

Role Of Enteropathogenic Escherichia Coli In Paediatric Diarrhoeas In South India

Gandham Pavani Tilak *, Jyothi lakshmi G Mudaliar**

*Associate Professor , Department of Microbiology , Medciti Institute of Medical Sciences , Hyderabad.

**Associate Professor , Department of Microbiology , Gandhi Medical College , Hyderabad

Abstracts: Background: Enteropathogenic Escherichia coli(EPEC) is a major cause of diarrhoea in children below 5 years of age. Serotyping is the classical method and PCR detection of virulence factors is a rapid way of detecting diarrhoeagenic Esch.coli. Objectives : To study the role of EPEC in Paediatric diarrhoea by both Serogrouping and Multiplex PCR assay and to analyse the antibiotic susceptibility pattern of EPEC strains in our area. Materials and Methods : Prospective study of stool samples collected from children with diarrhoea and without diarrhoea who were below 5 years of age was conducted from May to November 2011. EPEC isolates were identified by Serogrouping. Escherichia coli isolates were subjected to Serogrouping and Multiplex PCR assay and those isolates which showed pathogenic genes were further serotyped. Antibiotic susceptibility pattern of EPEC isolates was determined by Clinical and Laboratory Standards Institute guidelines. Results : Among the Escherichia coli isolates in the diarrhoeal group, 36.8% were identified as EPEC by Serogrouping and 38.8% of them were found to possess EAEC genes by molecular characterisation. In the nondiarrhoeal Esch. coli strains , none agglutinated with EPEC polyvalent sera, 46.6% showed EAEC genes out of which 85.7% were of a single serotype O153. Among the Escherichia coli isolates which agglutinated with EPEC polyvalent antisera , 33.3% were positive for Enteroaggregative genes. Conclusion : EPEC is still an important pathogen in paediatric diarrhoeas . O serogrouping can still be relied upon for detection of EPEC. EAEC are present in classical ' O ' serogroups. Serotype O 153 has an increasing potential for asymptomatic carrier state in children below 5 years of age.[Tilak G P et al NJIRM 2012; 3(5) : 21-26]

Key words: Andhra Pradesh , Enteropathogenic Escherichia coli (EPEC) , Antibiotic Susceptibility , Serotyping , Molecular characterisation , Enteroaggregative Escherichia coli (EAEC)

Author for correspondence: Dr .Gandham Pavani Tilak , Associate Professor , Department of Microbiology , Medciti Institute of Medical Sciences(MIMS),plot no89,vinayaknagar,sherilingampally , Ranga Reddy District , Andhra Pradesh , India – 500050 Email : drpavanic@gmail.com

Introduction: Diarrhoea is major cause of illness in many areas of the world .¹ EPEC is a very important pathogen in children with diarrhoea.² It is a major cause of diarrhoea in children below 5 years of age.³ Incidence of EPEC varies from one locality to another.⁴ Serotyping is the classical method for identification of EPEC strains.⁵ But serotypic markers are rarely sufficient to reliably identify a strain as Escherichiacoli.⁶

Introduction of PCR methodology which depends on detection of virulence factors has provided a practical and rapid way of detecting diarrhoeagenic Escherichiacoli.⁷ Resistance of Enteropathogenic bacteria to commonly prescribed antibiotics is increasing both in the developing as well as developed countries and resistance has emerged even to the newer , more potent antimicrobial agents.⁸ Multidrug resistant EPEC strains are a common phenomenon in recent researches with world wide extension. More over for the selection of appropriate therapy, knowledge of local antimicrobial therapy pattern plays an

important role.⁹ Thus , keeping in mind all these facts the present study was conducted to assess the role of EPEC in paediatric diarrhoeas in our hospital isolates by both Serotyping and Molecular characterisation and to identify its Antibiotic susceptibility pattern.

