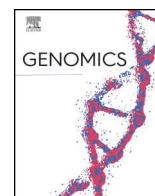




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Short Communication

Missense mutations in SARS-CoV2 genomes from Indian patients

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ABSTRACT

The genetic diversity of the severe acute respiratory syndrome coronavirus-2 (SARS-CoV2) in several countries sums up to worldwide genetic diversity. In this present study, variations in terms of missense mutations among the SARS-CoV2 genomes from 128 Indian patients, as of May 2020, are accounted and thereby some key findings with some hypotheses were made. These mutations across various genes of these genomes show wide genetic variations in sequence and rapid evolution of SARS-CoV2 virus. The presence of unique mutations in the studied SARS-CoV2 genomes may led to their attenuation. Few Genes such as ORF6, ORF10 are free from any mutations in the Indian context of 339 genomes observed as of 14th July 2020. Further, E protein contains only one mutation. This may suggest that designing a therapeutic approach against ORF6, ORF10 and E genes may have a beneficial effect in controlling COVID-19 pandemic especially in India.

1. The study

The pandemic of COVID-19, caused by the RNA coronavirus SARS-CoV2 has spread over 200 countries and infected millions of people worldwide [1,2]. The rate of mutation of RNA viruses is much higher than that of their hosts [3,4]. The rapid spread of COVID-19 across various countries opens an intriguing question whether the variations in genome sequences of the novel coronavirus are contributing to the variation of infection and mortality rate [5,6]. Having this question in mind, with the reference to the Wuhan based genome NC_045512, missense mutations were identified in the SARS-CoV2 genomes of the COVID-19 affected Indian patients. This study of mutations in the SARS-CoV2 genomes of 128 COVID-19 affected Indian patients has been carried out. Various mutations over the proteins of SARS-CoV2 genomes are presented in the articles [7,8,9,10,11,12,13]. A comprehensive list of patients with other associated details are presented in the Table 1. It is to be noted that most of these 128 patients were infected in Europe and USA and came back to India. Some of them were infected from neighbour Indian patients.

The following Tables 2, 3, 4 and 5 adumbrate all the missense mutations along with silent mutations across the 128 virus genomes from Indian COVID-19 affected patients.

Mutations of an amino acid A_1 to an amino acid A_2 is denoted by $A_1(l)A_2$ where l denotes location of amino acid in the sequence. The third column of the Tables 2, 3, 4 and 5 describe the locations of amino acids where the mutations were detected. Here, in the fourth column the gene names are mentioned with the total number of mutations in the parenthesis.

1.1. Findings from the Tables 2, 3, 4 and 5

There are several missense mutations in the different genes across the genomes of SARS-CoV2 from Indian patients. Some of the conclusive inferences as well as hypotheses are drawn, based on the missense mutations as presented in the Tables 2, 3, 4 and 5 as follows:

- Maximum number of missense mutations were found to be 11 which occurred in two genomes MT451890 (Ahmedabad-Gujarat) and

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Table 1

List of 128 SARS-CoV2 genomes from Indian patients with their respective locations and date of collection of the sample.

