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Comparative Study of Metoprolol Succinate and Metoprolol Tartrate: Therapeutic Efficacy and Safety through Oral and Nasogastric Tube Administration

Keerthiga J[1]*, Mirudula S[1], Manuelita Sharon Christina B[1], Dr. Karthickeyan Krishnan[2], Dr. Palani Shanmugasundaram

[1*]Pharm. D V Year Student, Department of Pharmacy Practice, School of Pharmaceutical Sciences, Vels Institute of Science, Technology and Advanced Studies, Pallavaram, Chennai, TN-600117. Email: keerthigajaisankar@gmail.com
[1]Pharm. D V Year Student, Department of Pharmacy Practice, School of Pharmaceutical Sciences, Vels Institute of Science, Technology and Advanced Studies, Pallavaram, Chennai, TN-600117. Email: mirudula.s310@gmail.com
[1]Pharm. D V Year Student, Department of Pharmacy Practice, School of Pharmaceutical Sciences, Vels Institute of Science, Technology and Advanced Studies, Pallavaram, Chennai, TN-600117. Email: chrystina2721@gmail.com
[2]Professor and Head, Department of Pharmacy Practice, School of Pharmaceutical Sciences, Vels Institute of Science, Technology and Advanced Studies (VISTAS), Pallavaram, Chennai, TN-600117, India. Email: hodppractice@velsuniv.ac.in
Dean, School of Pharmaceutical Sciences, Vels Institute of Science, Technology and Advanced Studies, Pallavaram, Chennai, TN-600117. Email: dean.sps@vistas.ac.in

Correspondence:
Dr. Karthickeyan Krishnan, Professor and Head, Department of Pharmacy Practice, School of Pharmaceutical Sciences, Vels Institute of Science, Technology and Advanced Studies (VISTAS), Pallavaram, Chennai, TN-600117, India.
Email: hodppractice@velsuniv.ac.in

ABSTRACT

Background: Metoprolol, a selective β1-adrenergic receptor blocker, is widely prescribed in cardiovascular conditions including hypertension, heart failure, and arrhythmia. The route and formulation significantly influence therapeutic outcomes. This study aims to compare the efficacy and safety of Metoprolol Succinate (extended-release) and Metoprolol Tartrate (immediate-release) administered via oral and nasogastric (NG) routes in hospitalized patients requiring β-blocker therapy.

Methods: A prospective, comparative interventional study was conducted for six months at ESI Hospital, Ayanavaram, Chennai, including 108 patients aged 25–75 years diagnosed with cardiovascular diseases. Participants were categorized into four groups (n=27 each): Oral Succinate, Oral Tartrate, NG Succinate, and NG Tartrate. Baseline parameters such as systolic blood pressure (SBP), diastolic blood pressure (DBP), and heart rate (HR) were recorded. Therapeutic efficacy, safety (adverse drug reactions, ADRs), and biochemical parameters were assessed. Statistical analysis was conducted using SPSS v27.0 with ANOVA and paired t-tests; $p<0.05$ was considered significant.

Results: Oral Metoprolol Succinate exhibited the highest efficacy (77.8%), followed by Oral Tartrate (64.7%), NG Tartrate (55.6%), and NG Succinate (40.7%). Significant reductions in SBP and HR were observed across all groups ($p<0.05$), with the greatest decline in the Oral Succinate group (SBP 148.6±11.4 to 124.2±9.8 mmHg; HR 92.7±6.2 to 73.3±5.8 bpm). ADRs were mild, with fatigue and dizziness being most common. No severe ADRs or biochemical abnormalities were noted.

Conclusion: Oral Metoprolol Succinate demonstrated superior therapeutic efficacy and safety compared to other groups, attributed to its stable plasma concentration and extended-release profile. NG Tartrate remains a suitable alternative when oral administration is not feasible. This study emphasizes the importance of formulation and administration route in optimizing cardiovascular pharmacotherapy.

KEYWORDS: Metoprolol succinate, Metoprolol tartrate, Oral vs nasogastric, β-blockers, Hypertension, Cardiovascular efficacy.

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1. INTRODUCTION

β-blockers form a cornerstone in the management of cardiovascular diseases, particularly hypertension, ischemic heart disease, and arrhythmias. Metoprolol, a cardioselective β1-adrenergic blocker, is available in two formulations: Metoprolol Tartrate (immediate-release) and Metoprolol Succinate (extended-release). The pharmacokinetic and pharmacodynamic properties of these formulations differ significantly, influencing their clinical outcomes.