Materials And Methods : Approval was obtained from the Institute Research council before commencement of the study. A total of 100 stool samples collected from patients suffering from acute diarrhoea and 30 samples from nondiarrhoeal cases in children below 5 years admitted to Gandhi hospital during the period May to November 2011 , were processed in Microbiology department , Gandhi Medical College, Musheerabad, AP , India. Details of of age, sex , antibiotic usage , clinical signs of dehydration of these children were recorded. Wet films were prepared from the samples and examined under microscope for pus cells . Each sample was inoculated on MacConkey agar , Wilson & Blair and Thiosulphate Citrate Bile

Sucrose agar before and after enrichment with Selenite F broth and Alkaline Peptone water. After overnight incubation, plates were examined and organisms were identified by Gram stain, motility, Culture and Standard biochemical reactions as per Mackie McCartney Practical medical Microbiology 14th edition. Escherichia coli isolates were subjected to serogrouping using EPEC polyvalent antisera which included antisera to the predominant O antigens of Enteropathogenic strains implicated in paediatric diarrhoeas i.e., O 26, O 55, O 86, O 111, O 114, O 119, O 125, O 126, O 127, O 128 and O 142. Antibiotic sensitivity testing for these EPEC isolates was done by Kirby-Bauer technique on Mueller Hinton agar with Ampicillin (10mcg) Amikacin (30 mcg), Cotrimoxazole (1.25 mg + 23.75 mcg), Nalidixic acid (30mcg), Ciprofloxacin (30 mcg) and Norfloxacin (30 mcg) discs as per CLSI guidelines. All the Esch.coli isolates were sent to National Institute of Cholera & Enteric Diseases (NICED) for Molecular characterisation by Multiplex PCR assay. The Escherichia coli isolates which were reported to contain pathogenic genes were serotyped using O antisera to all Escherichia coli strains by NICED.

Results: Among the 100 stool samples from acute diarrhoeal cases analysed, 82 (82%) were Escherichia.coli, 8 (8%) Klebsiella, 5 (5%) Citrobacter and 2 (2%) Enterococci. The isolates in nondiarrhoeal group were Escherichia coli 18 (60%), Klebsiella 9 (30%), Enterococci 2 (6.7%) and Proteus 1 (3.3%) Escherichia coli was the most common isolate in both the diarrhoeal and nondiarrhoeal groups followed by Klebsiella, Proteus and Citrobacter in the diarrhoeal group and in the age matched controls, Klebsiella was the next common pathogen followed by Enterococci. Among the Escherichia coli isolates subjected to serogrouping, 30 isolates (36.8%) agglutinated with EPEC polyvalent antisera. In the control group, none of them showed agglutination.

Total no of Esch.coli	% of Agglutination with EPEC Polyvalent antiserum			
	Diarrhoeal group		Nondiarrhoeal group	
	EPEC	Non EPEC	EPEC	Non EPEC
82	36.8 %	63.4 %	0 %	100 %

Of the 30 EPEC isolates, most of them 16 isolates (73.3%) were of the below 2 years age group. Overall the sex distribution of EPEC showed a female preponderance 30 (57.6%). Mild to moderate dehydration was seen in 18 (59.9%) of the isolates of EPEC. On microscopy, fecal leukocytes were seen in 17 (56.6%) of EPEC. Antibiotic susceptibility of EPEC isolates showed highest sensitivity to Amikacin (100%). Sensitivity to Norfloxacin and Ciprofloxacin was 46.6% and 36.7% respectively. Resistance was observed to Cotrimoxazole (34.4%), Nalidixic acid (30%) and Ampicillin (30%). The results of Multiplex PCR assay revealed that out of the Escherichia coli isolates from the diarrhoeal group, 31 (38.8%) were positive for Enteroaggregative genes. No other diarrhoeagenic Escherichia coli genes were found in this group.

Among the 18 Esch.coli strains in the nondiarrhoeal group, 7 (46.6%) were positive for Enteroaggregative genes. No other diarrhoeagenic Esch.coli genes were found in this group. In the EAEC strains in the diarrhoeal group, 14 (60.8%) of them were of below 1 year age group. In the EAEC strains in the nondiarrhoeal group, 4 (57.1%) were below 1 year age group. There was a female preponderance in the EAEC isolates in both the diarrhoeal 15 (65.2%) and nondiarrhoeal 5 (71.4%) groups. Mild dehydration was seen only in 6 (26.1%) of EAEC strains in the diarrhoeal group. No dehydration was seen in the nondiarrhoeal group. Fecal leukocytes were seen in 5 (21.7%) of isolates in the diarrhoeal and 1 (7%) in the nondiarrhoeal group. The Serotyping of EAEC isolates in the diarrhoeal group revealed that EAEC belonged to Multiple serotypes. 15 (50%) strains were nontypable, 7 (30.4%) were of the serotype O 153, 3 (13.1%) each were of the serotypes O 86a and O 127a and 1 (4.4%) each was of the serotype O 78 and O 8. Out of the EAEC isolates in nondiarrhoeal group, most of

them belonged to a single sero type. 6 (85.7%) were of the serotypes O 153 and 1 (14.3%) was nontypable. Among the 30 Esch.coli isolates which agglutinated with EPEC polyvalent antisera , 10 (33.3%) were positive for Enteroaggregative genes.