Accession	Geo_Location	Collection_Date	Accession	Geo_Location	Collection_Date	Accession	Geo_Location	Collection_Date
MT509494	Vadodara	2020-05-03	MT496981	Ahmedabad	2020-05-03	MT467252	Ahmedabad	2020-04-29
MT509495	Kodinar	2020-05-10	MT496982	Ahmedabad	2020-05-03	MT467253	Ahmedabad	2020-04-29
MT509496	Botad	2020-05-09	MT496983	Ahmedabad	2020-05-05	MT467254	Ahmedabad	2020-04-29
MT509497	Una	2020-05-11	MT496984	Ahmedabad	2020-05-03	MT467255	Ahmedabad	2020-04-30
MT509498	Jamnagar	2020-05-09	MT496985	Ahmedabad	2020-05-05	MT467256	Ahmedabad	2020-04-29
MT509499	Jamnagar	2020-05-07	MT496986	Ahmedabad	2020-05-05	MT467257	Ahmedabad	2020-04-30
MT509500	Dahod	2020-05-03	MT496987	Ahmedabad	2020-05-04	MT467258	Ahmedabad	2020-04-29
MT509501	Jamnagar	2020-05-06	MT496988	Ahmedabad	2020-05-03	MT467259	Prantij	2020-05-02
MT509502	Jamnagar	2020-05-10	MT496989	Ahmedabad	2020-05-03	MT467260	Prantij	2020-05-02
MT509503	Junagadh	2020-05-09	MT496990	Gandhinagar	2020-04-29	MT467261	Modasa	2020-05-04
MT509504	Rajkot	2020-05-06	MT496991	Gandhinagar	2020-04-27	MT467262	Modasa	2020-05-04
MT509505	Ahmedabad	2020-04-11	MT496992	Ahmedabad	2020-05-03	MT467263	Dhansura	2020-05-04
MT509506	Rajkot	2020-04-27	MT496993	Gandhinagar	2020-04-29	MT457402	Hyderabad	2020-03-24
MT509507	Una	2020-05-10	MT496994	Gandhinagar	2020-04-29	MT457403	Hyderabad	2020-03-25
MT509508	Jamnagar	2020-05-05	MT496995	Gandhinagar	2020-04-29	MT451874	Surat	2020-04-24
MT509509	Ahmedabad	2020-04-11	MT496996	Gandhinagar	2020-05-02	MT451876	Surat	2020-04-26
MT509510	Una	2020-05-10	MT496997	Gandhinagar	2020-04-29	MT451877	Surat	2020-04-26
MT509511	Rajkot	2020-04-28	MT483553	Modasa	2020-05-05	MT451878	Surat	2020-04-27
MT509512	Dahod	2020-05-01	MT483554	Modasa	2020-05-05	MT451880	Surat	2020-04-26
MT481895	Ahmedabad	2020-05-03	MT483555	Modasa	2020-05-05	MT451881	Ahmedabad	2020-04-26
MT481896	Ahmedabad	2020-05-03	MT483556	Modasa	2020-05-05	MT451882	Ahmedabad	2020-04-26
MT481897	Modasa	2020-05-05	MT483557	Modasa	2020-05-05	MT451883	Ahmedabad	2020-04-26
MT481898	Himatnagar	2020-05-05	MT483558	Modasa	2020-05-05	MT451884	Ahmedabad	2020-04-26
MT481899	Modasa	2020-05-05	MT483559	Prantij	2020-05-05	MT451885	Ahmedabad	2020-04-26
MT481900	Gandhinagar	2020-04-28	MT483560	Modasa	2020-05-05	MT451886	Ahmedabad	2020-04-26
MT481901	Dahegam	2020-04-28	MT483702	Modasa	2020-05-05	MT451887	Ahmedabad	2020-04-26
MT481902	Dahegam	2020-05-03	MT477885	India*	2020-03-25	MT451888	Ahmedabad	2020-04-26
MT481903	Dahegam	2020-05-03	MT467237	Ahmedabad	2020-04-26	MT451889	Ahmedabad	2020-04-26
MT481904	Gandhinagar	2020-04-25	MT467238	Ahmedabad	2020-04-29	MT451890	Ahmedabad	2020-04-26
MT481905	Gandhinagar	2020-05-02	MT467239	Ahmedabad	2020-04-26	MT435079	Ahmedabad	2020-04-13
MT481906	Gandhinagar	2020-04-27	MT467240	Ahmedabad	2020-04-30	MT435080	Ahmedabad	2020-04-13
MT481907	Gandhinagar	2020-04-26	MT467241	Ahmedabad	2020-04-26	MT435081	Ahmedabad	2020-04-13
MT481908	Mansa	2020-04-28	MT467242	Ahmedabad	2020-04-29	MT435082	Ahmedabad	2020-04-13
MT481909	Modasa	2020-05-05	MT467243	Ahmedabad	2020-04-30	MT435083	Ahmedabad	2020-04-07
MT496972	Ahmedabad	2020-04-29	MT467244	Ahmedabad	2020-04-30	MT435084	Ahmedabad	2020-04-14
MT496973	Ahmedabad	2020-04-29	MT467245	Ahmedabad	2020-04-29	MT435085	Gandhinagar	2020-04-22
MT496974	Ahmedabad	2020-04-29	MT467246	Ahmedabad	2020-04-29	MT435086	Mansa	2020-04-21
MT496975	Ahmedabad	2020-04-29	MT467247	Ahmedabad	2020-04-29	MT415320	India*	2020-03-01
MT496976	Ahmedabad	2020-05-03	MT467248	Ahmedabad	2020-04-29	MT415321	India*	2020-03-11
MT496977	Ahmedabad	2020-05-03	MT467249	Ahmedabad	2020-04-29	MT415322	India*	2020-03-16
MT496979	Ahmedabad	2020-05-05	MT467250	Ahmedabad	2020-04-29	MT415323	India*	2020-03-20
MT496980	Ahmedabad	2020-05-03	MT467251	Ahmedabad	2020-04-29	MT358637	Rajkot	2020-04-05
						MT012098	Kerala State	2020-01-27
						MT050493	Kerala State	2020-01-31

* No specific name of the state/city of India is mentioned in the NCBI database.

MT509510(Una-Himachal Pradesh). Note that the only common missense mutations among these 11 mutations is P(4715)L. Therefore, we propose that these two patients (one from Gujarat and another from Himachal Pradesh, located 1300 KM apart) were infected by two different strains of the virus.

- From Una, MT509507 genome has ten different missense mutations that are significantly different from others, which is depicted in the Table 5. So the patient carrying the SARS-CoV2 genome MT509507 has a distinct origin of infection.
- No mutation was observed in the ORF6, E, ORF10 genes of the SARS-CoV2 genomes of the 128 strains. It is worth mentioning that among 128 genomes, MT509496 is the only genome where protein ORF7b possesses a missense mutation S(31)L. During this study (May 2020), SARS-CoV2 genome sequence from 128 Indian patients was available, but as on 14th July, 2020, SARS-CoV2 genome

sequence from 339 Indian patients were available. Now, It is also checked that no missense mutation is present over the genes ORF6 and ORF10 in 339 virus sequences. This directly recommends that designing a therapeutic approach against these genes may have a significant role in prevention of COVID-19 pandemic, especially in India. It is further to be noted that one mutation V(62)F (N-terminus domain) in the envelope (E) gene of MT635409 genome (Nadiad, Gujarat) has been detected.

