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Review article

A REVIEW ON ANALYTICAL METHOD DEVELOPMENT AND DETERMINATION OF RANOLAZINE IN SYNTHETIC MIXTURE

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ABSTRACT:

Ranolazine Hydrochloride (RAN) chemically is a piperizine derivative used as an anti-aginal drug. Ranolazine is used for the treatment of cardiac ischemia and it effects sodium dependent calcium channel during myocardial ischemia. Ranolazine indirectly prevents the calcium overload that causes cardiac ischemia. Ranolazine Hydrochloride is indicated for the treatment of chronic angina. Ranolazine may be used with beta-blockers, nitrates, calcium channel blockers, antiplatelet therapy, lipid-lowering therapy, ACE inhibitors, and angiotensin receptor blockers. This review article represents the various analytical methods which have been reported for estimation of ranolazine in synthetic mixture. Chromatographic methods like HPLC, RP-HPLC, HPTLC, GC, LC-MS, LC-MS/MS were reported.

KEYWORDS: Ranolazine Hydrochloride, High performance liquid chromatography, Estimation, Angina.

INTRODUCTION:

The approval of Ranolazine in the EU (2008) and the US (2006) was based on efficacy and safety.[1-4] Ranolazine is an anti-anginal drug and chemically it is a piperazine derivative.

IUPAC name of Ranolazine is (RS)-N-(2,6-dimethylphenyl)-2-[4-[2-hydroxy3-(2-methoxyphenoxy)-propyl]piperazin-1-yl]acetamide, Molecular formula is $C_{24}H_{33}N_3O_4$, Molecular weight is 427.537g/mol.

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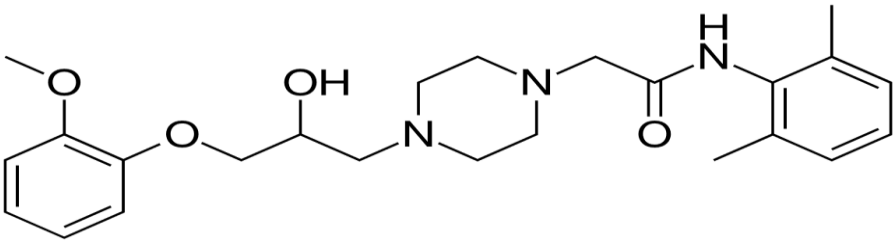

Fig 1: Structure of Ranolazine

MECHANISM OF ACTION:

Ranolazine is used for the treatment of Cardiac ischemia it affects sodium dependent calcium channels during myocardial ischemia [5].

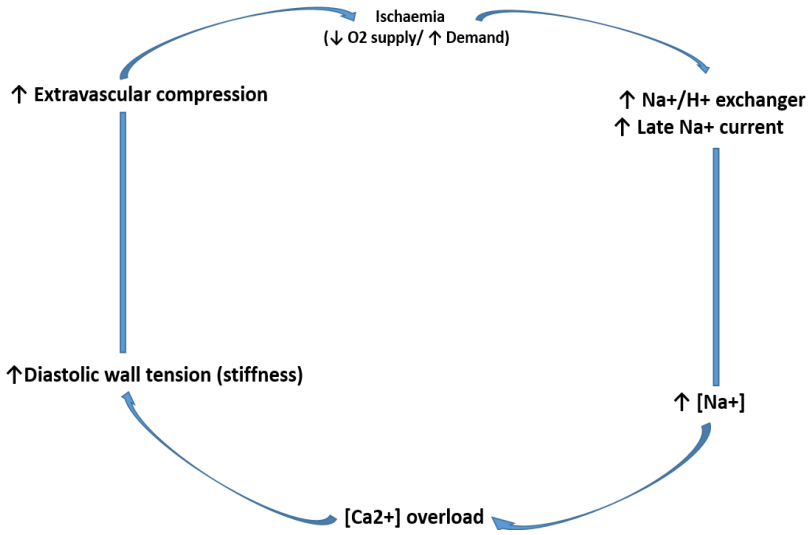

Fig 2: Mechanism of Ischaemia.

