Supplementary Table 3. Continued

Gene	Reference position	Chromosome	Coding sequence	Coverage	Allele change	Amino acid change	Functional predictions by SIFT	Patient no.
PTCH1[a]	1571085902	9	17	111	T < C	NS	N	1
GRIN3A	1577199512	9	9	20	A < T	NS	N	3
MUSK	1586295091	9	1	57	G < A	NS	N	3
FKBP15	1588814600	9	13	33	A < C	NS	N	4
COL27A1	1589933932	9	59	118	A < G	NS	N	4
ORM2	1589957833	9	4	37	G < C	NS	D	4
GSN	1596958694	9	17	159	T < C	S	N	4
MAPKAP1	1601110716	9	8	14	A < T	S	N	3
CDK9	1603414267	9	4	23	A < G	NS	D	3
C9orf78	1605455403	9	8	32	A < G	S	N	4
C9orf98	1608412608	9	9	23	T < A	NS	N	1
C9orf98	1608412610	9	9	24	G < A	S	N	1
GFI1B	1608580179	9	6	19	T < A	NS	D	1
GFI1B	1608580182	9	6	19	G < T	NS	NO	1
ABO	1608845331	9	7	39	C < T	NS	NR	4
ABO	1608845366	9	7	43	A < T	NS	NR	4
SARDH	1609287306	9	10	36	G < A	S	N	4
OLFM1	1610646021	9	2	93	T < C	S	N	4
PAEP	1611120049	9	4	108	C < A	NS	N	4
CACNA1B	1613566398	9	28	22	G < A	S	N	3
CACNA1B	1613566402	9	28	24	A < C	NS	N	3
PFKP	1617341440	10	9	103	C < T	S	N	4
AKR1CL2	1619063490	10	2	31	A < T	NS	D	3
ITIH2	1621971113	10	16	62	C < G	NS	N	4
BEND7	1627671894	10	7	32	T < A	S	N	4
ARMETL1	1629060660	10	2	54	T < A	NS	D	3
CUBN	1631072959	10	62	38	T < A	S	N	3
CUBN	1631276445	10	26	49	T < A	NS	N	3
MRC1L1	1632130724	10	24	11	G < T	NS	D	4
PIP4K2A	1637047251	10	6	18	T < A	NS	D	3
ARHGAP21	1639064800	10	25	109	C < T	NS	N	1
TMEM72	1656420929	10	5	46	C < T	S	N	4
ANUBL1	1657125773	10	5	19	C < T	S	N	4
ANXA8L2	1658602609	10	12	48	T < C	S	N	4
AGAP9	1658906406	10	1	38	G < T	NS	D	4
AGAP9	1658906463	10	1	30	T < G	NS	N	4
MSMB[a]	1662146277	10	2	105	A < G	NS	D	1
PCDH15	1666172531	10	34	14	G < T	NS	N	2
PCDH15[a]	1666177751	10	32	70	A < G	S	N	1
TMEM26	1673760923	10	6	22	C < T	NS	N	3
HKDC1	1681600842	10	12	23	C < T	S	N	4
ADAMTS14	1683108476	10	21	79	A < G	NS	N	4
USP54	1685873867	10	15	93	G < A	NS	N	1
DLG5	1690161340	10	23	67	G < T	NS	N	4
FAM22B	1692061925	10	7	25	A < C	S	N	4
BMPR1A	1699271849	10	9	83	C < T	S	N	4
FAM25A	1699372551	10	2	93	A < G	S	N	4
MYOF	1705731605	10	20	24	G < C	NS	D	3
MYOF	1705731606	10	20	24	C < T	S	N	3
TLL2	1708736294	10	15	21	T < G	NS	N	3
TLL2	1708736297	10	15	22	A < T	NS	D	3
MMS19[a]	1709816131	10	18	118	G < A	S	N	1
MMS19[a]	1709816132	10	18	116	C < A	S	N	1
BTRC	1713888546	10	13	19	C < G	NS	D	2
POLL	1713935693	10	3	174	G < T	NS	N	4
PNLIPRP1	1728959073	10	12	57	T < C	NS	D	4
DMBT1	1734932783	10	13	13	G < T	NS	NO	1
DMBT1	1734934333	10	14	38	A < T	S	N	3
DMBT1	1734942466	10	20	106	T < C	S	N	4
CTBP2	1737305458	10	1	13	G < A	S	N	3

Supplementary Table 3. Continued

Gene	Reference position	Chromosome	Coding sequence	Coverage	Allele change	Amino acid change	Functional predictions by SIFT	Patient no.
MMP21	1738045784	10	7	33	G < A	NS	D	3
JAKMIP3	1744395894	10	10	74	A < G	NS	N	4
C10orf93	1745195014	10	4	39	G < A	S	N	2
KNDC1	1745437947	10	5	104	C < T	S	N	4
SYCE1	1745809057	10	13	80	T < C	NS	N	4
FRG2B	1745879355	10	4	105	C < T	S	N	4
SCGB1C1	1746098936	11	2	28	A < G	S	N	4
B4GALNT4	1746279024	11	8	44	G < A	S	N	4
CHID1	1746775660	11	11	37	G < A	NS	N	4
MUC2	1746998500	11	30	33	C < G	S	N	4
MUC2	1746998519	11	30	39	C < A	S	N	4
MUC5AC	1747163509	11	40	33	A < G	S	N	4
MUC5AC	1747176291	11	50	197	G < T	NS	N	4
MUC5AC	1747183167	11	59	41	G < A	NS	N	4
KRTAP5-3	1747534374	11	1	73	C < T	NS	N	3
TNNT3	1747860451	11	10	88	C < A	NS	D	2
ART1	1749586329	11	2	22	A < G	S	N	4
DCHS1	1752558224	11	6	111	C < T	NS	D	2
SOX6	1761982617	11	9	24	T < C	S	N	3
SAAL1	1764013726	11	9	29	T < C	NS	N	4
SAAL1	1764016154	11	7	38	T < A	NS	N	4
MRGPRX3	1764064511	11	1	277	G < A	S	NO	1
MRGPRX3	1764064669	11	1	70	T < C	NS	D	4
NAV2	1765806846	11	5	40	G < A	S	N	4
NAV2	1765972037	11	14	74	A < G	NS	D	3
FANCF	1768551685	11	1	24	C < T	NS	N	3
SLC5A12	1772648382	11	1	29	C < A	NS	NO	3
SLC5A12	1772648383	11	1	29	C < A	NS	N	3
MPPED2	1776462933	11	2	21	G < T	S	N	3
MPPED2	1776462935	11	2	20	C < G	NS	N	3
ZNF408	1792629936	11	4	54	T < A	NS	N	2
GLYAT	1800978539	11	3	36	G < C	NS	D	3
PGA3	1803475551	11	6	166	T < G	NS	D	4
AHNAK	1804789193	11	3	55	T < C	NS	N	4
SIPA1	1807916289	11	15	12	G < T	S	N	1
CATSPER1	1808286286	11	7	52	C < T	NS	N	4
RBM4B	1808942484	11	1	34	A < G	NS	D	3
TPCN2	1811349628	11	19	316	T < C	NS	N	4
FADD	1812550653	11	2	45	G < T	NS	N	2
C11orf30	1818755429	11	19	54	T < C	S	N	4
GDPD4	1819477756	11	8	38	C < T	NS	D	3
ALG8	1820310415	11	13	26	G < A	S	N	3
GAB2	1820434380	11	5	79	A < G	S	N	4
FAT3	1835072125	11	17	53	G < T	NS	N	4
PANX1	1836411162	11	4	21	C < A	NS	N	3
PIWIL4	1836824979	11	9	76	G < C	NS	N	4
CWC15	1837197727	11	5	30	A < G	NS	NR	2
TMEM133	1843211533	11	1	84	A < C	NS	N	4
TRPC6[a]	1843723722	11	2	65	C < T	S	N	1
TMEM123	1844621025	11	3	11	G < A	NS	D	2
ZC3H12C	1852355676	11	2	23	G < T	NS	N	3
LAYN	1853779209	11	7	40	G < A	NS	N	2
ZW10	1855955650	11	15	49	A < C	NS	N	3
CEP164	1859631014	11	31	58	G < T	S	N	4
DSCAML1	1859657009	11	25	62	G < A	S	N	4
DSCAML1	1859751449	11	4	51	G < T	NS	N	4
IL10RA	1860212261	11	4	49	A < G	S	N	4
TMPRSS4	1860336319	11	12	79	C < T	NS	D	4
BCL9L	1861117811	11	8	14	G < T	NS	D	1
CCDC84	1861234319	11	10	45	C < G	S	N	2