- The six genomes MT451882, MT451888, MT496986, MT496983, MT496974 and MT509505 from Ahmedabad possess seven missense mutations among which only three are commons viz. P(4715)L, Q(57)H and S(194)L in the proteins ORF1, ORF3a and N respectively.
- There are six identical missense mutations across the genomes MT496995 and MT496994 from Gandhinagar, which imply their same source of infection of COVID-19. Similarly, two genome

Table 2
Missense and silent mutations in the entire genome of SARS-CoV2 from Indian patients.

Virus Genome ID	Location	Missense and silent mutations	Genomic regions	Missense mutation
MT415321	India	F(924)F, P(4715)L, G(614)G	ORF1 (2), S (1)	1
MT451878	Surat	F(5251)F, Y(789)Y, P(13)L	ORF1 (5), S (2)	1
MT481909	Modasa	F(924)F, Q(57)H, Y(71)Y	ORF1(1), ORF3a(1), M(1)	1
MT467257	Ahmedabad	F(924)F, P(4715)L, D(614)G	ORF1(2), S(1)	2
MT451884	Ahmedabad	F(924)F, P(4715)L, K(4803)K, D(614)G	ORF1(3), S(1)	2
MT467244	Ahmedabad	F(924)F, P(4715)L, K(4803)K, D(614)G	ORF1(3), S(1)	2
MT415320	India	N(5020)N, G(5074)G, Y(28)H, N(856)N, P(344)S	ORF1(3), S(2), N(1)	2
MT435084	Ahmedabad	F(924)F, P(4715)L, D(614)G	ORF1(4), S(1)	2
MT435079	Ahmedabad	F(924)F, P(4715)L, D(614)G	ORF1(9), S(1)	2
MT451883	Ahmedabad	P(4715)L, K(4803)K, D(614)G	ORF(9), S(1)	2
MT496990	Gandhinagar	F(924)F, P(4715)L, D(614)G	ORF1(2), S(1)	2
MT496977	Ahmedabad	F(924)F, P(4715)L, D(614)G	ORF1(2), S(1)	2
MT481907	Gandhinagar	F(924)F, P(4715)L, D(614)G	ORF1(2), S(1)	2
MT496996	Gandhinagar	F(924)F, P(4715)L, D(614)G, I(692)I	ORF1(2), S(2)	2
MT481904	Gandhinagar	F(924)F, P(4715)L, K(4803)K, D(614)G	ORF1(3), S(1)	2
MT481903	Dahegam	F(924)F, P(4715)L, K(4803)K, D(614)G, L(116)L	ORF1(3), S(1), ORF7a(1)	2
MT481902	Dahegam	F(924)F, P(4715)L, K(4803)K, D(614)G	ORF1(3), S(1)	2
MT481900	Gandhinagar	F(924)F, P(4715)L, V(5999)V, D(614)G, I(692)I	ORF1(3), S(2)	2
MT496981	Ahmedabad	P(4715)L, V(5272)I, L(6205)L, N(6629)N	ORF1(4)	2
MT451886	Ahmedabad	P(4715)L, D(614)G, Q(677)H	ORF1(1), S(2)	3
MT467260	Prantij	F(924)F, T(3058)I, P(4715)L, D(614)G	ORF1(3), S(1)	3
MT467250	Ahmedabad	F(924)F, P(4715)L, D(614)G, A(892)V	ORF1(2), S(2)	3
MT467249	Ahmedabad	F(924)F, P(1960)F, P(4715)L, D(614)G, Q(677)H	ORF1(3), S(2)	3
MT467242	Ahmedabad	F(924)F, P(4715)L, V(6600)A, D(614)G, I(692)I	ORF1(3), S(2)	3
MT467246	Ahmedabad	F(924)F, P(4715)L, L(6205)L, D(614)G, Q(57)H, Y(71)Y	ORF1(3), S(1), ORF3a(1), M(1)	3
MT467238	Ahmedabad	N(189)N, F(924)F, N(4550)N, M(4588)I, P(4715)L, D(614)G	ORF1(5), S(1)	3
MT435083	Ahmedabad	G(662)R, F(924)F, L(2253)L, P(4715)L, V(6536)V, V(6660)V, D(614)G, I(692)I	ORF1(6), S(2)	3
MT483559	Prantij	F(924)F, T(3058)I, P(4715)L, D(614)G	ORF1(3), S(1)	3
MT483553	Modasa	F(924)F, T(3058)I, P(4715)L, D(614)G	ORF1(3), S(1)	3
MT483555	Modasa	F(924)F, N(3405)H/I, L(6205)L, D(614)G, Q(57)H, Y(71)Y	ORF1(4), S(1), ORF3a(1), M(1)	3
MT496973	Ahmedabad	G(192)D, F(924)F, P(4715)L, D(614)G	ORF1(3), S(1)	3
MT481908	Mansa	F(924)F, P(4715)L, L(6205)L, D(614)G, Q(57)H, Y(71)Y	ORF1 (3), S (1), ORF3a (1), M (1)	3

sequences MT481898(Himatnagar) and MT496985(Ahmedabad), had six identical missense mutations and they are P(4715)L, V(5272)I, E(583)D, D(614)G, Q(57)H and S(194)L in the proteins ORF1, ORF1, S, S, ORF3a and N, respectively. So, the immediate source of infection of these two patients is either neighbouring or family patients.