Discussion: The present study was undertaken to assess the role of EPEC in diarrhoea in children below 5 years . Among the 100 stool samples from the acute diarrhoeal cases analysed , the isolation of Escherichia coli was 82 (82%) , Klebsiella 8 (8%) , Proteus 5 (5 %) , Citrobacter 3 (3%) and Enterococci 2 (2%) . In the study conducted by C.K.Joshi et al , 73% isolation of Esch.coli , 46% isolation of Klebsiella , 0.8 % isolation of Enterococci was reported which correlates well with our study.¹⁰ Study by K.K .Khanna et al showed as isolation of Escherichia coli 21.1% , Proteus 1.1% and Klebsiella 2.8% which was in contrast to our study.¹¹

The incidence of EPEC was 30 % in our diarrhoeal group which was comparable with the study of Amela et al which showed an incidence of 54% .¹² Our study was in contrast to the studies of Tawfeek et al which showed an incidence of 13%.¹³ In the nondiarrhoeal group , none of the isolates could be typed as Enteropathogenic strains in the present study . PAK Addy et al reported an incidence of 4.1 % . EPEC in the control group.¹⁴ Seropositives only in the diarrhoeal group and no seropositives in the control group suggests that Serogrouping of EPEC is still an important method for detection of EPEC . O serogrouping appears to be still the simplest and useful test for presumptive identification of EPEC.¹⁵ 22 (73.3%) cases of EPEC diarrhoea in the present study occurred in children below 2 years of age , predominantly in below 1 year age group . This correlated well with the studies of C.K Joshi et al (73.8%) and K.K.Khanna (75%) .^{10,11} This can be due to a decline in maternally acquired antibodies and the introduction of weaning foods that are potentially contaminated . In addition , crawling usually begins at this age and the risk of ingesting contaminated materials is high. ¹⁶ Lower incidence of EPEC diarrhoea in children after 2 years may be due to acquisition of antibodies

reactive to EPEC virulence associated proteins by infants living in endemic areas. ¹⁷ Though a slight female preponderance was observed in the sex distribution of our study group , no significant difference was observed in the present study . This compares well with study conducted by Barbara J Stoll et al .¹⁸ Mild to moderate dehydration was seen in 59.9% cases of EPEC diarrhoea which was in accordance with the study by K.K.Khanna et al which showed 64.5% dehydration .¹¹ In a study conducted by Ulysses Fagundes et al , dehydration was noted in 95.2% cases of EPEC diarrhoea which was in contrast to our study.¹⁹ Dehydration in EPEC diarrhoea is due to the production of a bacterial toxin in stomach that interacts with the digestive juices and causes the patient to lose large amounts of water through the intestines . ²⁰ Faecal leukocytes were observed in 17 (56.6%) of cases of EPEC diarrhoea in our study . This is similar to the observations of K.K.Khanna et al (46.4%).¹¹ . Relatively high frequencies of fecal leukocytes in our study suggest that although EPEC strains are not invasive pathogens , they induce an inflammatory response in the gut epithelium *in vivo* by triggering the production of cytokines and chemokines which recruit polymorphonuclear leukocytes to the infection site .²¹ EPEC strains are found to be resistant to several antibiotics . There was high resistance to Nalidixic acid (70%) , Ampicillin (70%) , Cotrimoxazole (66.6%) , Ciprofloxacin (63.3%) , Norfloxacin (58.4%) . Multidrug resistance was also observed by S.N.Saxena et al . ²²