Supplementary Table 3. Continued

Gene	Reference position	Chromosome	Coding sequence	Coverage	Allele change	Amino acid change	Functional predictions by SIFT	Patient no.
ZNF202	1865948687	11	2	14	C < A	NS	NO	3
HSN2	1878252896	12	1	49	T < C	S	N	1
VWF	1883406765	12	25	19	T < C	NS	D	2
ACSM4	1884701983	12	11	32	G < T	NS	D	3
PRB2	1888770834	12	3	58	T < C	S	N	4
PRB2	1888770905	12	3	100	G < T	NS	N	2
PRB2	1888771519	12	3	100	C < T	NS	N	4
PIK3C2G	1895940574	12	25	19	C < T	NS	D	3
SLCO1C1	1898110764	12	9	41	A < G	S	N	4
ARID2	1920469949	12	15	35	T < C	S	N	3
AMIGO2	1921696779	12	1	29	C < A	NS	N	3
KRT86	1926923866	12	5	158	G < A	NS	N	4
KRT86	1926923877	12	5	167	C < G	S	N	4
KRT2	1927263989	12	9	24	C < A	NS	D	3
KRT2	1927263991	12	9	24	C < A	NS	D	3
NCKAP1L	1929139765	12	18	111	C < T	S	N	4
RDH16	1931575957	12	1	144	G < T	NS	D	2
LRP1	1931814492	12	54	29	C < T	S	N	4
LRIG3	1933499258	12	13	28	T < A	NS	D	3
TMEM5	1938398588	12	1	72	G < A	S	N	4
RASSF9	1960454767	12	1	16	T < A	NS	NO	3
C12orf12	1965572650	12	1	74	C < A	NS	N	3
NUP37	1976695411	12	7	27	A < C	NS	D	3
USP30	1983694022	12	8	37	C < T	S	N	4
C12orf51	1986840857	12	36	47	T < C	S	N	2
DDX54	1987789501	12	7	85	G < A	S	N	4
PLBD2	1987987438	12	5	27	C < T	NS	NO	3
SDSL	1988046794	12	4	40	G < T	NS	N	3
MED13L	1990588227	12	24	18	C < A	NS	D	3
CIT	1994346828	12	24	71	T < C	S	N	4
ORAI1	1996254022	12	2	53	C < T	S	N	4
B3GNT4	1996814014	12	1	20	C < G	NS	N	4
CLIP1	1996970528	12	4	25	G < A	S	N	2
SBNO1	1997954707	12	3	23	T < C	NS	N	3
SETD8	1998000144	12	3	24	C < T	S	N	2
GPR133	2005609817	12	9	29	A < G	S	N	3
POLE	2007276853	12	12	66	T < C	NS	D	3
PGAM5	2007320186	12	6	59	C < T	NS	N	4
TPTE2	2008847341	13	18	64	A < G	S	N	4
TPTE2	2008847342	13	18	61	T < A	NS	N	4
PARP4	2013890787	13	15	79	G < A	S	N	1
SLC7A1	2018953795	13	2	58	G < C	S	N	4
NBEA	2024476994	13	7	190	T < C	S	N	4
DCLK1	2025231759	13	11	53	G < T	S	N	4
KBTBD6	2030552300	13	1	29	C < T	NS	N	4
MED4	2037507221	13	3	16	T < A	NS	D	3
RB1	2037880563	13	20	49	G < A	S	D	1
RCBTB1	2038988090	13	1	88	G < A	S	N	4
PCDH9	2056646696	13	1	23	T < A	NS	NO	3
PCDH9	2056646999	13	1	39	C < A	NS	N	3
KLF12	2063234134	13	4	43	C < G	NS	N	3
COL4A1	2099524302	13	37	135	T < A	S	N	4
C13orf16	2100677265	13	2	112	C < T	S	N	4
ATP11A	2102082860	13	29	44	T < C	S	N	4
RASA3	2103108926	13	21	105	C < T	S	N	4
POTEG	2104010042	14	1	119	C < T	NS	N	4
P704P	2104476800	14	1	60	C < T	S	N	4
NDRG2	2105942492	14	15	51	G < C	NS	D	4
HAUS4	2107873469	14	7	11	G < T	S	N	2
HOMEZ	2108202700	14	2	14	A < T	NS	N	3

