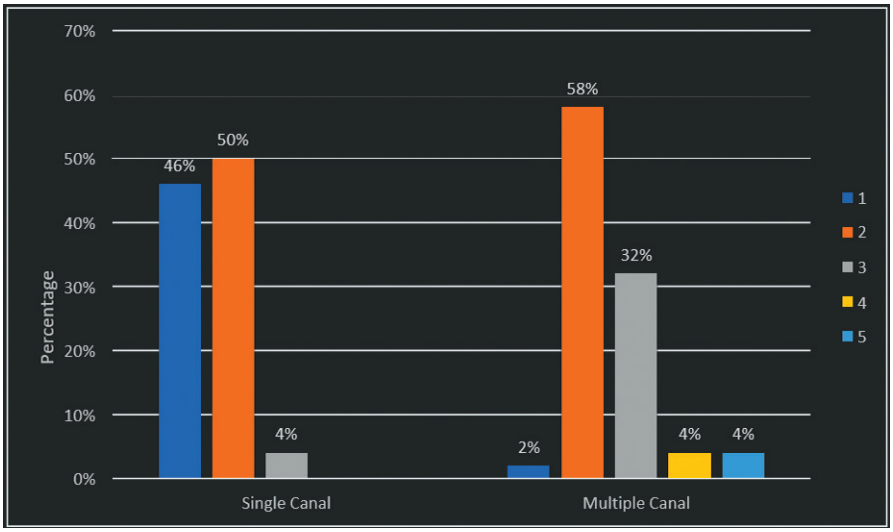

Figure 7. Comparison of number of revisits for symptoms resolution in Single canal and Multiple canal BPPV

In single canal BPPV, Posterior semicircular canal was most commonly affected followed by horizontal canal. No patients had anterior canal BPPV.

The most affected side was Right followed by Left in both groups which is consistent with the results of previous studies.[12] This may be related to the habit of sleeping in right lateral decubitus position.

Manual Reduction

Patients with both single canal BPPV & multiple canal BPPV after diagnosis were asked to review in ENT OPD every 2 days till symptoms resolves to compare the efficacy of repositioning manoeuvre in multiple canal BPPV. In this study we are only doing repositioning manoeuvre for the most affected canal in each visit.

There is no clear consensus regarding order of manual reduction in multiple canal BPPV. Parnes et al.[4] suggested that manual reduction should be performed based on the intensity of symptoms, as well as the nystagmus induced by different canals.

Nearly half of (46.0%) those with Single Canal BPPV has symptom resolved by the first visit. About 60% of those with Multiple canal BPPV had symptom resolution by second visit. Overall, by the second visit, 96% of those with Single Canal BPPV had resolution of symptoms, whereas in case of Multiple Canal BPPV, this was 60%; this difference in proportion was statistically significant.

None of those with single canal BPPV needed more than three visits, while among those with Multiple canal BPPV; there were four cases who needed more than three visits for resolution of symptoms.

Tomaz, et al.[13] described that treatment was as successful in multiple canal BPPV as in single canal BPPV, and that there was no difference among the different combinations of affected canals.

Table 12. Comparison of number of revisits for symptoms resolution for different canal involvement in Single canal and Multiple canal BPPV

Group	Most affected Canal	No of visit for symptom resolution					Total
		1	2	3	4	5	
Single Canal	Right PSCC	12 (44.4%)	13 (48.1%)	2 (7.4%)			27 (100%)
	Left PSCC	10 (50.0%)	10 (50.0%)	0			20 (100%)
	Right LSCC	0	1 (100%)	0			1 (100%)
	Left LSCC	1 (50.0%)	1 (50.0%)	0			2 (100%)
	Total	23 (46.0%)	25 (50.0%)	2 (4.0%)			50 (100%)
Multiple Canal	Right PSCC	0	18 (62.1%)	8 (27.6%)	2 (6.9%)	1 (3.4%)	29 (100%)
	Left PSCC	1 (5.6%)	10 (55.6%)	6 (33.3%)	0	1 (5.6%)	18 (100%)
	Right LSCC	0	0	2 (100%)	0	0	2 (100%)
	Left LSCC	0	1 (100%)	0	0	0	1 (100%)
	Total	1 (2.0%)	29 (58.0%)	16 (32.0%)	2 (4.0%)	2 (4.0%)	50 (100%)
TOTAL	Right PSCC	12 (21.4%)	31 (55.4%)	10 (17.9%)	2 (3.6%)	1 (1.8%)	56 (100%)
	Left PSCC	11 (28.9%)	20 (52.6%)	6 (15.8%)	0	1 (2.6%)	38 (100%)
	Right LSCC	0	1 (33.3%)	2 (66.7%)	0	0	3 (100%)
	Left LSCC	1 (33.3%)	2 (66.7%)	0	0	0	3 (100%)
	Total	24 (24.0%)	54 (54.0%)	18 (18.0%)	2 (2.0%)	2 (2.0%)	100 (100%)