Resistance to antibiotics such as Ampicillin , Cotrimoxazole is found in diarrhoeagenic Esch.coli isolated from children with diarrhoea in developing countries where the over use and misuse of antibiotics is common. ²³ Resistance to fluoroquinolones i.e Ciprofloxacin and Norfloxacin which is 63.3% and 58.4% respectively shows that resistance is also emerging to these drugs .This is because these antibiotics are widely used as the first choice for treatment of diarrhoea in developing countries.²⁴ Fluoroquinolones should only be prescribed as second line antibiotics in case of specific infections or as second line antibiotics in severe bacterial infections with

proven resistance to safer drugs.²⁵ In our diarrhoeal group, in the 80 Esch. Coli isolates which were subjected to Multiplex PCR assay, 31(38.8%) were EAEC and no other diarrhoeagenic Escherichia coli group was found. In the study conducted by Kyung Hee Kim et al, EAEC were 14.7%, ETEC were 22.5%, EPEC were 6.5% and EIEC were 1%.²⁶ Terasa Estrada Garcia et al in their study showed EAEC as 26%, ETEC as 27%, EPEC as 16% and EIEC as 3%.²⁷ In comparison to our results of multiplex PCR assay, where 31(38.8%) isolates were positive for EAEC genes, the studies conducted by Jav Saranya et al revealed an EAEC positivity of 15.1%.²⁸ Terasa Estrada Garcia et al showed a positivity of 26.6% of EAEC genes.²⁷ In the 18 nondiarrhoeal Escherichia coli isolates subjected to Multiplex PCR assay, 12 (66.6%) showed EAEC genes in comparison to the study of Jav Saranya et al which showed a positivity of 0.6%. In our diarrhoeal group among the Escherichia coli isolates identified by Multiplex PCR assay as EAEC, the most common serotype was O153 (O Nontypable). This finding is comparable to the study of Soumen K et al.²⁹ However this serotype O153 is a frequent characteristic of EAEC strains.³⁰ Due to their aggregative phenotype, many EAEC strains autoagglutinate and are often described as nontypable or as O-rough. It is also well established that EAEC are highly heterogeneous.³¹ Therefore we can think that most of the EAEC strains in our area are rough strains. In our control group, in the EAEC strains identified by Multiplex PCR assay, most of the strains were of a single serotype, this was in accordance with the study of Angela Christina Rodrigues Gilardi et al.³² But the predominant serotype in our study was O153, whereas in the above study the predominant serotype was O86. The presence of a single serotype O153 in most of the nondiarrhoeal group EAEC isolates suggests that the serotype O153 has an increasing potential for asymptomatic carrier state in children less than 5 years in our area. Since this serotype is common in cattle and studies have suggested its presence in animal foods like curds and since its transmission from animals to humans is also reported, its presence in controls can be explained.^{33, 34} Among

the 30 Escherichia coli isolates which agglutinated with EPEC polyvalent antisera, 10(33.3%) were positive for EAEC genes. Among these 10 isolates which were positive for EAEC genes, 7 isolates(70%) belonged to Enteroaggregative serotypes. This shows that EAEC are present in classical EPEC O Serogroups.^{35, 36}

Conclusion : EPEC is still an important pathogen in Paediatric diarrhoeas. O Serogrouping appears to be still the simplest and useful method for presumptive identification of EPEC and can be relied upon for detection of EPEC. Dehydration can be considered as one of the clinical features of Paediatric diarrhoeas. Fluoroquinolones should only be prescribed to children as second line antibiotics in case of severe bacterial infections only with proven resistance to safer drugs. Most of the EAEC strains in our area are rough strains which are nontypable. Serotype O153 which is present in animal foods like curd in India has an increasing potential for causing asymptomatic carrier state in children below 5 years of age in our area. EAEC are present in classical O Serogroups.

Acknowledgement : We acknowledge our gratitude to Dr N.K. Saxena, Retired HOD, Department of Microbiology, Gandhi Medical College for his constant encouragement and guidance throughout the study. We also express our gratitude to Dr Ramaswamy, NICEED for helping us with the molecular characterization of our isolates

References :

1. Mamatha B, Shivananda P.G. Rotavirus and Enteric pathogens in Infectious Diarrhoea in Manipal, South India. Indian Journal of Pediatrics 2002; 69 (5) : 393 - 396
2. Samuel .V, Daniel R, Margarite P. Prevalence of diarrhoeagenic Esch.coli in children from Leon, Nicaragua. Journal of Medical Microbiology 2009; 58(5) : 630 - 637
3. Ashrafal Haq J, Hirchoon L, Rosliza Abdur R. Detection of Enteropathogenic Esch.coli by serotyping & cell Adhesion