Supplementary Table 3. Continued

Gene	Reference position	Chromosome	Coding sequence	Coverage	Allele change	Amino acid change	Functional predictions by SIFT	Patient no.
DHRS4	2108891643	14	4	116	C < T	NS	NO	4
DHRS4L2	2108914889	14	1	132	G < T	NS	D	3
DHRS4L2	2108916099	14	2	35	G < A	S	N	4
GZMH	2109533483	14	3	196	G < C	NS	N	4
GZMH	*2109533541*	*14*	*3*	*38*	*C < A*	*NS*	*D*	3
C14orf182	2134929075	14	1	27	A < T	NS	D	3
MAP4K5	2135379887	14	13	28	G < A	NS	D	3
PPM1A	2145206418	14	2	80	G < T	NS	N	3
SYNE2	2148878083	14	7	85	A < G	NS	D	1
PLEKHG3	2149666422	14	14	36	C < A	NS	D	2
PLEKHG3	2149666423	14	14	38	C < T	NS	D	2
GPHN	2151839368	14	6	21	G < A	S	N	3
SIPA1L1	2156512152	14	1	22	A < T	S	N	3
DIO2	2165125971	14	3	63	C < T	S	N	3
FLRT2	2170544935	14	1	20	G < T	NS	N	3
DDX24	2178978135	14	6	101	A < C	NS	D	2
BEGAIN	2185466810	14	4	97	T < C	S	N	4
C14orf73	2188025488	14	2	16	T < G	S	N	2
TMEM179	2189527477	14	1	28	C < G	NS	N	2
ADSSL1	2189666079	14	10	107	G < A	NS	D	2
AHNAK2	2189862548	14	7	57	G < A	S	N	4
AHNAK2	2189862844	14	7	26	A < C	NS	N	4
LOC727832	2192485885	15	8	14	A < G	NS	N	1
C15orf2	2196518354	15	1	17	C < G	S	N	3
GOLGA8G	2200364560	15	8	34	T < A	NS	D	3
GOLGA8G	2200368232	15	3	23	T < G	NS	D	4
CHRNA7	2203996850	15	7	134	G < A	S	N	4
RYR3	2205498123	15	33	72	T < G	S	N	4
RYR3	2205507714	15	37	44	T < G	NS	D	1
SRP14	2211874811	15	5	170	G < A	S	N	4
STARD9	2214531200	15	23	19	A < T	NS	N	3
DMXL2	2223337705	15	18	32	A < G	NS	N	4
RNF111	2230919345	15	7	17	C < T	S	N	3
ANXA2	2232187466	15	12	29	G < A	NS	D	2
ITGA11	2240170436	15	14	59	G < A	S	N	4
GOLGA6B	2244497986	15	4	49	G < A	S	N	4
GOLGA6	2245910065	15	15	18	G < T	NS	N	1
CYP1A2	2246588818	15	1	41	A < G	NS	D	3
GOLGA6C	2247104814	15	11	23	A < T	NS	N	4
GOLGA6C	2247104889	15	11	35	G < A	NS	N	4
GOLGA6C	2247106801	15	13	22	G < A	NS	N	2
CSPG4	2247528218	15	3	39	G < A	NS	D	2
SGK269	2248972147	15	3	11	G < C	NS	N	3
KIAA1024	2251295855	15	1	14	C < A	NS	N	3
AP3B2	2254828471	15	20	55	A < G	S	N	1
LOC100288732	2260124462	15	5	24	G < C	NS	NR	3
LOC100288732	2260124464	15	5	27	T < A	NS	NR	3
KIF7	2261638402	15	3	16	T < G	NS	D	2
SEMA4B	2262210365	15	5	49	G < A	NS	N	4
FURIN	2262865860	15	3	115	T < G	NS	D	4
MEF2A	2271698884	15	9	28	A < C	NS	N	3
ADAMTS17	2271960760	15	22	65	T < C	NS	N	4
HBA2	2274131104	16	3	26	T < G	S	N	3
PDIA2	2274242118	16	2	51	G < C	S	N	4
JMJD8	2274641266	16	4	23	T < A	NS	N	3
PRSS22	2276813235	16	4	38	C < T	NS	N	4
CLDN9	2276971003	16	1	43	C < T	S	N	1
ALG1	2279037309	16	9	58	T < C	S	N	4
TMEM114	2282529635	16	1	33	A < T	NS	D	4
TEKT5	2284677496	16	5	142	T < C	NS	N	4

Supplementary Table 3. Continued

Gene	Reference position	Chromosome	Coding sequence	Coverage	Allele change	Amino acid change	Functional predictions by SIFT	Patient no.
NOMO2	2292457809	16	10	19	T < A	NS	N	4
TMC5	2293409286	16	16	94	C < T	NS	NO	1
ACSM5[a]	2294342868	16	5	162	C < G	NS	N	1
ACSM5	2294348591	16	7	60	C < G	NS	D	4
NPIPL3	2295321650	16	8	32	A < G	S	N	4
OTOA	2295663836	16	23	35	C < T	NS	D	4
VWA3A	2296051856	16	20	40	C < T	NS	N	4
PRKCB	2298073558	16	10	19	C < T	NS	NO	3
KIAA0556	2301696816	16	27	72	G < A	NS	N	4
TUFM[a]	2302763330	16	6	66	C < A	S	N	2
INO80E	2303915676	16	3	14	A < G	S	N	3
POL3S	2305006549	16	3	23	T < C	NS	N	4
ERAF	2305447472	16	2	18	G < T	S	N	4
LOC100287647	2307849444	16	2	151	G < A	S	NR	1
ABCC12	2310775449	16	28	22	T < G	NS	D	3
ABCC12	2310775450	16	28	22	C < A	NS	D	3
ABCC12	2310796723	16	19	112	G < A	S	N	1
BRD7	2313015114	16	12	42	A < C	NS	NO	4
SALL1	2313830540	16	2	19	A < C	NS	D	3
CETP	2319673630	16	14	59	G < A	NS	N	4
SETD6	2321208022	16	5	48	G < A	S	N	4
CDH5	2329078423	16	2	105	C < T	S	N	4
PDPR	2332847939	16	17	49	C < T	S	N	4
PKD1L2	2343889813	16	7	21	G < A	NS	NR	4
MPHOSPH6	2344839892	16	5	61	G < A	S	N	4
CRISPLD2	2347537002	16	2	20	A < G	NS	N	4
FAM38A	2351390771	16	35	14	C < T	NS	N	4
FAM38A	2351393656	16	33	16	A < C	NS	D	1
WDR81	2354433283	17	1	18	G < A	S	N	4
WDR81	2354443084	17	10	67	C < T	S	N	4
TSR1	2355042000	17	1	34	G < A	NS	D	3
TRPV3	2356238371	17	7	155	C < T	S	N	4
TRPV3	2356249176	17	4	23	T < C	NS	N	4
ITGAE	2356435127	17	24	49	G < A	NS	D	4
ITGAE	2356463343	17	9	31	G < A	S	D	4
ZZEF1	2356772099	17	28	13	C < A	NS	N	3
GGT6	2357265990	17	1	13	G < A	NS	N	4
CXCL16	2357444046	17	3	22	C < T	S	N	4
TEKT1	2359518533	17	5	87	G < A	NS	D	4
AMAC1L3	2360187655	17	2	35	G < A	NS	N	4
AMAC1L3	2360187863	17	2	20	G < A	NS	N	4
AMAC1L3	2360188508	17	2	179	T < C	NS	N	4
TP53[a]	2360379830	17	6	38	G < A	NS	D	1
MYH13	2363018801	17	28	98	G < A	S	N	4
COX10	2366807730	17	4	62	G < A	S	N	4
COX10	2366897810	17	6	105	C < T	S	N	4
FAM18B2	2368251449	17	5	57	A < G	NS	N	4
FAM18B2	2368259332	17	3	141	A < C	S	N	4
TBC1D26	2368443097	17	3	80	A < C	NS	D	4
TBC1D26	2368443106	17	3	90	A < G	NS	N	4
SHMT1	2371041192	17	7	30	C < T	S	N	3
LGALS9C	2371193284	17	4	95	C < T	S	N	4
LGALS9C	2371193294	17	4	83	G < A	NS	N	4
ULK2	2372501833	17	19	21	G < T	S	N	3
KCNJ12	2374121073	17	1	157	G < A	NS	D	4
KCNJ12	2374121499	17	1	55	C < T	NS	D	4
KCNJ12	2374121521	17	1	67	G < C	NS	N	4
KIAA0100	2376657621	17	24	46	A < C	NS	N	4
SUPT6H	2376730797	17	36	14	C < T	S	N	1
CCL8[a]	2382349668	17	2	51	A < G	NS	N	1