Table 13. Comparison of most affected canal in each revisit in Single canal and Multiple canal BPPV

Group	Most affected Canal	No of visit for symptom resolution		
		1	2	3
1st visit	Right PSCC	15 (30.0%)	27 (54.0%)	42 (42.0%)
	Left PSCC	10 (20.0%)	18 (36.0%)	28 (28.0%)
	Right LSCC	2 (4.0%)	2 (4.0%)	4 (4.0%)
	Left LSCC	1 (2.0%)	2 (4.0%)	3 (3.0%)
	No	22 (44.0%)	1 (2.0%)	23 (23.0%)
2nd visit	Right PSCC	2 (4.0%)	9 (18.0%)	11 (11.0%)
	Left PSCC	0 (0.0%)	9 (18.0%)	9 (9.0%)
	Right LSCC	0 (0.0%)	2 (4.0%)	2 (2.0%)
	No	48 (96.0%)	30 (60.0%)	78 (78.0%)
3rd visit	Right PSCC	1 (2.0%)	1 (2.0%)	2 (4.0%)
	Left PSCC	0 (0.0%)	3 (6.0%)	3 (3.0%)
	No	49 (98.0%)	46 (92.0%)	95 (95.0%)
4th visit	Left PSCC	0 (0.0%)	2 (4.0%)	2 (2.0%)
	No	50 (100%)	48 (96.0%)	98 (98.0%)
Total		50 (100%)	50 (100%)	100 (100%)

But in our study, it was found that only 60 % of patients with multiple canal BPPV had symptom resolution by the second visit, but all had symptom resolution with repositioning manoeuvres. But they needed slightly longer duration of treatment compared to that of single canal BPPV.

Previous studies have shown that otolith repositioning manoeuvres can successfully resolve the symptoms associated with multiple canal BPPV.[7,5] Soto-Varela et al.[6] conducted a study that compared the effectiveness of repositioning manoeuvres in the treatment of single canal BPPV and multiple canal BPPV. Their findings

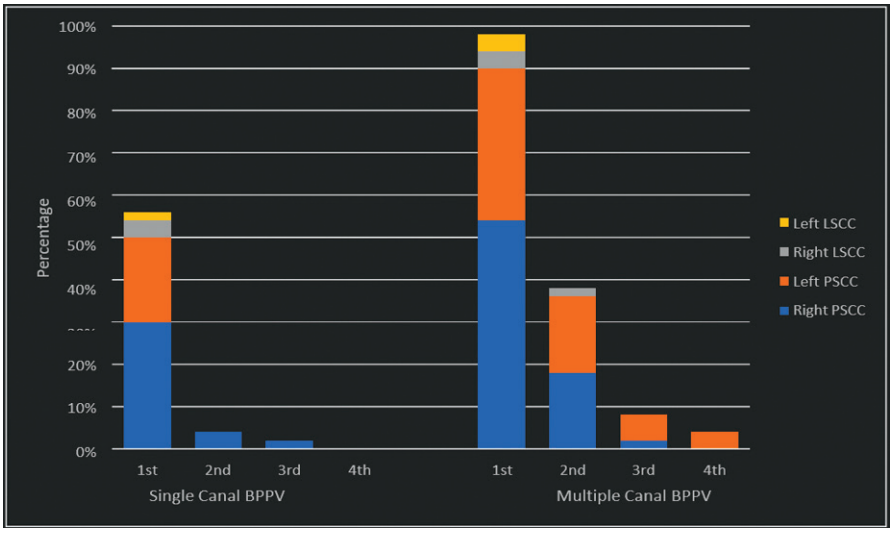

Figure 8. Comparison of most affected canal in each revisit in Single canal and Multiple canal BPPV

Table 14. Comparison of CRM done in each revisit in Single canal and Multiple canal BPPV

Re-Visit	CRM Done	Group		Total
		Single Canal	Multiple Canal	
1st visit	Right PRM	15 (30.0%)	27 (54.0%)	42 (42.0%)
	Left PRM	10 (20.0%)	18 (364.0%)	28 (28.0%)
	Right ROM	2 (4.0%)	2 (4.0%)	4 (4.0%)
	Left ROM	1 (2.0%)	2 (44.0%)	3 (3.0%)
	No	22 (44.0%)	1 (2.0%)	23 (23.0%)
2nd visit	Right PRM	2 (4.0%)	9 (18.0%)	11 (11.0%)
	Left PRM	0 (0.0%)	9 (18.0%)	9 (9.0%)
	Right ROM	0 (0.0%)	2 (4.0%)	2 (2.0%)
	No	48 (96.0%)	30 (60.0%)	78 (78.0%)
3rd visit	Right PRM	1 (2.0%)	1 (2.0%)	2 (2.0%)
	Left PRM	0 (0.0%)	3 (6.0%)	3 (3.0%)
	No	49 (98.0%)	46 (92.0%)	95 (95.0%)
4th visit	Left PRM	0 (0.0%)	2 (4.0%)	2 (2.0%)
	No	50 (100%)	48 (96.0%)	98 (98.0%)
Total		50 (100%)	50 (100%)	100 (100%)