It is believed that Ranolazine have its effects via altering the trans-cellular late sodium current. During myocardial ischemia, by altering the intracellular sodium level Ranolazine effects the sodium dependent calcium channel. Thus, Ranolazine indirectly prevents the calcium overload that leads to cardiac ischemia. Ranolazine is also used with beta blockers, calcium channel blockers, nitrates, antiplatelet therapy, ACE inhibitors, angiotensin receptor blockers and lipid-lowering therapy. It exerts its action mainly through inhibition of peak and late Na+ currents, as well as rapidly activating delayed-rectifier K+ current. [6]

CHROMATOGRAPHIC METHOD:

The High Performance Liquid Chromatography (HPLC) for Ranolazine estimation. Gas Chromatography (GC) method for residual solvents determination in Ranolazine. High Performance Thin Layer Chromatography (HPTLC) method is widely used chromatographic method in the analysis of Ranolazine in formulation. Liquid Chromatography with Tandem Mass Spectrometry (LC- MS/MS), Liquid Chromatography-Mass Spectrometry (LC- MS), and Ultra High Pressure Liquid Chromatography (UHPLC) use for estimation of Ranolazine in plasma. Reverse Phase High Performance Liquid Chromatography (RP-HPLC) method also development for determination of concentration of Ranolazine in human serum and also for simultaneous determination of Ranolazine and its synthetic mixture.

Table 1: Summary of Chromatographic Method of Ranolazine.

Title	Method	Mobile phase	Stationary phase	Wave length
Assay of Ranolazine in Bulk and Pharmaceutical Dosage form.[7]	LC	-	C_{18} (150 ×4.6 mm, 3.0 µ particles)	-
Determination of Ranolazine in Rat Plasma.[8]	LC-MS	Methanol-10 mM Ammonium acetate (76:24)	C_{18} column	-
Sensitive quantification of Ranolazine in human plasma. [9]	LC-MS-MS	Acetonitrile : Water : Formic acid : 10% n-butyl amine (70:30:0.5:0.08)	Nova-Pak C_{18} column	-
Determination of Ranolazine in human plasma. [10]	LC-MS-MS	Methanol: water containing formic acid (1.0%) (65:35)	Cyano column (33 ×4.6 mm, 3.0 µ particles)	-
Determination of Ranolazine in human plasma. [11]	LC-MS-MS	Methanol: 10 mM Ammonium acetate (60:40, pH 4.0)	Zorbax extend C_{18} column	-

Determination of Ranolazine and its Pharmacokinetics in Dog. [12]	LC-MS	Acetonitrile 0.05% : Acetic acid (60:40)	Shim pack C_{18} 150×20 mm column	-
Estimation of Ranolazine. [13]	HPLC	Methanol : 10 mM Ammonium acetate (6:4)	Silica gel G 60 F254	271
Determination of Ranolazine in pure form and pharmaceutical formulation. [14]	RP-HPLC	Methanol and water containing 1% formic acid (60:40)	Kromasil C_{18} column with 5 µm particle size	273
Estimation of Ranalozine in bulk and its Pharmaceutical Formulations. [15]	RP-LC	Potassium dihydrogen phosphate monohydrate buffer (pH 3.0): Methanol: Acetonitrile (400:400:200)	RP-18 ((Make: Waters Corporation; 150 mmx4.6 mm I.D; particle size 3 µ)Column	225
Analytical Method Development and Validation of Ranolazine in Bulk and in Tablet Dosage form. [16]	RP-HPLC	Potassium di-hydrogen phosphate buffer (pH 3.0): Methanol (400:600)	ODS C_{18} (Make: Kromasil Corporation; 250 mm × 4.6 mm I.D.; particle size 5 µm) Column	225
Determination of Ranolazine Hydrochloride in the bulk drug and in pharmaceutical dosage form. [17]	LC	Methanol:Water (99:1)	HiQ Sil C-18 H S, (250mm×4.6 mm, 5µm)	273
Analysis of Ranolazine in Tablet dosage form. [18]	RP-HPLC	Acetonitrile: Methanol:THF 40:50:10	C_{18} column	269
Simultaneous determination of Ranolazine and Dronedarone in	HPLC	0.02N NH_2PO_4 buffer at pH 4 and	ODS 3V 250 x 4.6 mm, 5µm	282