Supplementary Table 3. Continued

Gene	Reference position	Chromosome	Coding sequence	Coverage	Allele change	Amino acid change	Functional predictions by SIFT	Patient no.
TBC1D3B	2384202011	17	5	27	C < T	NS	D	4
TBC1D3E	2384401830	17	9	36	A < T	NS	D	4
TBC1D3D	2385938140	17	2	61	A < G	NS	N	4
TBC1D3D	2385940014	17	4	85	C < A	NS	N	4
TBC1D3D	2385940944	17	6	147	G < A	NS	N	4
ERBB2	2387531879	17	17	51	A < G	NS	N	4
TOP2A	2388219990	17	9	19	T < C	S	N	3
KRT25	2388559828	17	4	159	G < A	S	N	2
KRT26	2388580603	17	1	18	A < T	S	N	3
KRT40	2388787496	17	6	48	A < G	S	N	4
KRTAP3-2	2388808375	17	1	95	T < C	NS	N	4
KRTAP1-1	2388849768	17	1	37	G < C	NS	D	4
KRTAP4-1	2388993082	17	2	33	G < C	NS	N	4
KRTAP4-1	2388993086	17	2	30	A < G	S	N	4
KRTAP9-4	2389058283	17	1	217	C < T	NS	D	4
KRTAP9-4	2389058336	17	1	39	A < C	NS	N	3
KRTAP9-9	2389063986	17	1	44	A < C	NS	N	4
TUBG1	2390418855	17	10	14	C < A	S	N	1
BRCA1	2390878791	17	13	31	C < T	NS	NO	3
NAGS	2391737375	17	6	45	G < A	NS	N	3
CDK5RAP3	2395703185	17	3	61	T < G	NS	D	2
FAM117A	2397445898	17	7	17	G < A	S	N	3
ITGA3	2397801147	17	6	33	T < C	S	N	4
NOG	2404324293	17	1	67	A < C	NS	N	3
MTMR4	2406238200	17	6	13	A < T	NS	NO	3
CSH2	2411602334	17	4	55	C < T	NS	N	4
GH2	2411610386	17	4	18	G < C	NS	N	1
TEX2	2411943294	17	1	21	A < T	NS	D	3
COG1	2420849730	17	7	78	C < T	S	N	4
GPR142[a]	2422019077	17	3	57	A < G	NS	D	1
UNK	2423468317	17	14	19	A < G	S	N	4
QRICH2	2423941144	17	4	44	T < G	NS	N	4
HRNBP3	2426764023	17	1	22	G < A	S	N	4
CBX4	2427461157	17	5	66	C < T	NS	N	2
RNF213	2427979649	17	9	73	G < A	S	N	4
MYL12A	2434375274	18	1	40	G < A	NS	N	3
MYL12A	2434375275	18	1	41	A < T	NS	D	3
AMAC1L1	2442732047	18	1	22	G < A	S	N	2
C18orf1	2444767403	18	5	65	A < G	S	D	3
LOC729774	2445483471	18	2	38	G < T	NS	NR	3
POTEC	2445664872	18	1	68	T < C	NS	N	2
CTAGE1	2448017831	18	1	35	C < T	NS	N	1
KCTD1	2452149054	18	1	18	T < G	NS	N	3
DSG4	2457014977	18	15	41	G < T	NS	NO	3
FAM59A	2457889818	18	4	30	G < T	S	N	3
FAM59A	2457889821	18	4	29	A < C	NS	D	3
MOCOS	2461870479	18	15	143	T < C	NS	N	4
SLC14A2	2471234230	18	4	39	G < A	NS	N	3
KIAA1632	2471505962	18	25	17	A < T	NS	N	3
KIAA1632	2471505963	18	25	17	A < T	NS	NO	3
FUSSEL18	2472796815	18	1	35	A < T	NS	D	1
ZBTB7C	2473578004	18	2	78	T < G	NS	D	4
ZBTB7C	2473588900	18	1	208	T < C	S	N	4
KIAA0427	2474259908	18	6	22	T < A	NS	N	3
CXXC1	2475832249	18	10	67	A < G	S	N	4
TCF4	2480799098	18	12	33	C < A	NS	D	3
TCF4	2481003232	18	3	19	C < A	S	N	3
CCBE1	2485008619	18	4	99	C < T	S	N	2
NETO1[a]	2498404004	18	3	115	A < T	NS	D	1
C19orf6	2506845912	19	4	13	T < G	NS	D	1

Supplementary Table 3. Continued

Gene	Reference position	Chromosome	Coding sequence	Coverage	Allele change	Amino acid change	Functional predictions by SIFT	Patient no.
ABCA7	2506887468	19	25	15	A < G	S	N	4
REXO1	2507659336	19	3	14	C < T	S	N	4
FAM108A1	2507714358	19	2	13	T < C	NS	N	4
PIP5K1C	2509476658	19	13	27	G < A	NS	N	3
MAP2K2	2509934448	19	6	47	C < T	NS	D	4
ACER1	2512145698	19	3	26	T < C	NS	N	4
LASS4	2514105354	19	7	55	T < C	S	N	4
MUC16	2514735984	19	51	113	T < C	NS	N	4
MUC16	2514735995	19	51	104	C < T	NS	N	4
MUC16	2514783318	19	5	66	C < T	NS	N	4
MUC16	2514793493	19	3	59	C < T	NS	N	4
MUC16	2514797580	19	3	46	T < C	S	N	3
ICAM3	2516182922	19	2	22	T < C	NS	N	4
MAST1	2518717997	19	26	18	G < A	S	N	3
CYP4F12	2521526643	19	5	51	T < C	NS	N	4
OR10H2	2521572582	19	1	89	C < T	S	N	4
AP1M1	2522077812	19	11	81	C < G	NS	D	3
CPAMD8	2522819358	19	17	55	G < A	NS	N	3
KIAA1683	2524110904	19	2	62	C < G	NS	N	4
ISYNA1	2524280086	19	7	57	T < C	S	N	4
KIAA0892	2525185534	19	7	61	G < A	S	N	3
ZNF536	2533672403	19	3	28	T < C	S	N	4
GPI	2537503303	19	7	71	C < G	S	N	4
CD22	2538462717	19	5	17	C < G	S	N	3
C19orf15	2541461368	19	1	88	T < C	NS	N	4
MAP4K1	2541732174	19	14	25	G < A	NS	N	4
CAPN12	2541857821	19	18	71	A < G	S	N	4
LGALS4[a]	2541932950	19	3	30	C < A	NS	D	1
ECH1	2541939937	19	9	29	C < T	NS	D	4
PLEKHG2	2542544839	19	12	22	C < T	S	N	3
FCGBP	2543017507	19	21	76	G < A	S	N	4
FCGBP	2543053201	19	6	13	G < T	S	N	1
SNRPA	2543896811	19	2	60	A < G	S	N	4
CYP2F1	2544255597	19	1	31	G < A	S	N	4
ERF	2545386691	19	4	32	G < A	S	N	4
PSG3	2545867483	19	4	156	C < A	S	N	4
PSG8	2545901763	19	2	60	C < A	NS	D	3
CEACAM20	2547650657	19	7	58	T < C	NS	NR	4
ERCC2	2548501717	19	6	71	T < G	S	N	4
EMP3	2551464282	19	2	40	G < T	NS	NO	1
TMEM143	2551479358	19	6	19	A < C	NS	D	3
PTH2	2552559200	19	2	22	G < C	NS	N	3
SHANK1	2553853011	19	2	18	T < C	NS	N	1
ZNF808[a]	2555691982	19	3	39	G < A	NS	N	1
ZNF765	2556544681	19	3	19	C < G	NS	N	1
ZNF765	2556544684	19	3	19	T < C	S	N	1
ZNF761	2556586232	19	2	16	G < A	S	NR	4
LILRB3[a]	2557359732	19	3	208	G < C	NS	N	2
LILRA1	2557740721	19	5	61	T < C	NS	N	2
KIR2DL4	2557949666	19	3	17	C < G	NS	N	3
KIR3DL1	2557963191	19	3	109	A < G	S	N	4
KIR2DS4	2557982650	19	3	37	T < G	S	NR	2
KIR2DS4	2557982701	19	3	36	G < T	NS	NR	2
KIR2DS4	2557982728	19	3	21	G < C	NS	NR	2
RDH13	2558201492	19	1	28	C < T	NS	N	4
RDH13	2558201493	19	1	29	G < T	NS	N	4
ZFP28	2559692350	19	3	33	C < A	S	N	3
ZNF550[a]	2560701027	19	1	67	C < T	NS	D	1
ZSCAN22	2561483213	19	2	17	T < G	NS	N	3
KIR2DS1	2561871082	19	3	153	A < G	S	NR	2