Nasogastric (NG) administration of medications is frequently required in critically ill or post-operative patients unable to take oral medications. However, drug bioavailability may be compromised through this route due to crushing or dispersion, which

can alter release profiles or absorption. Metoprolol Succinate's controlled-release matrix is particularly sensitive to such manipulation, potentially impacting its efficacy and safety.

While previous studies have compared oral formulations of Metoprolol, limited data exist on NG administration efficacy and pharmacokinetic behavior. Hence, this study aims to provide a comparative evaluation of therapeutic efficacy and safety of both formulations administered via oral and NG routes, with the goal of guiding clinical decisions in acute care settings.

2. MATERIALS AND METHODS

2.1 Study Design and Setting:

A six-month prospective, comparative interventional study was conducted in the Department of General Medicine, ESI Hospital, Ayanavaram, Chennai, after obtaining Institutional Ethics Committee approval

2.2 Sample Population and Size:

In Patients with Cardiovascular disease and Hypertension were determined for the study by the Department of General Medicine, ICU and Surgery. A total of 108 cardiovascular patients (25–75 years) were recruited. Participants were divided into four equal groups (n=27 each):

2.3 Inclusion and Exclusion Criteria:

Inclusion: Adults (≥25 years) with hypertension, arrhythmia, or heart failure requiring β-blocker therapy.
Exclusion: Pregnancy, bradycardia (<50 bpm), AV block, renal/hepatic dysfunction, hypersensitivity to β-blockers.

2.4 Complete Study Procedure:

This prospective study involves hospitalized patient with a case of Hypertension, Congestive heart failure and Atrial fibrillation. This study aims to investigate the pharmacodynamic effects of metoprolol Succinate and tartrate in adult patient requiring beta-blocker therapy.

Participants were divided into four equal groups (n=27 each):

- Group 1- Oral Administration - metoprolol succinate.
- Group 2 - Oral Administration - metoprolol tartrate.
- Group 3 - NG tube Administration - metoprolol succinate.
- Group 4 - NG tube Administration - metoprolol tartrate.

2.5 Baseline Assessment:

Baseline heart rate and blood pressure will be recorded, followed by drug administration. Pharmacodynamic monitoring will occur at multiple time points to assess heart rate and blood pressure reductions. Symptomatic improvements and adverse pharmacodynamic effects will also be evaluated. The study will compare the pharmacodynamic responses between oral and NG tube administration of both formulations, analyzing safety and tolerability profiles to determine the optimal therapeutic approach.

2.6 Statistical Analysis and Data Collection:

Baseline demographic and clinical parameters (SBP, DBP, HR, lipid profile) were recorded. Follow-up readings were taken on Day 3 and Day 5 post-treatment. Safety assessment included monitoring for adverse effects such as hypotension, dizziness, and fatigue. All continuous variables were expressed as mean ± SD. Intergroup comparisons were made using ANOVA, and paired sample t-tests were used for pre-post comparisons. Statistical significance was fixed at $p<0.05$.

3. RESULTS

3.1 Demographics and Baseline Characteristics

Among 108 patients, 66% were male and 34% female. The age distribution was uniform across groups (mean age 58.2±9.6 years). No significant difference was found in baseline SBP, DBP, or HR ($p>0.05$), confirming homogeneity.

Table 1 : Therapeutic Efficacy Across Groups

Therapeutic Efficacy	Metoprolol Succinate NG	Metoprolol succinate Oral	Metoprolol tartate oral	Metoprolol Tartrate NG	Grand Total
Achieved	11	22	20	15	68

Not Achieved	**16**	**5**	**7**	**12**	**40**
Grand Total	**27**	**27**	**27**	**27**	**108**

Table 2: Paired Sample T-Test – BP Reduction (Day 1 vs Day 5)

Paired Samples Statistics						
		Mean	**N**	**Std. Deviation**	**Std. Error Mean**	**P value**
Pair 1	**bpd1**	**126.21**	**108**	**18.269**	**1.750**	**0.025**
	bpd_5	**128.97**	**108**	**16.405**	**1.571**	