bulk and pharmaceutical dosage forms. [19]		Acetonitrile in the ratio of 50:50		
Estimation of Ranolazine in Bulk and Marketed Formulation. [20]		Methanol and 0.5% Tri Eethyl Amine pH 6 (75:25)	Water LC 10 AT Pump	271
Stability Indicating Method Development and Validation of Ranolazine Hydrochloride in Bulk and Tablet Dosage Form. [21]	HPTLC	Chloroform : Methanol : Toluene (5 : 1 : 1)	Precoated silica gel aluminium plate 60 F - 254, (20 × 10 cm) with 250 µm thickness	273
Simultaneous Estimation of Metoprolol and Ranolazine and Quantification in Marketed Formulations.[22]	RP-HPLC	Methanol: 0.05% and 0. 1% OPA Water (40:60, 50:50 and 45:55)	PRIMESIL (C_{18}, 4.6 × 250 mm length, 5µm)	224, 225, 230
Determining Related Substances in Compatibility Studies and Novel Extended Release Formulation for Ranolazine. [23]	HPLC	Phosphate buffer pH 7.0 and Methanol in ratio of 350:650	Supelcosil C-18, (250×4.6 mm, 5 µm) column	220
Ranolazine in bulk & marketed formulation. [24]	HPLC & UV	Methanol : 0.5% tri ethyl amine pH 6 with orthophosphoric acid (75:25)	-	271
Estimation of Ranolazine HCl in Tablet Dosage Form. [25]	RP-HPLC	Buffer : Acetonitrile(60:40), (pH adjust with trimethylamine)	Inertsil ODS C18	224
Estimation of Ranolazine in Bulk and Tablet Dosage Form. [26]	RP-HPLC	Ammonium acetate buffer pH-4 : acetonitrile : methanol(30:50:20)	ODS C_{18} column	200

Determining Related Substances in Compatibility Studies in novel Formulation for Ranolazine. [27]	HPLC	Phosphate buffer pH 7.0 : Methanol (350:650 v/v)	Supelcosil C_{18} column	220
Determination of Ranolazine in human plasma. [28]	HPLC	Acetonitrile: 0.1% formic acid(90:10)	Agilent-ZORBAX C_{18} column	-
Estimation of Ranolazine in Tablet dosage form. [29]	RP-HPLC	Sodium dihydrogen phosphate buffer (pH adjust to 5): Acetonitrile (60:40)	X-terra C_{18} column	210
Estimation of Ranolazine in bulk and Pharmaceutical formulation. [30]	RP-HPLC	Sodium dihydrogen phosphate buffer pH adjust to 5 : Acetonitrile (60:40)	X-terra RP18 column	225
Determination of Ranolazine drug substance and drug product. [31]	RP-UPLC	Monobasic sodium buffer : Acetonitrile	Acquity BEH RP18 column	-
Semi preparative resolution of Ranolazine enantiomers. [32]	LC	Methanol	Cellulose tris (3,5dimethyl phenylcarbamate) Chiral stationary phases	-
Estimation of Ranolazine. [33]	RP-HPLC	Phosphate buffer pH 3.5 : Acetonitrile 65:35 (v/v)	Agilent Eclipse XDB C18 column	272
Analysis of Ranolazine and Desmethyl Ranolazine. [34]	LC-MS/MS	-	Chiralcel ODH Column	-
Estimation of Ranolazine. [35]	HPTLC	Methanol : 10 mM Ammonium acetate solution (6:4 V/V)	Aluminium plates precoated with Silica gel G 60 F254	271

