Class I Integrons and SXT Elements in El Tor Strains Isolated before and after 1992 Vibrio cholerae O139 Outbreak, Calcutta, India

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We examined the distribution of class I integrons and SXT elements in Vibrio cholerae O1 El Tor strains, isolated in Calcutta, India, before and after the V. cholerae O139 outbreak in 1992. Class I integrons, with aadA1 gene cassette, were detected primarily in the pre-O139 strains; the SXT element was found mainly in the post-O139 strains.

Since the introduction of antibiotics in the treatment of infectious diseases, antibiotic resistance has spread dramatically among microbes. The occurrence of drug-resistant strains of Vibrio cholerae is being reported with increasing frequency (1). Spread of antibiotic resistance in microbes has been attributed to the mobilization of drug-resistance markers by a variety of agents (e.g., plasmids, transposons, and integrons). In V. cholerae, antibiotic-resistance determinants have traditionally been found on plasmids. Recently, in a few cases, these determinants have also been detected on integrons and a novel conjugative transposable element, SXT.

Integrons are DNA elements capable of mobilizing individual gene cassettes into bacterial chromosomes by site-specific recombination. Integrons consist of a central variable region that often harbors antibiotic-resistance gene cassettes, flanked by 5′ and 3′ conserved sequences (CS) (2). Integrons have been categorized into four different classes on the basis of the distinctive integrase (int) genes they carry on their 5′-CS (2,3). Among the different integron families, class I integrons are found to be most prevalent in drug-resistant bacteria. Class I integrons have been detected in V. cholerae O1 strains isolated in Vietnam, Thailand, and Italy (4–6). Their presence in V. cholerae O1 strains isolated in India, however, had not been previously reported. SXT is a transmissible genetic element that harbors resistant determinants to trimethoprim, streptomycin, sulfamethoxazole, and chloramphenicol. SXT was first discovered in V. cholerae O139 (7), a new epidemic strain that emerged in the Indian subcontinent in late 1992 and displaced the V. cholerae O1 El Tor as the primary cholera-causing agent for approximately 6 months. After this period, V. cholerae O1 El Tor reemerged and became predominant (8). Unlike those of the pre-O139 period, most of these poststrains were found to be resistant to trimethoprim, sulfamethoxazole, and streptomycin, and in a few cases, this resistance was found to be due to the SXT element. We describe the results of a study in which we examined, retrospectively, the presence and the relative abundance of class I integrons and SXT elements in V. cholerae El Tor O1 strains, isolated in Calcutta, before, during, and after the O139 outbreak.

The Study
A total of 58 strains of V. cholerae O1 El Tor isolated in Calcutta before (March–December 1992; group I), during (July–November 1993; group II), and after (March 1994–June 1995; group III) the V. cholerae O139 outbreak (8) were included in this study. These strains, belonging to ribotypes RI, RII, and RIII, were maintained in brain-heart infusion broth supplemented with 15% glycerol at –70°C and grown when needed (8).

Occurrence of Class I Integrons
The 3′ conserved sequence of class I integrons is characterized by antibiotic resistance gene qacE?1 and the sulfonamide resistance gene sul1. To identify class I integrons, primers ATCGCAATAGTTGCGAAGT (accession no. X15370) and GCAAGGCGAAACCCGCGGC (accession no. X12869), specific for 3′ CS (5), were amplified in this region by polymerase chain reaction as described (5). A 0.8-kb product, found in 22 of the 58 isolates, was confirmed to be the 3′ CS of class I integrons by sequencing (Table). To identify the gene cassette in the class I integrons, primers previously used to amplify the region between the 5′ CS and 3′ CS (5) were used. All 22 strains produced a 1.0-kb amplicon, which on sequencing was found to contain the aadA1 gene that confers resistance against aminoglycosides, streptomycin, and spectinomycin (4,5). Nucleotide sequence of aadA1 cassette has been assigned the GenBank accession no. AY115577.