- Assay among children in N.Eastern Peninsular Malaysia : A Hospital Based study . Ibrahim Medical College .J. 2008 ; 2(2) : 40 – 43
4. Hala A.R.E , Hoda A.H.I , Marwa N.E – Multiplex PCR for Detection of Diarrhoeagenic Esch.coli in Egyptian children . Journal of Medical Sciences 2007 , 7:255-262
 5. Neelam T,Balvinder M , Sumeeta.K . Antimicrobial resistance in selected bacterial enteropathogens in N.India . Indian J Med Res 2004 ; 120 : 39 – 43
 6. Arif A , Asiya A , Zahida Q . Drug resistance in Indian isolates of enteropathogenic Esch.coli. World J Microbial Biotechnol 2008 , 24 : 2633-2638
 7. Joshi CK, Bhardwaj AK , Vyas BL. A Study of bacterial infantile diarrhoea, India J Pediat 1980, Vol. 47; p. 307 – 310.
 8. Khanna KK, Ramanathan AL, Puri RK , Bhatia VN and Sundaraj T. Childhood Diarrhoea and its Association with Enteropathogenic Esch.coli “, Indian Journal of Pediatrics July 1977, Vol. 44, 354, P. 169 – 175.
 9. Amela D , Mirsada H , Daria K. Diarrhoeagenic Esch.coli strains isolated from pediatric patients with Diarrhoea in Bosnia and Herzegovina. Bousman Journal of Basic Medical Surdives 2009 ; 9 (2) : 148 -155.
 10. Prasannan M , Jesudason MV , Kang G. A study on some phenotypic virulence markers of Enteropathogenic Esch.coli. Indian J Med Res.2004 ; 114 : 95 - 8
 11. Tawfeek H.I , Najim N.H , N.Mashikhi S. Studies on diarrhoeal illness among hospitalised children under 5 years of age in Baghdad during 1990-97. 2002 ; 8 (1)
 12. Addy PAK, Antepim G, Frimpong EH . “ Prevalence of pathogenic Escherichia coli and parasites in infants with Diarrhoea in Kumasi , Ghana “ , East African Medical Journal Nweze E.I Aetiology of Diarrhoea & virulence properties of diarrhoeagenic Esch.coli among patients & Healthy subjects in S.E Nigeria. J Health Popul Nutr 2010 ; 28 (3) : 245 – 252
 13. Alikhani M , Mirsalahian A , Fatollahadeh B. Prevalence of Enteropathogenic & Shiga toxin producing Esch.coli among children with & without Diarrhoea in Iran . Journal of Health, Population and Nutrition . (J Health popul Nutr , 2007 ; 25 (1) ; 88-93
 14. Nataro JP,Kaper JB , Diarrhoeagenic Esch.coli Clinical Microbiology Rev.1998 ; 11: 142-201 , 2004 , Vol, No.7 , p. 1-2
 15. Prasannan M, Jesudason MV , Kang G, Sridharan G.A Study on some phenotypic virulence markers of Enteropathogenic Esch.coli , Indian J Med Res. September , 2001; Vol 114: 91 - 95
 16. El-Gilamy A.H , Hanmool S. Epidemiology of diarrhoeal diseases among children under age 5 years in Dakahlia , Egypt. Eastern Mediterranean Health Journal , 2005 ; 11 (4) 762 – 775.
 17. Cristiane Barros C , Solange Barros C , Magda Maria S . Early acquisition of serum & saliva antibodies reactive to enteropathogenic Esch.coli virulence associated proteins by infants living in an endemic area.Pediatric Allergy and Immunology 2003 ; 14 (3) : 222 – 228.
 18. Barabara J S , Roger I G , Imdaul H M, Khan MU , James E H , Hasina B . Surveillance of patients attending a diarrhoeal disease hospital in Bangladesh . British Medical Journal , 23 October , 1982, Vol.285, p. 1185 – 1188.
 19. Ulysses Fagundes-Neto , Isabel Cristina Affonso Scarletsky . The gut at war : the consequences of enteropathogenic Esch.coli infection as a factor of Diarrhoea and malnutrition , Sao Paulo Med J/ Rev. Paul Med. 2000 ; 118 (1) , p. 21 – 29
 20. Enterobacterial infections . Encyclopedia of Childrens Health 2005 edition
 21. Mercado E , Ochoa , T , Ecker L , Ckary T. Fecal leucocytes in children infected with diarrhoeagenic Esch.coli Jour nal of clinical Microbiology 2011 ; 49 (4) : 1376 – 1381