Ranolazine HCL in bulk and Tablet dosage form. [36]	HPTLC	Chloroform: Methanol : Toluene (5 : 1 : 1)	Silica gel aluminium plate 60 F – 254	273
Determination of Ranolazine HCL in bulk and dosage form. [37]	LC	Methanol : Water (99:1)	HiQ Sil C_{18} HS	273
Quantitation of Ranolazine and its three metabolites. [38]	LC-MS/Ms	Methanol: 5 mM Ammonium acetate	Gemini C_{18} column	-
Quantitation of Ranolazine in human plasma. [39]	U-HPLCMS/MS	Acetonitrile : aqueous ammonium acetate solution(40:60, V/V)	BEH C18 column	-
Estimation of Ranolazine in human plasma. [40]	LC-MS/MS	Methanol : water containing formic acid (1.0%, v/v) (65:35, v/v)	Peerless Cyano column	-
Method for Ranolazine dihydrochloride and its degradation product. [41]	RPHPLC	Methanol : Acetonitrile : Phosphate buffer (pH 3.6,6.3 mM) (4 : 3 : 3, V/V)	C_{18} column	220

DISCUSSION:

The present review explored the efficacy and safety of Ranolazine as well as quality of life in patients with stable angina pectoris using this agent in combination with other drugs in a real world setting. Presented systemic review covers the current analytical method for Determination of Ranolazine, its formulation and biological sample like plasma and serum. HPLC method was found to be most widely used for Ranolazine.

CONCLUSION:

A simple, rapid, accurate, and precise stability indicating HPLC analytical method to be used frequently for simultaneous qualitative and quantitative determination of Ranolazine. The

present information is useful for the further study and research involved in formulation development and quality control of Ranolazine.

REFERENCE:

1. Chaitman BR, Skettino SL, Parker JO, Hanley P, Meluzin J, et al. (2004) Anti-ischemic effects and long-term survival during ranolazine monotherapy in patients with chronic severe angina. J Am Coll Cardiol 43: 1375-1382.

2. Chaitman BR, Pepine CJ, Parker JO, Skopal J, Chumakova G, et al. (2004) Effects of ranolazine with atenolol, amlodipine, or diltiazem on exercise tolerance and angina frequency in patients with severe chronic angina: a randomized controlled trial. JAMA 291: 309-316.

3. Stone PH, Gratsiansky NA, Blokhin A, Huang IZ, Meng L; ERICA Investigators (2006) Antianginal efficacy of ranolazine when added to treatment with amlodipine: the ERICA E efficacy of Ranolazine in Chronic Angina) trial. J Am Coll Cardiol 48: 566-575.

4. Morrow DA, Scirica BM, Karwatowska-Prokopczuk E, Murphy SA, Budaj A, et al. (2007) effects of ranolazine on recurrent cardiovascular events in patients with non-ST-elevation acute coronary syndromes: the Merlintimi randomized trial. JAMA 297: 1775-1783.

5. Luiz B, John CS (2006) The mechanism of Ranolazine action to reduce ischemia-induced diastolic dysfunction. Eur Heart J Suppliments 8: A10-A13

6. Antzelevitch C, Burashnikov A, Sicouri S, et al. Electrophysiologic basis for the antiarrhythmic actions of ranolazine. Heart Rhythm. 2011;8:1281–1290.

7. Madhvi A, Subba Rao DV. Development and Validation of a new analytical method for the determination of related Components and assay of Ranolazine in bulk drug and Pharmaceutical dosage Forms by LC. Chromatographia 2009; 70(1-2):333-8.

8. Zhong J, Liu X.Q, Chen Y, Zhao X.P, Wang Y.S, Wang G.J, "Determination of Ranolazine in rat plasma by liquid chromatography-electrospray ionization mass spectrometry.", J. Chromatographia, 2006, 63(3-4), 123-127

9. Tian L, Jiang J. Sensitive quantification of Ranolazine in human plasma by liquid Chromatography - Tandem mass spectrometry with positive electrospray ionization. J Chromatogr B 2007; 846(1-2):346-350.

10. Bhaumik U, Ghosh A. Determination of Ranolazine in human plasma by LC – MS/MS and its application in bioequivalence study. J pharm biomed anal 2008; 67(5): 370-2.

11. Zhao L, Li H. Determination of Ranolazine in human plasma by liquid Chromatographic-tandem mass spectrometric assay. J Chromatogr Sci 2008; 46(8): 697-700.

12. Tsing H. Determination of Ranolazine and its Pharmacokinetics in Dog by LC – MS. J of china pharma uni 2004; 25(3):445-6.