A total of 17 out of the 22 class I integron-bearing strains belonged to the before period. The remaining five, though isolated after June 1993, probably represented carry-over strains. These five strains belonged to the same RI ribotype as the other 17 strains from the before period (Table) and had a CTX structure identical to the other strains with RI ribotype (8).

Antibiotic Resistance Profile
Resistance of V. cholerae isolates to ampicillin (10 µg), ciprofloxacin (5 µg), furazolidone (50 µg), gentamycin (10 µg), neomycin (30 µg), nalidixic acid (30 µg), streptomycin (10 µg), sulfamethizole (100 µg), tetracycline (30 µg), and trimethoprim (25 µg) were examined by using commercial discs (Hi Media, Bombay, India) as described (1). An overall increase in the number of strains with resistance to a greater
number of antibiotics was seen in the isolates of the post-O139 period; a fourfold increase in resistance against trimethoprim, a drug often used for the treatment of cholera in children and pregnant women, was noted. Almost all strains, from all isolation periods, were uniformly resistant to streptomycin and sulfamethizole, but none were found to be resistant to tetracycline, gentamycin, or ciprofloxacin. None of the strains examined were found to harbor any plasmid.

Presence of SXT Elements

None of the strains belonging to the ribotypes RII and RIII, which were all isolated during and after the O139 outbreak, carried the aadA1 gene cassette (coding for aminoglycoside resistance); however, they were all resistant to streptomycin. Further, all of the strains were resistant to trimethoprim. Since strains of *V. cholerae*, which harbor the SXT element, are resistant to streptomycin and trimethoprim (7), we sought to determine if the resistance of the post-O139 strains to streptomycin and trimethoprim could be traced to an SXT element. Colony hybridization of the 58 strains with a 0.8-kb probe, specific for the SXT integrase gene (7), showed that all trimethoprim-resistant strains from all isolation periods and all “during” and after streptomycin-resistant strains carried the SXT element (Table). Further, five of these strains harbored both SXT and the aadA1 gene cassette (Table). Our survey thus suggested that while the streptomycin resistance of the strains isolated before the O139 outbreak was due to the aadA1 gene cassette carried by the class I integrons, the SXT element was probably responsible for this phenotype in the post-O139 strains.

All *V. cholerae* strains included in this study were resistant to multiple antibiotics. Since none of the strains harbored any plasmid and the resistance determinants present in the class I integrons and in the SXT element could account for only a few markers, other determinants of antibiotic resistance may exist.

Dalsgaard et al. (4) found that the O1 strains isolated in Vietnam in 1994 and after, had the ribotype identical to that found in some of the O1 strains isolated in Samutsakorn, Thailand, during and after the 1993 O139 outbreak there. Both pre- and post-O139 isolates carried class I integrons with the aadA2 gene cassette. This fact led Dalsgaard et al. to conjecture that this distinct O1 strain might have been transferred between Thailand and Vietnam (5). However, the possibility of its migrating from a third country could not be ruled out. It should be noted that the ribotype of the pre-O139, O1 Calcutta strains examined in this study was identical to that of the Samutsakorn strains (4,5,8). However, as can be seen from the data presented here, unlike the Samutsakorn strains, these strains harbored aadA1 and aadA2 gene cassettes. We had shown previously that the post-O139, O1 strains isolated in Calcutta could have migrated to Guinea-Bissau in Africa (9). Further evidence has shown that this strain, which caused an outbreak in 1994–1995, could have subsequently acquired class I integrons bearing the [ant(3’)-1a] gene cassette by a 150-kb plasmid from an unknown source (10).

Conclusions

While the class I integron with aadA1 gene cassette was widely distributed among the pre-O139 O1 strains isolated in Calcutta, it was mostly absent in the post-O139 O1 strains.
DISPATCHES

Ms. Amita holds a master’s degree in microbiology and is working towards her doctoral degree under the supervision of Dr. Amit Ghosh. She is researching the emergence of drug resistance in *Vibrio cholerae*.

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**References**


**Figure.** Distribution of class I integrons and SXT elements in *Vibrio cholerae* El Tor strains isolated before, during, and after the O139 outbreak.