Supplementary Table 3. Continued

Gene	Reference position	Chromosome	Coding sequence	Coverage	Allele change	Amino acid change	Functional predictions by SIFT	Patient no.
SIGLEC1	2565630685	20	3	19	C < T	NS	N	4
PAK7	2571487871	20	4	131	C < T	NS	N	4
FLRT3	2576252200	20	1	17	T < G	NS	D	3
CST9L	2585490888	20	2	216	T < G	NS	N	4
BPI	2595650275	20	11	148	A < G	NS	N	4
LBP	2595672219	20	2	23	G < A	S	N	4
LBP[a]	2595691968	20	10	25	G < T	S	N	1
KIAA1219	2595847726	20	10	14	T < G	NS	D	3
PTPRT	2599404902	20	31	37	C < A	NS	D	3
SEMG2	2602544774	20	2	42	A < G	S	N	4
ZNF335	2603273210	20	21	32	A < G	S	N	4
PCK1	2614832083	20	3	52	A < G	S	N	4
CTSZ	2616266012	20	5	51	A < G	S	N	4
OGFR	2620085220	20	4	20	G < A	S	N	4
KCNQ2	2620689776	20	14	14	C < G	NS	N	4
LOC100132288	2622007697	21	2	24	C < T	NS	NR	4
LOC100288017	2623267208	21	1	18	G < A	NS	NR	2
POTED	2623681322	21	1	60	G < A	NS	N	2
KRTAP13-2	2640442822	21	1	81	A < T	NS	D	3
C21orf66	2642816546	21	12	14	A < C	NS	N	1
C21orf66	2642816547	21	12	14	C < T	NS	N	1
WRB	2649461227	21	2	73	G < T	NS	NO	4
WRB	2649461228	21	2	73	A < T	NS	D	4
DSCAM	2650145634	21	27	116	G < C	S	N	4
PRDM15	2651870131	21	31	65	G < A	S	N	4
PFKL	2654380692	21	4	19	C < T	S	N	4
KRTAP10-6	2654660390	21	1	137	G < A	S	N	4
KRTAP12-2	2654734983	21	1	59	C < T	NS	N	4
KRTAP12-2	2654735333	21	1	71	G < A	S	N	4
KRTAP12-2	2654735334	21	1	69	C < T	NS	N	4
COL6A2	2656200935	21	27	63	C < G	S	N	3
FTCD	2656222648	21	2	55	T < A	NS	D	2
CECR5	2658218162	22	6	14	T < G	NS	D	3
CECR2	2658624712	22	16	25	C < T	S	N	4
LOC100288065	2658662354	22	4	63	A < G	NS	N	4
TBX1	2660347982	22	4	51	C < T	S	N	4
ZNF280B[a]	2663338671	22	1	78	G < A	S	N	2
C22orf30	2672604693	22	3	17	C < T	NS	NO	3
ISX	2675974809	22	2	60	G < A	S	N	1
HMGXB4	2676157665	22	4	42	A < T	S	N	3
APOL1	2677147183	22	2	27	C < T	NS	N	1
TMPRSS6	2677959079	22	17	144	G < A	S	N	4
TMPRSS6	2677959089	22	17	133	A < G	NS	N	4
SSTR3	2678099174	22	1	18	G < A	S	N	4
APOBEC3A	2679853734	22	3	53	C < T	S	N	4
L3MBTL2	2682109341	22	5	24	C < T	S	N	4
NAGA	2682959967	22	3	46	C < T	S	N	4
TTLL12	2684071796	22	5	53	C < T	S	N	3
SCUBE1	2684110469	22	15	48	C < G	S	N	4
LOC100289317	2686220100	22	1	25	A < G	NS	NR	4
CELSR1	2687425845	22	1	58	A < G	NS	N	4
MAPK8IP2	2691494874	22	11	52	G < A	NS	N	4
CD99	2693971425	X	6	16	G < A	NS	D	4
PRKX	2694923444	X	2	88	G < A	S	N	4
ARHGAP6[a]	2702537703	X	4	81	G < A	NS	D	2
DMD	2723711682	X	37	92	T < C	NS	N	4
WAS	2739828502	X	11	13	G < T	NS	N	3
GATA1	2739931290	X	2	14	A < C	NS	N	3
GAGE12E	2740547782	X	1	62	G < T	NS	D	4
PAGE1[a]	2740686656	X	3	37	T < C	S	N	1

Supplementary Table 3. Continued

Gene	Reference position	Chromosome	Coding sequence	Coverage	Allele change	Amino acid change	Functional predictions by SIFT	Patient no.
USP27X	2740875896	X	1	39	G < C	NS	NR	3
TSPYL2	2744246047	X	6	76	A < G	NS	N	3
FAM120C	2745238526	X	14	66	C < A	NS	D	2
ITIH5L	2745914425	X	8	22	G < A	NS	N	3
MSN	2752987418	X	9	47	G < A	S	N	2
OPHN1	2755314567	X	20	47	T < C	NS	N	3
DGAT2L6	2757452592	X	5	20	C < T	S	N	3
LPAR4	2765991350	X	1	46	G < T	NS	D	3
LPAR4	2765991352	X	1	43	C < T	S	N	3
PCDH11X	2779854213	X	7	171	C < A	NS	N	3
SYTL4	2787924130	X	9	24	G < A	S	N	3
SYTL4	2787924131	X	9	24	T < C	NS	D	3
NXF5	2789077402	X	3	81	T < C	NS	D	1
NXF2	2789554971	X	10	19	C < T	S	N	3
CLDN2	2794152808	X	1	26	C < A	NS	N	3
CLDN2	2794152809	X	1	26	C < T	NS	N	3
TRPC5	2799176319	X	1	24	G < A	NS	D	3
TRPC5	2799176320	X	1	24	G < T	NS	N	3
RHOXF2B	2807087244	X	4	29	A < G	NS	N	3
PLAC1	2821580905	X	1	20	A < G	NS	N	3
RBMX	2823837181	X	8	40	G < C	NS	D	4
SLITRK4	2830598721	X	1	56	T < C	NS	N	3
NSDHL	2839816887	X	6	109	A < G	NS	D	3
MPP1	2841799005	X	5	36	T < C	S	N	3
MPP1	2841799006	X	5	36	T < C	NS	N	3
RBMY1D	2863471281	Y	11	23	T < C	S	N	1

SIFT, Sorting Intolerant From Tolerant; N, nonsynonymous mutation; D, deleterious; N, neutral; S, synonymous mutation; NO, nonsense mutation; NR, no record found.
[a]These genes were commonly mutated in the synchronously developed HCCs from patients 1 and 2.