- Each pair of genomes {MT 467252, MT 467247} and {MT 467258, MT 467256} from Ahmedabad have five identical missense mutations across various proteins.
- The pairs of genomes {MT 483558, MT 483554} and {MT 467262, MT 467261} from Modasa hold four identical (pairwise) mutations in ORF1, S, ORF3a and M proteins.
- Except MT509503(Junagadh), all SARS-CoV2 genomes from 128 Indian patients had mutations at Q(57)H and Y(71)Y of the protein ORF3a and M respectively, apart from other mutations.
- There are 13 genomes viz. MT451878, MT451883, MT451886, MT467240, MT467239, MT012098, MT451880, MT467262, MT467261, MT050493, MT451889, MT451874 and MT435082 where the missense mutations are restricted to the structural (except E) and non-structural proteins.

2. Conclusions

Several missense mutations over these 128 SARS-CoV2 genomes from Indian patients from diverse geo-locations show the wide genetic

variations in a few of the SARS-CoV2 genes. Within a very small time frame, the virus evolved rapidly in most of the genes. Quite a few patients had identical mutations in SARS-CoV2 genes, indicating infection received from neighbouring or family patients. It will be interesting to study how many of these variations in the virus were carried by the patients from outside India or evolved within India. Whether the missense mutations over these 128 genomes lead to different functions of the proteins, is certainly the next question which is to be investigated by further studies. The hypotheses proposed in this article would be much stronger if the results are consistent while the number of SARS-CoV2 genomes from Indian patients increases significantly. Although the clinical significance of the observed mutations is not readily available, our findings lay the groundwork to understand the impact of SARS-CoV2 mutations on disease severity, host immune response, vaccine development and serological response.

Author contributions

SH, PPC, SSJ conceived the problem. SH determined the mutations. SH, PPC, BR and SSJ analysed the data and result. SH wrote the initial draft which was checked and edited by all other authors to generate the final version.

Table 3
Missense and silent mutations in the entire genome of SARS-CoV2 from Indian patients.