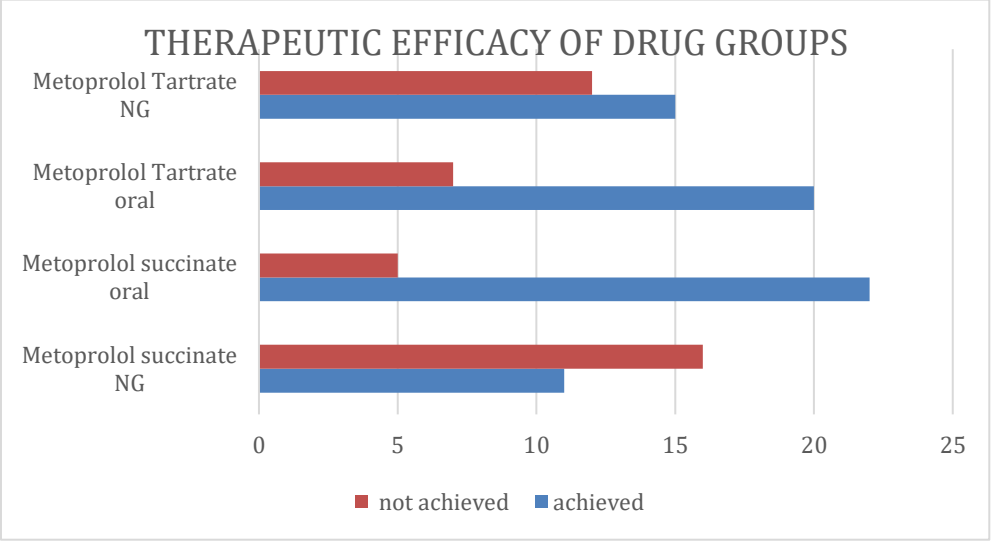
This table presents paired sample statistics comparing systolic BP between Day 1 and Day 5. The statistically significant reduction (p = 0.025) underscores overall treatment effectiveness across all groups, with Metoprolol Tartrate Oral contributing significantly to the observed drop.

Table 3:- ANOVA – Percentage Reduction in BP

ANOVA					
Reduction percentage					
	Sum of Squares	Degree of freedom	Mean Square	F	P value
Between Groups	163.290	3	54.430	2.006	0.011
Within Groups	2822.097	104	27.136		
Total	2985.387	107			

This table compares the percentage of BP reduction among the four groups. A significant difference (p = 0.011) was observed, with Metoprolol Succinate Oral showing the greatest reduction percentage among oral groups, and Metoprolol Tartrate NG performing best among NG groups.

Figure 1 : Therapeutic Efficacy Across Drug Groups



Thias depicts that this clustered bar chart compares therapeutic success rates among the four drug groups. Metoprolol Succinate Oral showed the highest efficacy with 22 out of 27 patients achieving therapeutic targets. This was followed by Metoprolol Tartrate Oral (20/27), Metoprolol Succinate NG (11/27), and Metoprolol Tartrate NG (15/21). These findings support the superior performance of the oral Metoprolol Succinate route.

Table 2 : Paired Sample T-Test – BP Reduction (Day 1 vs Day 5)

Paired Samples Statistics						
		Mean	**N**	**Std. Deviation**	**Std. Error Mean**	**P value**
Pair 1	**bpd1**	**126.21**	**108**	**18.269**	**1.750**	**0.025**
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This table presents paired sample statistics comparing systolic BP between Day 1 and Day 5. The statistically significant reduction ($p = 0.025$) underscores overall treatment effectiveness across all groups, with Metoprolol Tartrate Oral contributing significantly to the observed drop.

4. DISCUSSION

This study demonstrates that the route and formulation of Metoprolol play a crucial role in determining therapeutic outcomes. Oral Metoprolol Succinate, due to its extended-release characteristics, achieved superior BP and HR control compared to other groups. NG administration of Metoprolol Tartrate retained moderate efficacy, aligning with its immediate-release nature that is less affected by manipulation during tube delivery.

The reduced efficacy of NG-administered Metoprolol Succinate is likely attributed to disruption of the extended-release matrix, leading to altered absorption kinetics. This aligns with pharmacotechnical evidence that crushing extended-release tablets reduces bioavailability and can lead to unpredictable plasma concentrations. Clinical literature corroborates that ER formulations are less suitable for NG administration due to formulation integrity concerns.

These findings are consistent with pharmacokinetic studies showing better stability and predictable plasma levels with oral Succinate administration, improving therapeutic adherence and cardiovascular outcomes.