Supplementary Table 4. Functional Relevance of Mutations Detected in HCC Tumors

Patient 1					
HCC 1	No. of mutated genes	51			
	Amino acid change (+)	38 (74.5%)			
	Functional loss[a] (+)	20 (39.2%)			
	KEGG pathway				
	Pathways in cancer	CTNNB1	PDGFRB	TP53	
	Wnt signaling pathway	FBXW11			
	PI3K-Akt signaling pathway	ITGB8			
	Others	ALDH1A1	HDAC9	SORBS2	RYR3
HCC 2	No. of mutated genes	79			
	Amino acid change (+)	58 (73.4%)			
	Functional loss[a] (+)	23 (29.1%)			
	KEGG pathway				
	Viral carcinogenesis	HDAC9	RB1	TP53	
	Wnt signaling pathway	FBXW11			
	PI3K-Akt signaling pathway	ITGB8			
	Others	ALDH1A1	NXF5		
Patient 2					
HCC 1	No. of mutated genes	39			
	Amino acid change (+)	20 (51.3%)			
	Functional loss[a] (+)	10 (25.6%)			
	KEGG pathway				
	Metabolic pathways	DBH			
	Others	AGRN			
HCC 2	No. of mutated genes	70			
	Amino acid change (+)	40 (57.1%)			
	Functional loss[a] (+)	20 (28.6%)			
	KEGG pathway				
	Metabolic pathways	ADSSL1	FTCD	RDH16	
	Others	ABCA13	BTRC	VWF	C4A
		GRM4			
Patient 3					
HCC 1	No. of mutated genes	30			
	Amino acid change (+)	20 (66.7%)			
	Functional loss[a] (+)	6 (20.0%)			
	KEGG pathway				
	Metabolic pathways	CYP1A2			
HCC 2	No. of mutated genes	276			
	Amino acid change (+)	208 (75.3%)			
	Functional loss[a] (+)	90 (32.6%)			
	KEGG pathway				
	Metabolic pathways	ACSM4	ADSS	UGT2B28	DHRS4L2
		GALNT5	ME1	POLE	NSDHL
		PIK3C2G			
	PI3K-Akt signaling pathway	COL6A6	HGF	ANGPT1	LPAR4
	Neuroactive ligand receptor	GLRA2			
	Others	CDK9	CA2	ABCC12	AP1M1
		GNPAT	GLYAT	RUVBL1	GDF9
		MYL12A	MLL3	SLC18A2	MAP4K4
		PRPF8	PIP4K2A	SLC9A4	NUP37
		VCP	TTN		

Supplementary Table 4. Continued

Patient 4					
HCC	No. of mutated genes	364			
	Amino acid change (+)	177 (48.6%)			
	Functional loss[a] (+)	46 (12.6%)			
	KEGG pathway				
	Metabolic pathways	ACSM5	ALPP	PNLIPRP1	
	MAPK signaling pathway	HSPA6	MAP2K2		
	PI3K-Akt signaling pathway	FLT4			
	Others	ECH1	CHI3L1	FURIN	CD99
		KCNJ12	ITGAE	TMPRSS4	REXO1L1
		RBMX	PLOD3	TUBA4A	PGA3

[a]The number of mutated genes predicted to be "damaging (deleterious)" by Sorting Intolerant From Tolerant (SIFT) functional impact predictions (http://provean.jcvi.org/index.php). The genes categorized in multiple pathways are shown in only one representative pathway.

Supplementary Table 5. List of 448 Indels in 409 Genes at a Frequency of >20% of Reads in 7 HCC Tumors From 4 Patients

Reference position	Gene	Chromosome	Coding sequence	Coverage	Allele change	Patient no.
7813482	ERRFI1	1	3	17	insA	3
12628605[a]	PRAMEF11	1	3	27	insC	2
12718307	PRAMEF7	1	2	47	insT	3
17358674[a]	PADI6	1	9	41	delG	4
17358674[a]	PADI6	1	9	62	delGT	2
26696284	ARID1A	1	2	19	delC	4
31395890[a]	SERINC2	1	9	17	insG	3
46770747	CYP4B1	1	8	42	delAT	4
46770748	CYP4B1	1	8	42	delT	4
52949277[a]	LOC100133211	1	1	42	delG	4
53189215	MAGOH	1	3	25	insA	3
54095320[a]	CDCP2	1	4	21	insC	4
62557547	ANGPTL3	1	4	17	insT	3
78876012	ELTD1	1	10	13	insA	3
89014597	GBP1	1	4	17	insA	2
90670304	BARHL2	1	2	20	insC	3
108974106	CLCC1	1	6	84	insG	4
122705624[a]	PDE4DIP	1	14	80	delG	4
122713730[a]	PDE4DIP	1	6	465	delT	1
131401399	DENND4B	1	12	43	insG	3
131474740	NUP210L	1	34	13	insG	3
131951749	SHE	1	3	112	insA	2
133072970	MSTO1	1	11	33	insA	3
133795656	CCT3	1	2	34	insT	3
133844355[a]	RHBG	1	9	40	delC	4
134043234[a]	TTC24	1	3	12	delC	3
136505109	IFI16	1	7	31	insT	3
146999551	F5	1	13	23	insT	3
151907797	GPR52	1	1	18	insA	2
162596811	C1orf25	1	10	26	insT	3
163815430	TPR	1	15	43	delT	3
174374155	CFHR4	1	5	18	insC	3
177507300	NR5A2	1	5	20	insT	3
201685738	NVL	1	6	32	insA	3
203543660	ACBD3	1	2	18	insG	3
208315870[a]	ARV1	1	3	146	delCT	1
208315871[a]	ARV1	1	3	144	delT	1
213162772	LYST	1	3	19	insG	3
214770350	RYR2	1	11	22	insG	3
219641707	PLD5	1	2	102	insA	1
224245114	AHCTF1	1	14	19	insG	3
230467928	RNASEH1	2	8	13	insT	3
236404886	ADAM17	2	19	29	insG	3
251086730[a]	LOC375190	2	8	40	insC	4
254371933	IFT172	2	38	18	insT	3
258505433[a]	SRD5A2	2	1	28	insG	2
267355164	SLC8A1	2	1	15	insG	3
282849120	EFEMP1	2	1	14	insA	3
287714203	PAPOLG	2	15	20	delT	3
288274645	USP34	2	15	14	insC	3
301408194	CCDC142	2	2	27	insC	3
302628924	C2orf3	2	3	22	insA	3
312276713	RETSAT	2	4	55	delC	2
314781292	RGPD2	2	5	27	insT	3
317672121[a]	LOC391405	2	4	43	delA	4
318709414	TRIM43	2	1	22	insA	3
325574912	SLC9A4	2	6	27	insT	3
329490991	RGPD3	2	20	29	insT	3
331565693	GCC2	2	22	18	insC	2
332910299	RGPD5	2	21	25	insA	3
333616906	RGPD7	2	8	21	delA	3