Virus Genome ID	Location	Missense and silent mutations	Genomic regions	Missense mutation
MT509494	Vadodara	S(443)S, F(924)F, D(1273)D, P(4715)L, G(5862)G, L(6082)F, D(614)G	ORF1 (6), S (1)	3
MT496997	Gandhinagar	F(924)F, G(5530)C, L(6205)L, V(6385)L, V(6536)V, D(614)G, Q(57)H, Y(71)Y, D(225)D	ORF1 (5), S (1), ORF3a (2), M (1), M (1)	3
MT467240	Ahmedabad	P(4715)L, L(4721)I, E(156)D, D(614)G	ORF1 (2), S (2)	4
MT477885	India	T(2016)K, L(3606)F, A(4489)V, Y(789)Y, P(13)L	ORF1 (3), S (1), N (1)	4
MT435080	Ahmedabad	F(924)F, A(4577)V, I(4593)L, P(4715)L, D(614)G	ORF1 (4), S (1)	4
MT467239	Ahmedabad	L(3338)F, P(4715)L, L(6205)L, D(614)G, Q(57)H, Y(71)Y	ORF1 (3), S (1), ORF3a (1), M (1)	4
MT358637	Rajkot	F(924)F, K(2067)K, P(4715)L, Q(271)R, D(614)G, R(41)R, T(393)I	ORF1 (3), S (2), N (2)	4
MT415323	India	F(924)F, P(4715)L, D(614)G, R(203)K, G(204)R	ORF1 (2), S (1), N (2)	4
MT012098	Kerala	I(671)T, P(2144)S, A(4798)V, A(5703)A, R(408)I	ORF1 (4), S (1)	4
MT451880	Surat	T(2016)K, L(3606)F, A(3645)A, A(4489)V, F(5251)F, Y(789)Y, V(1264)V, P(13)L	ORF1 (5), S (2), N (1)	4
MT467259	Prantij	F(924)F, P(4715)L, L(6205)L, D(614)G, Q(57)H, Y(71)Y, P(13)L	ORF1 (3), S (1), ORF3a (1), M (1), N (1)	4
MT467241	Ahmedabad	F(924)F, S(1534)I, P(4715)L, L(4721)I, F(6251)F, D(614)G	ORF1 (5), S (1)	4
MT467237	Ahmedabad	F(924)F, L(3338)F, P(4715)L, L(6205)L, D(614)G, Q(57)H, Y(71)Y	ORF1 (4), S (1), ORF3a (1), M (1)	4
MT457402	Hyderabad	F(924)F, P(4715)L, L(6205)L, M to AYG, D(614)G, Q(57)H	ORF1 (4), S (1), ORF3a (1)	4
MT451885	Ahmedabad	F(924)F, N(3405)H/I, P(4715)L, L(6205)L, D(614)G, Q(57)H, Y(71)Y	ORF1 (5), S (1), ORF3a (1), M (1)	4
MT467262	Modasa	D(4117)D, P(4715)L, L(6205)L, R(78)M, D(614)G, Q(57)H, Y(71)Y	ORF1 (3), S (2), ORF3a (1), M (1)	4
MT467261	Modasa	D(4117)D, P(4715)L, L(6205)L, R(78)M, D(614)G, Q(57)H, Y(71)Y	ORF1 (3), S (2), ORF3a (1), M (1)	4
MT467251	Ahmedabad	F(924)F, Q(1084)Q, P(4715)L, L(6205)L, D(614)G, T(827)I, Q(57)H, Y(71)Y, D(225)D	ORF1 (4), S (2), ORF3a (1), M (1), N (1)	4
MT467248	Ahmedabad	C(857)C, F(924)F, P(4715)L, L(6205)L, D(294)D, D(614)G, Q(57)H, Y(71)Y, S(194)L	ORF1 (4), S (2), ORF3a (1), M (1), N (1)	4
MT467245	Ahmedabad	C(857)C, F(924)F, P(4715)L, L(6205)L, D(294)D, D(614)G, Q(57)H, Y(71)Y, S(194)L	ORF1 (4), S (2), ORF3a (1), M (1), N (1)	4
MT467255	Ahmedabad	F(924)F, P(4715)L, L(5580)L, K(5957)R, L(6205)L, D(614)G, Q(57)H, Y(71)Y, G(70)G, Q(39)Q, D(225)D	ORF1 (5), S (1), ORF3a (1), M (1), ORF7a (1), N (2)	4
MT451887	Ahmedabad	V(682)F, F(924)F, P(4715)L, D(5437)D, T(5775)T, D(614)G, G(236)C	ORF1(5), S (1), N (1)	4