5. CONCLUSION

This study compared the therapeutic efficacy and safety of Metoprolol Succinate (extended-release) and Metoprolol Tartrate (immediate-release) administered via oral and nasogastric (NG) tube routes in patients with cardiovascular diseases. The findings demonstrated that oral Metoprolol Succinate provided the most consistent and effective control of heart rate and blood pressure, with the highest therapeutic success rate among all groups. The comparative analysis of therapeutic efficacy, heart rate, and blood pressure control revealed that oral Metoprolol Succinate emerged as the most effective formulation among the four groups. It demonstrated significantly better outcomes in achieving therapeutic goals by Day 5, with superior reductions in both heart rate and blood pressure ($p < 0.05$). The Chi-square analysis confirmed a statistically significant association between formulation type and efficacy ($p < 0.017$), with the oral succinate group achieving the highest success rate.

NG administration, particularly of the extended-release formulation, resulted in reduced efficacy, likely due to disruption of the controlled-release mechanism. However, Metoprolol Tartrate, being an immediate-release formulation, was better suited for NG administration and showed relatively improved outcomes when delivered through this route. No significant differences were observed in lipid profiles or cardiac enzyme levels, indicating a comparable safety profile across all formulations.

In conclusion, oral Metoprolol Succinate appears to be the most clinically favorable option in terms of both therapeutic efficacy and safety, satisfying the primary and secondary objectives of the study. It should be the preferred choice in stable patients for optimal cardiovascular management, while Metoprolol Tartrate via NG tube remains a practical alternative when oral administration is not feasible. Proper selection of formulation and administration route is essential to ensure effective and safe therapy, particularly in hospitalized or critically ill patients.

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Conflict of Interest: The authors declare no conflict of interest.

6. REFERENCES

1. Rajkumar, L. A. P., Chandy, S. J., Bright, H. R., Jiji, V. J. H., Basker, J., & Gunaraj, K. (2023). Importance of Appropriate Medication Administration in Patients with Nasogastric Feeding Tube. Journal of Pharmaceutical Research, 22(3), 152–157. https://doi.org/10.18579/jopcr/v22.3.23.46

2. Verhaeghe C, Peperstraete H, Devuyst S, De Somer F, Gevaert S, Devreese K. Antiplatelet effects and pharmacokinetics of crushed ticagrelor in resuscitated patients after cardiac arrest. Eur Heart J Acute Cardiovasc Care. 2021;10(Suppl 1):zuab020.230. doi:10.1093/ehjacc/zuab020.230. PMCID: PMC8263973.

3. Nair S. A study on identifying and resolving problems associated with administration of drugs via nasogastric tube [dissertation]. Manipal: Manipal College of Pharmaceutical Sciences; 2019. Available from: https://impressions.manipal.edu/mcops/30

4. Li Q, Zhang Z, Xie B, Ji X, Lu J, Jiang R,Et.al. Effectiveness of enteral feeding protocol on clinical outcomes in critically ill patients: a before and after study. PLoS One. 2017;12(8):e0182393. doi:10.1371/journal.pone.0182393. PMID: 28771622; PMCID: PMC5542540.

5. Zhu LL, Zhou Q. Therapeutic concerns when oral medications are administered nasogastrically. J Clin Pharm Ther. 2013;38(4):272–6. doi:10.1111/jcpt.12041. PMID: 23600913.

6. Grissinger M. Preventing errors when drugs are given via enteral feeding tubes. P T. 2013;38(10):575–6. PMID: 24391375; PMCID: PMC3875244.

7. Schier JG, Howland MA, Hoffman RS, Nelson LS. Fatality from administration of labetalol and crushed extended-release nifedipine. Ann Pharmacother. 2003;37(10):1420–3. doi:10.1345/aph.1D091.

8. Berkovitch M, Dafni O, Leiboviz A, Mayan H, Habut B, Segal R. Therapeutic drug monitoring of theophylline in frail elderly patients: oral compared with nasogastric tube administration. Ther Drug Monitor. 2002;24(5):594–7. doi:10.1097/00007691-200210000-00003. PMID: 12352930.

9. Shimizu H, Nishimura Y, Shiide Y, Ueda M, Yokota S, Kato Y, et al. Edaravone administered orally and via nasogastric tube in healthy adults: a comparative bioavailability phase 1 study. Clin Pharmacol Drug Dev. 2023;12(1):77–84.