Supplementary Table 5. Continued

Reference position	Gene	Chromosome	Coding sequence	Coverage	Allele change	Patient no.
335725611	SLC20A1	2	8	14	insC	3
336700192	RABL2A	2	4	76	delG	1
340887331	DDX18	2	7	18	insT	3
350555029	IWS1	2	11	62	delG	3
355383031[a]	ZNF806	2	3	50	delC	4
355383457[a]	ZNF806	2	3	56	insA	4
355383669[a]	ZNF806	2	3	52	delA	4
361736116	NXPH2	2	2	48	insT	3
385464478	KCNH7	2	10	41	insT	3
387807820	COBLL1	2	2	23	insA	3
388452944	SCN2A	2	26	57	insT	3
400689016	TTC30A	2	1	32	insA	3
401650351	TTN	2	270	19	insG	3
401670059	TTN	2	242	25	insT	3
401800064	TTN	2	64	26	insA	3
402189048	SESTD1	2	14	31	insG	3
403038177	CWC22	2	11	16	insA	3
418958541	DNAH7	2	34	27	insC	3
439213578	XRCC5	2	13	22	delC	3
446013793	ACSL3	2	14	26	insT	3
446670417	SCG2	2	1	17	insA	3
446671148	SCG2	2	1	30	insC	3
456401277[a]	SAG	2	10	76	delA	2
463724350	AQP12B	2	1	26	delC	2
479793553[a]	GRIP2	3	10	55	insG	4
504388108	TTC21A	3	6	13	insA	3
509772719	ZNF852	3	3	20	delTC	4
509772720	ZNF852	3	3	19	delC	4
511646368	CCR5	3	1	24	insT	3
515483759[a]	SLC38A3	3	2	18	insG	4
538148646	GLT8D4	3	6	14	insC	3
538243406[a]	FLJ10213	3	1	12	insA	2
538564462	PDZRN3	3	10	24	insG	3
540846731[a]	LOC100288801	3	2	39	delG	2
540918687	ZNF717	3	4	18	delC	1
570208682	HHLA2	3	4	18	insT	3
570487430	DZIP3	3	10	45	insT	3
574780156	CD200R1	3	4	24	insA	3
587083495	ZNF148	3	6	14	insG	3
591946859[a]	LOC644974	3	6	36	delC	3
595459401	TOPBP1	3	26	16	insT	3
608303870	PLSCR2	3	4	59	insG	3
611616867	C3orf16	3	5	22	delCT	3
611616868	C3orf16	3	5	21	delT	3
612474548	SELT	3	4	38	insT	4
631967149	PHC3	3	10	13	insT	3
648156647	DGKG	3	2	44	insC	3
652237997[a]	CLDN16	3	1	271	delG	2
658673909	PAK2	3	12	16	insT	3
660166378	ZNF595	4	4	17	insA	1
662098266[a]	POLN	4	23	65	delG	3
696277331	FLJ16686	4	3	53	delC	1
725715810	TMPRSS11F	4	7	30	insA	3
728128121	LOC100129410	4	3	13	insC	2
752860649	UNC5C	4	14	17	insT	3
767688857[a]	EGF	4	24	16	insC	1
779934903	KIAA1109	4	39	17	insT	3
782346647	ANKRD50	4	3	37	insT	3
827268418	NEK1	4	4	17	insT	3
841124368	CDKN2AIP	4	3	16	insA	3
853638502	KIAA0947	5	14	24	insT	3

Supplementary Table 5. Continued

Reference position	Gene	Chromosome	Coding sequence	Coverage	Allele change	Patient no.
889026155[a]	CARD6	5	3	32	insT	2
891727995	PAIP1	5	2	16	insG	2
901348948	MAP3K1	5	13	24	insC	3
909928153	ADAMTS6	5	3	23	insG	3
914509435	SERF1B	5	3	15	insG	3
914509482	SERF1B	5	3	49	insA	3
915509411[a]	GTF2H2	5	13	31	insT	2
919186632	HEXB	5	11	43	insA	3
922917852	SCAMP1	5	7	37	insA	1
928534269	EDIL3	5	7	25	insA	3
931867232	CCNH	5	7	26	insT	3
956697390	EPB41L4A	5	11	13	insT	1
966610635	ZNF474	5	1	39	delT	1
972596345	SLC12A2	5	8	35	insT	3
980635083[a]	SMAD5	5	6	105	insC	1
985314450[a]	LOC100288105	5	1	14	delC	4
985640033[a]	PCDHB9	5	1	32	insA	1
985844899[a]	PCDHGA8	5	1	27	delC	3
992330379	SCGB3A2	5	1	14	delA	3
994446878[a]	TIGD6	5	1	136	delT	1
994476149	HMGXB3	5	6	14	delA	3
998157358	GRIA1	5	11	19	insC	3
1020539380	FAM153B	5	4	23	insC	3
1039337531	C6orf114	6	1	30	insA	3
1052252527	BTN2A2	6	2	44	insG	3
1054107191[a]	ZNF187	6	1	33	insG	4
1056096293[a]	FLJ45422	6	2	18	insT	2
1057247419[a]	MICA	6	5	27	delG	3
1082305754	DST	6	45	18	insT	3
1088830738	EYS	6	6	19	insT	3
1093406718	COL19A1	6	5	16	insA	3
1113248546	MDN1	6	15	14	insC	3
1113280524	MDN1	6	2	40	insA	3
1131602437[a]	FOXO3	6	2	64	insG	3
1133380782	SLC22A16	6	4	20	insA	3
1135037748	C6orf225	6	1	17	delC	3
1153093327	SAMD3	6	7	14	delC	3
1154647636	LOC643854	6	1	26	insT	3
1154648098	LOC643854	6	1	20	insC	3
1159216432	BCLAF1	6	2	13	delT	2
1161156444	PBOV1	6	1	36	insG	3
1182019086	RSPH3	6	6	43	insA	3
1200500350	RSPH10B2	7	19	23	insG	3
1206053594	VWDE	7	19	26	insA	4
1221518316	TAX1BP1	7	13	14	insA	3
1222659823[a]	KIAA0644	7	1	90	delC	4
1222659922[a]	KIAA0644	7	1	26	insC	3
1226974977	BBS9	7	7	19	insT	1
1228643735[a]	DPY19L1	7	18	22	delAT	4
1228643736[a]	DPY19L1	7	18	50	delT	1
1262731853	TYW1B	7	8	142	delA	4
1262954278	TRIM74	7	2	24	insA	2
1265555276	TRIM73	7	2	84	insT	2
1266437261[a]	FLJ37078	7	14	43	insC	2
1266593512[a]	ZP3	7	8	51	insG	1
1266763110[a]	POMZP3	7	5	83	delA	4
1278946055	C7orf62	7	1	20	insC	3
1283360469	HEPACAM2	7	4	29	insT	3
1283589759	CALCR	7	9	26	insT	3
1290893801[a]	ZAN	7	30	28	insG	3
1291366094	MOGAT3	7	2	24	insA	3