MT483558	Modasa	F(924)F, D(4117)D, P(4715)L, L(6205)L, R(78)M, D(614)G, Q(57)H, Y(71)Y	ORF1 (4), S (2), ORF3a (1), M (1)	4
MT483554	Modasa	F(924)F, D(4117)D, P(4715)L, L(6205)L, R(78)M, D(614)G, Q(57)H, Y(71)Y	ORF1 (4), S (2), ORF3a (1), M (1)	4
MT483557	Modasa	F(924)F, V(1345)V, N(3405)H/I, P(4715)L, L(6205)L, D(614)G, Q(57)H, Y(71)Y	ORF1 (6), S (1), ORF3a (1), M (1)	4
MT496989	Ahmedabad	P(309)L, F(924)F, P(4715)L, F(2)L, D(614)G	ORF1 (3), S (2)	4
MT496975	Ahmedabad	N(3405)H/I, P(4715)L, D(614)G, Q(57)H, Y(71)Y	ORF1 (2), S (1), ORF3a (1), M (1)	4
MT481896	Ahmedabad	F(924)F, P(4715)L, Y(5541)Y, M(177)I, D(294)D, D(614)G, Q(57)H, Y(71)Y	ORF1 (3), S (3), ORF3a (1), M (1)	4
MT496988	Ahmedabad	F(924)F, A(3179)A, F(3614)F, P(4715)L, L(6205)L, D(614)G, V(1104)L, Q(57)H, Y(71)Y	ORF1 (5), S (2), ORF3a (1), M (1)	4
MT481899	Modasa	F(924)F, D(4117)D, P(4715)L, L(6205)L, R(78)M, D(614)G, Q(57)H, Y(71)Y	ORF1 (4), S (1), ORF3a (1), M (1)	4
MT481897	Modasa	F(924)F, D(4117)D, D(4275)D, P(4715)L, L(6205)L, R(78)M, D(614)G, Q(57)H, Y(71)Y	ORF1 (5), S (2), ORF3a (1), M (1)	4
MT509501	Jamnagar	F(924)F, N(1123)N, I(2385)I, N(4235)N, P(4715)L, N(5020)N, L(5)F, S(162)I, D(614)G	ORF1 (6), S (3)	4
MT509508	Jamnagar	C(857)C, F(924)F, L(1591)L, P(4715)L, L(6205)L, D(294)D, D(614)G, Q(57)H, Y(71)Y, S(194)L	ORF1 (5), S (2), ORF3a (1), M (1), N (1)	4
MT496979	Ahmedabad	F(924)F, P(4715)L, G(5530)C, L(6205)L, D(614)G, Q(57)H, Y(71)Y	ORF1 (4), S (1), ORF3a (1), M (1)	4
MT509495	Kodinar	F(924)F, P(3395)S, P(4715)L, L(6205)L, D(614)G, Q(57)H, Y(71)Y	ORF1 (4), S (1), ORF3a (1), M (1)	4
MT509506	Rajkot	S(2839)S, D(3681)N, T(302)T, L(41)F, L(84)S, S(202)N	ORF1 (2), S (1), ORF3a (1), ORF8 (1), N (1)	4
MT050493	Kerala	I(476)V, P(2079)L, S(2839)S, T(5538)I, A(930)V, L(84)S	ORF1 (4), S (1), ORF8 (1)	5
MT451889	Ahmedabad	D(1939)G, T(2016)K, S(2242)P, A(4489)V, T(22)T, Y(789)Y, P(13)L	ORF (4), S (2), N (1)	5
MT467252	Ahmedabad	F(924)F, P(1158)S, S(1534)I, L(2161)L, P(4715)L, L(4721)I, L(110)L, D(614)G	ORF1 (6), S (2)	5
MT467247	Ahmedabad	F(924)F, P(1158)S, S(1534)I, L(4149)L, P(4715)L, L(4721)I, L(110)L, D(614)G	ORF1 (6), S (2)	5
MT451874	Surat	G(519)S, S(2015)R, T(2016)K, L(2146)L, L(3606)F, A(4489)V, L(6420)L, Y(789)Y	ORF1 (7), S (1)	5
MT415322	India	T(2016)K, L(4606)F, A(4489)V, Y(789)Y, P(13)L	ORF1 (3), S (1), N (1)	5
MT435085	Gandhinagar	C(857)C, F(924)F, P(4715)L, V(5272)I, L(6205)L, D(294)D, D(614)G, Q(57)H, Y(71)Y, S(194)L	ORF1 (5), S (2), ORF3a (1), M (1), N (1)	5