10. Sawada H, Terakawa N, Nishimura N, Kogure A, Tachiki H, Oita A. Study on the nasogastric tube passage and the stability of active ingredients in a simple suspension method of oral drugs in combination with multiple drugs. Jpn J Pharm Health Care Sci. 2021;47(2):70–80.

11. Abdelrahman HA, Mohammed SR, Attia SAM. Assessment of nurses' knowledge and practices about medications administration via nasogastric tube at emergency hospital. Mansoura Nurs J. 2020;7(1):1–18.

12. Izadpanah M, Amraie N, Soltani F, Kouti L, Sayyadi S, Aghakouchakzadeh M, et al. Medication administration through enteral feeding tubes in mechanically ventilated critically ill patients: evaluation of the potential medication errors. J Pharm Care. 2019;7(3):49–53.

13. Jones W, Blagburn J, Morgan L. Considerations for medication administration via enteral feeding tubes. Br J Nurs. 2019;28(13):852–6.

14. Kaur H, Kaur S, Gill NK. Comparative evaluation of metoprolol formulations using different release modifiers. Indian J Pharm Sci. 2016;78(4):501–8.

15. Kassem MA, ElMeshad AN, Fares AR. Sublingual fast dissolving niosomal films for enhanced bioavailability and prolonged effect of metoprolol tartrate. Drug Des Devel Ther. 2016;10:2421–33.

16. Oh PY, Lai WM, Hoo FK, Boo YL, Ramachandran V, Ching SW. Techniques of medications administration through enteral feeding catheters in a tertiary care hospital, Malaysia. Rawal Med J. 2016;41:225–9.

17. Vaidya V, Patel P. Health expenditure comparison of extended-release metoprolol succinate and immediate-release metoprolol tartrate. Clinicoecon Outcomes Res. 2012;4:49–56.

18. Sharma S, Gupta GD. Formulation and characterization of fast dissolving tablets of metoprolol tartrate using natural superdisintegrants. Int J Pharm Pharm Sci. 2012;4(3):210–4.

19. Garg R, Gupta GD. Mouth dissolving tablets: A review. J Drug Deliv Ther. 2012;2(3):50–5.

20. Patel DM, Patel MM. Optimization of fast dissolving tablets of metoprolol tartrate using response surface methodology. Int J Pharm Sci Res. 2010;1(11):88–96.

21. Kumar S, Gupta SK, Sharma PK. A review on various approaches for the enhancement of the solubility of poorly soluble drugs. Int J Pharm Sci Res. 2010;1(7):1–10.

22. Sharma V, Singh G, Kumar D, Chauhan B. Formulation and evaluation of fast dissolving tablets of metoprolol tartrate using

different superdisintegrants. Int J Pharm Pharm Sci. 2010;2(3):70–5.

23. Fay MJ, Grauer DW. Strategies to improve medication administration through enteral feeding tubes. Nutr Clin Pract. 2010;25(4):389–97.

24. Alagusundaram M, Chanikya C, Ramesh Reddy K, Umashankari K, Madhu Sudhana Chetty C. Design and characterization of mouth dissolving tablets of metoprolol tartrate. Int J Res Pharm Sci. 2014;5(3):160–71.

25. Patel R, Patel M, Suthar M, Makwana S. Formulation and evaluation of mouth dissolving tablets of metoprolol tartrate by sublimation technique. Int J Pharm Sci Res. 2011;2(5):1148–53.

26. Kaur T, Gill B, Kumar S, Gupta GD. Mouth dissolving tablets: A novel approach to drug delivery. Int J Curr Pharm Res. 2011;3(1):1–7.

27. Patel VF, Liu F, Brown MB. Advances in oral transmucosal drug delivery. J Control Release. 2011;153(2):106–16

28. Andersson B, Caidahl K, di Lenarda A, Hall C, Hjalmarson A, Komajda M, et al. Metoprolol CR/XL controlled-release/extended-release (CR/XL) versus immediate-release (IR) metoprolol in patients with stable angina pectoris: a randomized, double-blind, crossover study.

29. Poole-Wilson PA, Swedberg K, Cleland JG, Di Lenarda A, Hanrath P, Komajda M, et al. Comparison of carvedilol and metoprolol on clinical outcomes in patients with chronic heart failure in the Carvedilol Or Metoprolol European Trial (COMET): randomized controlled trial. Lancet. 2003;362(9377):7–13.