22. Saxena SN , Mago ML , Rao Bhanu LN , Ahuja S, Gowal D “ Prevalence of multiple drug resistance amongst strains of Esch.coli isolates from cases of Diarrhoea”, Indian J pediat , 1983, 50: p. 607 – 611.
23. Djie – Maletz A , Reither K. Donors High rate of resistance to locally used antibiotics among enteric bacteria from children in Northern Ghana. J Antimicrob chemother 2008 ; 61, 1315 – 1318.
24. Trung Vu N , Phung Van L , Chinh Huy L . Antibiotic Resistance in Diarrhoeagenic Esch.coli and shigella strains isolated from children in Hanoi , Vietnam . Antimicrob agents Chemother 2005 ; 49 (2) : 816 – 819.
25. Daniel R , Luciani R , Nanci S. Antibiotic for empirical treatment of acute infections diarrhoea in children Braz J Infect Dis 2006 ; 10 (3)
26. Kyung Hee Kim, Inn-Soo such et al. Etiology of Childhood Diarrhoea in Korea . Jr.of Clinical microbiology , 1989; 1192 – 96.
27. Teresa Estrada-Garcia , Jorge F, Cerna C. “ Drug-resistant Diarrhoeagenic Esch.coli , Mexico “, Emerging Infectious Diseases , August , 2005 ; P 1-5
28. Jav Sarantuya , Junichiro Nishi , Naoko Wakimoto et al .Typical Enteroaggregative Escherichia coli is the Most Prevalent pathotype among E.coli Strains Causing Diarrhoea in Mongolian Children “Journal of Clinical Microbiology , January , 2004 Vol, 42, No. 1 ; p.133 – 139.
29. Souman K , Bharwati S , Rajendran K. Virulence characteristics and Molecular Epidemiology of Enteroaggregative Esch.coli isolates from Hospitalised diarrhoeal patients in Kolkata , India . J Clin Microbiol 2004 ; 42 (9).
30. Uber AP, Trabulsi LR , Irino K . Enteroaggregative Esch.coli from humans and animals differ in major phenotypic traits and virulence genes. FEMS Microbiology Letters 2006 ; 256 (2) : 251 – 7.
31. Andrej wein traub. Enteroaggregative Esch.coli Epidemiology , virulence and detection , Journal of Medical Microbiology 2007 ; 56(1) : 4 – 8. Vaishnavi C , Kaur^S Beutin^L Krueger^W Phenotypic and molecular characterisation of clinically isolated Esch.coli Indian Journal of Pathology & Microbiology 2010 ; 53 (3) : 503 – 508.
32. Angela Cristina Rodrigues G . Production of cytotoxic distending toxin and other virulence characteristics of Escherichia coli Strains of serogroup O86. Mem.Inst . Oswaldo Cruz 2001 ; 96 : 703 – 8 .
33. Vaishnavi C , Kaur S , Beutin L . Phenotypic and molecular Characterisation of clinically isolated Escherichia coli Indian Journal of Pathology & Microbiology 2010 ; 53 (3) : 503 – 508.
34. Priyanka S and Alka P . Isolation of Esch.coli , staphylococcus aureus and Listeria monocytogenes from milk products sold under market conditions at AGRA REGION , Acta agriculture Slovenic 2008 ; 92 (1) : 83 – 88.
35. Waldir P. Samar F , Cristiano G . Enteropathogenic Esch.coli strains among classical Enteropathogenic Esch.coli O serogroups Journal of clinical Microbiology 2002 ; 40 (9) : 3540 – 3541
36. Leila C.campos , Maria R Franzolui , Leiz R Trabulsi “ Diarrhoeagenic Esch.coli categories among the Traditional Enteropathogenic Esch.coli O serogroups - A Review Mem Inst Oswaldo Cruz, Rio De Janeiro , October 2004 ; 99 (6) : 545 – 552.

Conflict of interest: None

Funding: None