Table 4
Missense and silent mutations in the entire genome of SARS-CoV2 from Indian patients.

Virus Genome ID	Location	Missense and silent mutations	Genomic regions	Missense mutation
MT467258	ahmedabad	C(857)C, F(924)F, P(4715)L, L(6205)L, D(294)D, T(572)I, D(614)G, Q(57)H, Y(71)Y, S(194)L	ORF1 (4), S (3), ORF3a (1), M (1), N (1)	5
MT467256	ahmedabad	C(857)C, F(924)F, P(4715)L, L(6205)L, D(294)D, T(572)I, D(614)G, Q(57)H, Y(71)Y, S(194)L	ORF1 (4), S (3), ORF3a (1), M (1), N (1)	5
MT435086	Mansa	F(924)F, K(1230)K, S(1534)I, P(4715)L, L(6205)L, D(294)D, T(572)I, D(614)G	ORF1 (5), S (1)	5
MT483560	Modasa	F(924)F, L(3606)F, D(4117)D, P(4715)L, L(6205)L, R(78)M, D(614)G, Q(57)H, Y(71)Y	ORF1 (5), S (2), ORF3a (1), M (1)	5
MT483556	Modasa	F(924)F, L(3606)F, D(4117)D, P(4715)L, L(6205)L, R(78)M, D(614)G, Q(57)H, Y(71)Y	ORF1 (5), S (2), ORF3a (1), M (1)	5
MT509504	Rajkot	F(924)F, S(1534)I, P(4715)L, L(4721)I, N(7083)D, D(614)G	ORF1 (5), S (1)	5
MT496976	Ahmedabad	F(924)F, I(2806)I, V(4181)I, P(4715)L, S(13)I, D(614)G, R(192)L	ORF1 (4), S (2), N (1)	5
MT509509	Ahmedabad	F(924)F, P(4715)L, L(6205)L, E(583)D, D(614)G, H(1083)Q, Q(57)H, Y(71)Y	ORF1 (3), S (3), ORF3a (1), M (1)	5
MT496972	Ahmedabad	F(924)F, P(4715)L, A(5770)A, L(6205)L, P(7034)I, D(614)G, Q(57)H, V(77)F, Y(71)Y	ORF1 (6), S (1), ORF3a (2), M (1)	5
MT509503	Junaagadh	F(924)F, N(1123)N, K(2029)E, P(4715)L, N(5020)N, D(614)G, I(35)T, L(53)F	ORF1 (5), S (1), ORF3a (2)	5
MT496992	Ahmedabad	C(857)T, F(924)F, P(4715)L, L(6205)L, D(294)D, D(614)G, Q(57)H, Y(71)Y, H(73)H, S(194)L	ORF1 (4), S (2), ORF3a (1), M (1), ORF7a (1), N (1)	5
MT509499	Jannagar	C(857)C, F(924)F, L(1599)I, L(3606)F, P(4715)L, L(6205)L, D(294)D, D(614)G, Q(57)H, Y(71)Y, S(194)L	ORF1 (6), S (2), ORF3a (1), M (1), N (1)	5
MT496984	Ahmedabad	F(924)F, P(4715)L, L(6205)L, D(614)G, Q(57)H, Y(71)Y, H(125)Y, P(302)S	ORF1 (3), S (1), ORF3a (1), M (2), N (1)	5
MT509512	Dahod	V(1393)V, S(2015)R, T(2016)K, L(3606)F, T(4164)T, A(4489)V, L(6420)L, Y(789)Y, P(13)I	ORF1 (7), S (1), N (1)	5
MT509500	Dahod	V(1393)V, S(2015)R, T(2016)K, L(3606)F, T(4164)T, A(4489)V, L(6420)L, Y(789)Y, P(13)I	ORF1 (7), S (1), N (1)	5
MT509511	Rajkot	V(169)A, S(2839)S, D(3681)N, L(41)F, I(84)S, S(202)N	ORF1 (3), ORF3a (1), ORF8 (1), N (1)	5
MT457403	Hyderabad	T(2016)K, L(3606)F, A(4489)V, Y(789)Y, P(13)I	ORF1 (3), S (1), N (1)	6
MT435081	Ahmedabad	T(265)T, F(924)F, P(4715)L, T(5036)M, D(614)G, Q(57)H, E(110)STOP, S(32)I	ORF1 (4), S (1), ORF3a (1), ORF8 (1), N (1)	6
MT467263	Dhansura	C(857)C, F(924)F, P(2046)L, P(4715)L, L(6205)L, L(54)F, D(294)D, D(614)G, Q(57)H, Y(71)Y, S(194)L	ORF1 (5), S (3), ORF3a (1), M (1), N (1)	6
MT467254	Ahmedabad	V(751)Y, C(857)C, F(924)F, K(4081)R, P(4715)L, L(6205)L, D(294)D, D(614)G, Q(57)H, Y(71)Y, A(156)S, S(194)L	ORF1 (6), S (2), ORF3a (1), M (1), N (2)	6
MT467253	Ahmedabad	C(857)C, F(924)F, Y(4424)Y, P(4715)L, L(6205)L, D(294)D, T(572)I, D(614)G, Q(57)H, Y(71)Y, I(121)I, S(194)L	ORF1 (5), S (3), ORF3a (1), M (1), ORF8 (1), N (1)	6
MT467243	Ahmedabad	F(924)F, P(4715)L, D(5130)D, V(5272)I, L(6205)L, D(294)D, E(583)D, D(614)G, I(980)I, Q(57)H, Y(71)Y, S(194)L	ORF1 (5), S (4), ORF3a (1), M (1), N (1)	6
MT435082	Ahmedabad	P(4715)L, P(5828)I, D(614)G, Q(57)H, E(110)STOP, S(33)I	ORF (2), S (1), ORF3a (1), ORF8 (1), N (1)	6
MT451877	Surat	S(2839)I, F(3132)S, V(4746)I, T(302)T, G(38)Y, L(84)S, S(202)N	ORF1 (3), S (1), ORF7a (1), ORF8 (1), N (1)	6
MT496995	Gandhinagar	C(857)T, F(924)F, P(4715)L, V(5272)I, L(6205)L, D(294)D, D(614)G, Q(57)H, Y(71)Y, S(194)L	ORF1 (5), S (2), ORF3a (1), M (1), N (1)	6
MT496994	Gandhinagar	C(857)T, F(924)F, P(4715)L, V(5272)I, L(6205)L, D(294)D, D(614)G, Q(57)H, Y(71)Y, S(194)L	ORF1 (5), S (2), ORF3a (1), M (1), N (1)	6
MT496982	Ahmedabad	C(857)T, F(924)F, P(4715)L, L(6205)L, D(294)D, T(572)I, D(614)G, Q(57)H, Y(71)Y, S(194)L	ORF1 (4), S (3), ORF3a (1), M (1), N (1)	6
MT481906	Gandhinagar	C(857)T, F(924)F, S(1733)G, P(4715)L, L(6205)L, D(294)D, D(614)G, Q(57)H, Y(71)Y, H(73)H, S(194)L	ORF1 (5), S (2), ORF3a (1), M (1), N (1)	6
MT481898	Himmatnagar	F(924)F, P(4715)L, V(5272)I, L(6205)L, D(294)D, E(583)D, D(614)G, Q(57)H, Y(71)Y, S(194)L	ORF1 (4), S (3), ORF3a (1), M (1), N (1)	6
MT496993	Gandhinagar	C(857)T, F(924)F, P(4715)L, L(6205)L, D(294)D, D(614)G, A(706)S, Q(57)H, Y(71)Y, S(194)L	ORF1 (4), S (3), ORF3a (1), M (1), N (1)	6
MT496985	Ahmedabad	F(924)F, P(4715)L, V(5272)I, L(6205)L, N(6629)N, D(294)D, E(583)D, D(614)G, Q(57)H, Y(71)Y, S(194)L	ORF1 (5), S (3), ORF3a (1), M (1), N (1)	6
MT496980	Ahmedabad	C(857)C, F(924)F, P(4715)L, L(6205)L, L(54)F, D(294)D, D(614)G, Q(57)H, Y(71)Y, E(64)STOP, S(194)L	ORF1 (4), S (3), ORF3a (1), M (1), ORF8 (1), N (1)	6
MT481905	Gandhinagar	F(924)F, P(4715)L, G(5530)C, L(6205)L, V(6385)I, V(6536)I, D(614)G, Q(57)H, L(86)W, Y(71)Y, D(225)D	ORF1 (6), S (1), ORF3a (2), M (1), N (1)	6
MT481901	Dahegam	C(857)C, F(924)F, P(4715)L, V(4764)A, V(5272)I, L(6205)L, D(294)D, D(614)G, Q(57)H, Y(71)Y, S(194)L	ORF1 (6), S (2), ORF3a (1), M (1), N (1)	6

Table 5
Missense and silent mutations in the entire genome of SARS-CoV2 from Indian patients.