13. Rahul Chakraborty, Krishanu Pal, M Shaiba, Naresh Sangepu, Sridevi P. High performance thin layer chromatographic estimation of ranolazine, October – December 2010 RJPBCS 1(4) Page No. 152-157

14. Lincy Joseph, Mathew George, Navneet Kumara Upadhyay & Anju.V Development and Comparison of the Validation Methods of HPLC and UV for Determination of Ranolazine In Pure Form And Pharmaceutical Formulation, International Journal of Medical Research and Pharmaceutical Sciences Volume 4 (Issue 3): March 2017 Page No. 9-20

15. Brahma Reddy Gade, Sita Ram Bandhakavi, M. V. Satyanarayana and Pavani Peddi Development and validation of stability indicating RP-LC method for estimation of ranalozine in bulk and its pharmaceutical formulations, Journal of Chemical and Pharmaceutical Research, 2015, 7(8):454-461,Page No: 454-461

16. Pratik M. Karwanje1, Sanjay B. Bhawar, Sudarshan B. Kakad, Analytical Method Development and Validation of Ranolazine in Bulk and in Tablet Dosage form by RP-HPLC Method, The International journal of analytical and experimental modal analysis' Page No. 2000-2013

17. Tripti Sharma, Swapan K. Moitra1, Sudam C. SI, Dannana G. Sankar, Stability - indicating LC method for the determination of ranolazine hydrochloride in the bulk drug and in pharmaceutical dosage form, International Journal of Pharmacy and Pharmaceutical Sciences ISSN- 0975-1491 Vol 3, Suppl 4, 2011, Page No. 327-332

18. V. Phani kumar ,Y. Sunandamma, New RP - HPLC Method Development and validation for Analysis of Ranolazine in Tablet dosage form, Journal of Pharmacy Research 2011,4(10),3681-3683

19. Asifa Nahid, Haritha Pavani, Development and validation of HPLC method for simultaneous determination of Ranolazine and Dronedarone in bulk and pharmaceutical dosage forms, Indian Journal of Research in Pharmacy and Biotechnology, November-December 2014 Page 1524-1528

20. Parvathareddy Sri Sowmya, Desam Nirupama, Nuthalpati Mahanta, B Thangabanlan, Development and validation of HPLC and UV Methods for Estimation or Ranolazine in bulk and marketed formulation, International Journal of Innovative Pharmaceutical Science and Research 2(5), 2014, 1042-1058

21. Khedkar A. N., Veer S. U., Rakh M. S., Rao J. R. Stability Indicating Method Development and Validation of Ranolazine Hydrochloride in Bulk and Tablet Dosage Form by HPTLC, International Journal of Pharmaceutical and Clinical Research 2015; 7(1): 77-83

22. Vennapu DR, Palled MS. Stability Indicating RP-HPLC for Simultaneous Estimation of Metoprolol and Ranolazine and Quantification in Marketed Formulations. Anal Chem Ind J. 2019; 19 (1):147.

23. Suresh Babu VV, Sudhakar V, Murthy TEGK (2014) Validated HPLC Method for Determining Related Substances in Compatibility Studies and Novel Extended Release Formulation for Ranolazine. J Chromatograph Separate Technique 5: 209. doi:10.4172/2157-7064.1000209

24. Parvathareddy S, Desam N, Nuthalapati M, B.T, "Development and Validation of HPLC and UV methods for estimation of Ranolazine in Bulk and Marketed formulation." , International journal of Innovative Pharmaceutical Sciences and Research, 2014, 2(5), 1042-1058

25. Patel R.C, Rathod D.K, Patel P.R, Patel V.S, "Estimation of Ranolazine Hydrochloride by Spectrophotometric and RP-HPLC in tablet dosage forms." , International Journal of Pharmaceutical and Applied Sciences, 2010, 1(2), 79-83

26. Soujanya A, K.V.S, Puttagunta S, "Method Development and Validation for estimation of Ranolazine in its bulk and tablet dosage form." International Journal of inventions in Pharmaceutical Sciences, 2013, 1(4), 363-369