Table 15. Comparison of Symptoms at third-month review in Single canal and Multiple canal BPPV

		Group		Total
		Single Canal	Multiple Canal	
Symptoms at 3rd month review	Yes	3 (6.0%)	7 (14.0%)	10 (.0%)
	No	47 (94.0%)	43 (86.0%)	90 (.0%)
Total		50 (100%)	50 (100%)	100 (100%)

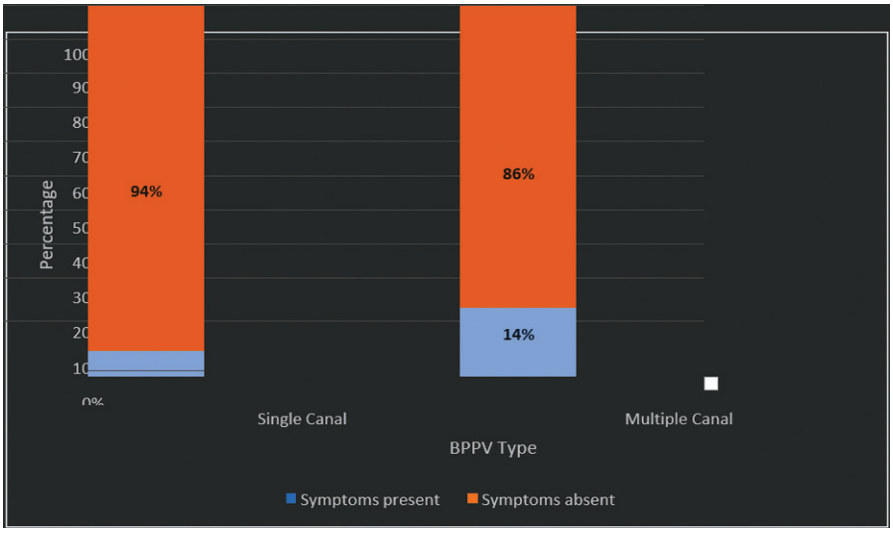

Figure 9. Comparison of Symptoms at third-month review in Single canal and Multiple canal BPPV

indicate that more than 90% of patients in both groups, including those with multiple canal BPPV, experienced a cure.

In our study also patients with multiple canal BPPV had response to repositioning manoeuvres, but they needed a slightly longer treatment course compared to patients with single canal BPPV.

It may be due to:

- The conditions of patients with multiple canal BPPV can be complex. They can have cupulolithiasis or mixture of canalolithiasis & cupulolithiasis. Those complex conditions lead to poor reduction.[14]
- Multiple canal BPPV patients with old age, obesity and several comorbidities showed decreased body mobility and poor coordination during the repositioning manoeuvres. The effectiveness of these manoeuvres often depends on the patient's ability to assume specific positions and execute movements with precision.
- Dysfunction of a semicircular canal or utricle in atherosclerotic patients may cause a continuous dropping of otoliths into the semicircular canals.

LIMITATIONS OF STUDY

One of the main limitations of our study is the small size hence actual recurrence cannot be assessed; some results may not be statistically significant due to the small sample size. Further studies with a larger sample size are needed to confirm the results.

CLINICAL IMPLICATION

Multiple canal BPPV is a less explored entity in BPPV. There are uncertainties still looming around the management of multiple canal BPPV. But from this study we were able to find that treatment outcomes of multiple canal BPPV are comparable to single canal BPPV with frequent follow-ups and doing the repositioning manoeuvre to most affected canal.

CONCLUSION

- Treatment response of multiple canal BPPV is comparable to single canal BPPV. But patients are required to have frequent follow ups to identify the most affected canal and to do the repositioning manoeuvres to most affected canal.
- Most of the patients with multiple canal BPPV required 2 or more visits for symptom resolution. But majority of patients with single canal BPPV had symptom resolution by second visit.
- Patients with comorbidities (e.g.: Diabetes Mellitus, Hypertension, CAD) are more prone to multiple canal BPPV.
- In multiple canal BPPV, unilateral involvement of posterior & horizontal semicircular canals was more common followed by bilateral posterior semicircular canals.
- In single canal BPPV, posterior semicircular canal was most commonly involved.

END NOTE

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