Virus Genome ID	Location	Missense and silent mutations	Genomic regions	Missense mutation
MT1509502	Jamnagar	C(857)C, F(924)F, P(4715)J, L(6205)J, L(54)F, D(294)D, D(614)G, Q(57)H, Y(71)Y, S(194)J	ORF1 (5), S (3), ORF3a (1), M (1), N (1)	6
MT496987	Ahmedabad	C(857)C, F(924)F, P(4715)J, S(6059)S, L(6205)J, L(54)F, D(294)D, E(471)I, D(614)G, Q(57)H, Y(71)Y, S(194)J	ORF1 (5), S (4), ORF3a (1), M (1), N (1)	6
MT481895	Ahmedabad	C(857)C, F(924)F, P(4715)J, Y(5541)Y, L(6205)J, M(177)I, D(294)D, D(614)G, Q(57)H, W(131)C, Y(71)Y, S(194)J	ORF1 (5), S (3), ORF3a (2), M (1), N (1)	6
MT509498	Jamnagar	C(857)C, F(924)F, L(1599)I, P(4715)J, L(6205)J, L(6909)F, D(294)D, D(614)G, Q(57)H, Y(71)Y, S(194)J, D(348)Y	ORF1 (6), S (2), ORF3a (1), M (1), N (2)	6
MT509496	Botad	S(2015)R, T(2016)K, L(2146)F, P(6805)S, Y(789)Y, S(31)I, P(13)I	ORF1 (4), S (1), ORF7b (1), N (1)	6
MT451882	Ahmedabad	C(857)C, F(924)F, E(4670)D, P(4715)J, L(6205)J, D(294)D, D(614)G, Q(243)F, Q(57)H, D(155)Y, Y(71)Y, S(194)J	ORF1 (5), S (3), ORF3a (2), M (1), N (1)	7
MT451888	Ahmedabad	N(418)N, C(857)C, F(924)F, L(1852)I, T(1854)A, K(1973)R, P(4715)J, L(6205)J, L(64)F, D(294)D, D(614)G, Q(57)H, Y(71)Y, S(194)J	ORF1 (8), S (3), ORF3a (1), M (1), N (1)	7
MT496986	Ahmedabad	C(857)T, F(924)F, P(2046)J, P(4715)J, L(6205)J, D(294)D, D(614)G, Q(57)H, Y(71)Y, G(120)R, S(194)J	ORF1 (5), S (2), ORF3a (1), M (1), N (2)	7
MT496983	Ahmedabad	F(924)F, E(3962)K, P(4715)J, V(5272)I, L(6205)J, N(6629)N, D(294)D, E(583)D, D(614)G, Q(57)H, Y(71)Y, S(194)J	ORF1 (6), S (3), ORF3a (1), M (1), N (1)	7
MT496974	Ahmedabad	F(924)F, P(4715)J, V(5272)I, L(6205)J, D(294)D, E(583)D, D(614)G, Q(57)H, A(143)S, Y(71)Y, S(194)J	ORF1 (4), S (3), ORF3a (2), M (1), N (1)	7
MT509505	Ahmedabad	F(924)F, D(4117)D, P(4715)J, V(5272)I, L(6205)J, R(78)M, D(294)D, D(614)G, H(1083)Q, Q(57)H, Y(71)Y, S(194)J	ORF1 (5), S (4), ORF3a (1), M (1), N (1)	7
MT451881	Ahmedabad	, C(857)C, F(924)F, E(4670)D, P(4715)J, L(6205)J, D(294)D, D(614)G, A(706)S, C(1243)F, Q(57)H, D(155)Y, Y(71)Y, S(194)J	ORF1 (5), S (4), ORF3a (2), M (1), N (1)	8
MT451876	Surat	F(924)F, L(3606)F, D(4776)Y, P(4715)J, M(5974)I, L(6205)J, P(7034)S, D(614)G, K(118)R, Q(57)H, Y(71)Y	ORF1 (7), S (2), ORF3a (1), M (1)	8
MT483702	Modasa	F(924)F, Q(3390)R, T(3453)A, A(4273)N, P(4715)J, L(6205)J, R(78)M, D(614)G, Q(57)H, Y(71)Y, L(116)F	ORF1 (6), S (2), ORF3a (1), M (1), ORF7a (1), N (9)	8
MT496991	Gandhinagar	C(857)C, F(924)F, P(4715)J, M(5060)I, L(6205)J, M(6723)I, D(294)D, D(614)G, Q(57)H, Y(71)Y, P(45)I, V(62)J, S(194)J	ORF1 (6), S (2), ORF3a (1), M (1), ORF7a (1), ORF8 (1), N (1)	8
MT509497	Una	N(120)N, G(519)S, S(2015)R, T(2016)K, P(2739)I, L(3606)F, A(4489)Y, L(6420)I, Q(677)H, Y(789)Y, P(13)I, A(152)S	ORF1 (8), S (2), N (2)	9
MT509507	Una	L(16)I, L(204)F, F(924)F, A(1812)D, L(3606)F, K(4451)N, P(4715)J, P(5624)I, K(6274)N, D(614)G, R(203)K, G(204)R	ORF1 (9), S (1), N (2)	10
MT451890	Ahmedabad	F(924)F, D(1939)G, T(2016)K, S(2224)P, D(4532)G, A(4489)N, P(4715)J, V(5272)I, L(6205)J, T(22)T, D(294)D, E(583)D, Y(789)Y, Q(57)H, S(171)I, P(13)I	ORF1 (10), S (4), ORF3a (2), N (1)	11
MT509510	Una	L(16)I, L(204)F, F(924)F, A(1812)D, L(3606)F, K(4451)N, P(4715)J, P(5624)I, K(6274)N, D(614)G, G(8)E, R(203)K, G(204)R	ORF1 (9), S (1), ORF8 (1), N (2)	11

Declaration of Competing Interest

The authors do not have any conflicts of interest to declare.

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