27. VV.S, V.S, TEGK.M, "Validated HPLC method for Determining Related Substances in Compatibility studies and Novel extended release formulation for Ranolazine." Chromatography Separation Techniques, 2014, 5(1), 1-7

28. Bai S, Gao H, Qu H, Liang Y, Li Y, Zheng Z, Wang X, Hao G, "Quantitative determination of Ranolazine in human plasma by high performance liquid chromatography-tandem mass spectrometry." , Northwest Pharmaceutical Journal, 2011

29. G.L, K.H, Agarwal N, "Development and validation of stability indicating RP-HPLC method for estimation of Ranolazine in bulk and tablet dosage form." International Research Journal of Pharmaceutical and Applied Sciences, 2012, 2(5), 217-223

30. Ganji R, D. R, G. S, Jayapal G, P. R, Srilakshmi V, "Development and Validation of stability indicating RP-LC method for estimation of Ranolazine in bulk and its Pharmaceutical formulation." , American Journal of analytical Chemistry, 2012, 3, 378-384

31. Malati V, Reddy A.R, Mukkanti K, Suryanarayana M.V, “A novel reversed phase stability indicating RP-UPLC method for the quantitative determination of fifteen related substances in Ranolazine drug substance and drug product.”, J. Talanta, 2012, 97, 563-373

32. Luo X, Zhai Z, Wu X, Shi Y, Chen L, Li Y, “Analytical and semipreparative resolution of Ranolazine enantiomers by liquid chromatography using polysaccharide chiral stationary phases.”, Journal of separation science, 2006, 29(1), 164-171

33. Boovizhikannan T, Palanirajan V, “Estimation of Ranolazine using Reverse phase High Performance liquid Chromatography Technique.” American journal of Pharma Tech Research, 2012, 2(6)

34. Rodrigo A.S, Thiago B, Pierina S.B, “Enantioselective analysis of Ranolazine and Dimethyl ranolazine in microsomal medium using dispersive liquid-liquid microextraction and LC-MS/MS.” , J. Bioanalysis, 5(2), 171-183

35. Chakraborty R, Pal K, Shaiba M, Sangepu N, P.S, “High performance thin layer chromatographic estimation of Ranolazine.” , Researh journal of Pharmaceutical, Biolgical and Chemical Sciences, 2010, 1(4), 152-157

36. Khedkar A.N, Veer S.U, Rakh M.S, Rao J.R, “Stability indicating method development and validationof Ranolazine Hydrochloride in bulk and tablet dosage form by HPTLC.” , International Journal of Pharmaceutical and Clinical Research, 2015, 7(1), 77-83

37. Sharma T, Moitra S.K, Si.S.C, Sankar D.G, “Stability indicating LC method for the determination of Ranolazine Hydrochloride in the bulk drug and in pharmaceutical dosage form.” , International Journal of Pharmacy and Pharmaceutical Sciences, 2011, 3(4), 327-332

38. Wang Y, Chen X, Sun Z, Yang Y, Liu W, Zhong D, “Development and Validation of a sensitive LC-MS/MS assay for simultaneous quantitaneous of Ranolazine and its three metabolites in human plasma.” , Journal of Chromatography B analyst Technology Biomed Life Sciences, 2012, 10(6), 889-890

39. Tan Q, Zhu R, Li H, Fang P, Yan M, Zhang Q, Peng W, “Development and Validation of a sensitive U-HPLC-MS/MS method with electrospray ionization for quantitation of Ranolazine in human plasma: Application to a clinical pharmacokinetic study.” , Journal of Chromatography B, 2012, 901, 119-124

40. Bhaumik U, Ghosh A, Sarkar A, Bose A, Selvan P, Sengupta P, Chakraborty U, Ghosh D, Pal T, “Determination of Ranolazine in human plasma by LC-MS/MS and its application in bioequivalence study.”, Journal of Pharmaceutical and Biomedical Analysis, 2008, 48(5), 1404- 1410

41. Laha T, Padhy D, Sen S, "A Validated stability indicating reversed phase high performance liquid chromatography method of Ranolazine Dihydrochloride and characterization of its degradation products.", International journal of Pharmacy and Pharmaceutical sciences, 2013, 5(1), 61-66

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