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Reference position	Gene	Chromosome	Coding sequence	Coverage	Allele change	Patient no.
1291722996[a]	EMID2	7	13	20	insG	4
1292538685	LOC100289561	7	1	14	insA	3
1295252926	MLL5	7	12	21	insG	3
1298402792	NRCAM	7	1	17	insT	3
1319055841[a]	KCP	7	10	62	insC	1
1319073009	KCP	7	1	30	delC	2
1333766379	LOC441294	7	1	46	insA	4
1334380185	CTAGE4	7	1	39	insA	3
1334381975	ARHGEF5L	7	1	19	insA	1
1339923632[a]	KRBA1	7	12	76	insC	2
1339973995[a]	SSPO	7	9	44	insC	1
1340003537[a]	SSPO	7	60	15	insC	4
1340012514	SSPO	7	76	23	delA	2
1340015859	SSPO	7	83	14	delC	2
1340525483	C7orf29	7	1	24	delC	1
1341211228[a]	ATG9B	7	10	49	insC	1
1341434558	SMARCD3	7	10	21	delC	3
1342197228	GALNTL5	7	5	71	delT	4
1342442397[a]	MLL3	7	14	208	insT	4
1356372261[a]	XKR5	8	6	55	delAG	1
1374409954[a]	NEFL	8	3	38	delG	4
1380219728[a]	UBXN8	8	7	83	insT	1
1380304215	TEX15	8	1	23	insA	3
1388426070[a]	PLEKHA2	8	11	28	delC	2
1395399601[a]	PRKDC	8	31	17	insG	1
1398930064	PXDNL	8	14	27	insA	3
1410692513[a]	YTHDF3	8	4	24	insG	1
1415952398	C8orf34	8	2	32	insG	3
1445261384	LAPTM4B	8	2	16	insC	3
1490189877[a]	JRK	8	1	12	delCA	3
1490189878[a]	JRK	8	1	19	delA	2
1491176363	ZNF623	8	1	29	insT	3
1492082552[a]	RECQL4	8	14	20	delG	3
1498992866	LOC645969	9	1	155	insT	4
1527437913[a]	C9orf144B	9	4	20	delC	4
1543290663[a]	FOXD4L5	9	1	39	delG	1
1546032104	TRPM3	9	22	19	insT	3
1552818643	VPS13A	9	48	29	insG	3
1574648314	COL15A1	9	13	29	insC	3
1586295095	MUSK	9	1	62	insT	3
1608846803[a]	ABO	9	6	117	insC	4
1620006324	GDI2	10	7	14	insG	3
1620254092	IL2RA	10	4	14	insC	3
1621795546[a]	ITIH5	10	14	23	delC	1
1633127998	NSUN6	10	2	26	insA	3
1647389817	ITGB1	10	13	22	insA	3
1652560241[a]	LOC340947	10	2	25	delT	1
1653671683[a]	LOC642424	10	3	117	delT	1
1657313101	AGAP4	10	7	23	delT	2
1658942495	FAM25G	10	3	48	insC	3
1662197526	LOC100287932	10	6	22	insA	4
1662338998[a]	AGAP6	10	1	50	insC	2
1666373362	PCDH15	10	19	56	insC	3
1673760921	TMEM26	10	6	25	insT	3
1685560504	FAM149B1	10	7	26	insT	3
1701949711	PANK1	10	3	30	insA	3
1708407108	CCNJ	10	3	18	insC	3
1708510568	ZNF518A	10	1	30	insC	1
1708668598	DNTT	10	2	18	insA	3
1709332414	C10orf12	10	1	18	insG	3
1728973932[a]	PNLIPRP2	10	3	52	insG	1

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Reference position	Gene	Chromosome	Coding sequence	Coverage	Allele change	Patient no.
1733216553	BRWD2	10	8	28	insT	3
1737221823	ZRANB1	10	1	17	insA	3
1738045786	MMP21	10	7	33	insG	3
1748226082	C11orf21	11	4	63	insG	1
1750053615	RRM1	11	14	17	insT	3
1753342600	SYT9	11	4	18	insG	3
1760006709[a]	SPON1	11	5	72	insC	4
1764016157	SAAL1	11	7	40	delT	4
1771005317	LUZP2	11	12	34	insA	3
1782417168	TRAF6	11	6	24	delG	3
1782519665	RAG2	11	1	21	insA	3
1792247476[a]	CREB3L1	11	12	40	insG	1
1802120506	TCN1	11	7	13	insA	3
1802663567[a]	MS4A14	11	2	61	delTT	4
1802663568[a]	MS4A14	11	2	22	delT	3
1803663946[a]	TMEM216	11	3	54	insA	4
1804797590	AHNAK	11	3	12	insG	3
1805556025	SLC22A10	11	1	17	insC	3
1810263379[a]	UNC93B1	11	7	53	insG	3
1810284280[a]	ALDH3B1	11	2	63	insC	2
1810287509[a]	ALDH3B1	11	6	18	insC	1
1810293595[a]	ALDH3B1	11	9	28	insC	4
1814065554	LOC729523	11	1	22	delT	3
1826743977	DLG2	11	5	23	insT	3
1832107207	LOC642446	11	1	33	delT	4
1837197723[a]	CWC15	11	5	152	insT	1
1837299118[a]	SFRS2B	11	1	36	insC	4
1850549218	ATM	11	49	24	insT	3
1852355678	ZC3H12C	11	2	25	insC	3
1854201323[a]	DIXDC1	11	7	16	insC	1
1860877259[a]	TREH	11	15	28	insG	2
1861246651[a]	SLC37A4	11	3	37	delC	1
1861288156	VPS11	11	2	13	insC	4
1867800518	EI24	11	9	14	insC	4
1867851321	CHEK1	11	5	44	insC	3
1888645169[a]	PRB3	12	4	34	delG	4
1888731023[a]	PRB1	12	3	136	delC	1
1891856090	ATF7IP	12	11	19	insG	3
1893735417[a]	MGST1	12	2	12	delAA	3
1893735418[a]	MGST1	12	2	18	delA	3
1898574937	SLCO1B1	12	7	17	insC	3
1902256413	BCAT1	12	5	22	insG	3
1913975525	KIF21A	12	10	20	insT	3
1914378775	SLC2A13	12	10	17	insA	3
1927092176	KRT6C	12	1	15	insG	2
1930622534	SUOX	12	3	14	insG	3
1931678522	TMEM194A	12	9	23	insG	3
1932337710	OS9	12	12	17	insA	3
1959863488	LRRIQ1	12	26	12	delA	3
1962616654	C12orf50	12	3	28	insA	3
1978598568[a]	TDG	12	3	14	insA	3
1986789153	LOC100287839	12	9	35	insC	3
1997115077	RSRC2	12	10	28	insG	3
1999523126	UBC	12	1	29	delT	3
2009256491	ZMYM5	13	5	14	insC	3
2012756904	SACS	13	9	20	insT	3
2012761230	SACS	13	9	23	insT	3
2017859185	FLT1	13	4	36	insA	3
2022550582	STARD13	13	5	85	delT	1
2026525487	CSNK1A1L	13	1	13	insC	2
2038965626	RCBTB1	13	8	17	insG	3

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Reference position	Gene	Chromosome	Coding sequence	Coverage	Allele change	Patient no.
2046563396	PRR20	13	2	28	delC	2
2063234131	KLF12	13	4	47	insT	3
2066482633	MYCBP2	13	75	17	insT	3
2066508358	MYCBP2	13	62	14	insC	3
2066632819	MYCBP2	13	22	23	delC	3
2066717508	MYCBP2	13	2	33	delAA	3
2066717509	MYCBP2	13	2	33	delA	3
2088603872	GPR18	13	1	20	insT	3
2105948032	NDRG2	14	1	34	delG	1
2106009532	FLJ10357	14	18	14	delG	3
2108927297	DHRS4L2	14	6	41	insA	4
2109139875[a]	MDP-1	14	6	13	delA	1
2117359342	AKAP6	14	1	20	insA	3
2117747539	AKAP6	14	12	21	insA	3
2137979011	DDHD1	14	10	22	insC	3
2148241015[a]	GPHB5	14	1	18	insG	4
2158414589[a]	C14orf169	14	1	19	insC	3
2159993929[a]	FAM164C	14	1	14	insA	1
2160606560	TTLL5	14	4	17	insA	3
2179419547	SERPINA12	14	2	54	insC	3
2179491154	SERPINA4	14	3	14	insG	3
2181450460	PAPOLA	14	5	33	insC	3
2202211427[a]	CHRFAM7A	15	4	191	delCA	1
2202211428[a]	CHRFAM7A	15	4	252	delA	4
2203996021[a]	CHRNA7	15	6	166	delTG	1
2203996022[a]	CHRNA7	15	6	50	delG	2
2204534873	SCG5	15	5	24	insC	3
2212460825	CASC5	15	10	14	insA	3
2220067652	SLC12A1	15	5	21	insA	3
2237036677	LOC100287371	15	3	32	insG	3
2243652079[a]	NR2E3	15	6	34	delC	1
2251295853	KIAA1024	15	1	14	insT	3
2252413491	ARNT2	15	14	24	insC	3
2256610001	ZSCAN2	15	2	14	insC	3
2257065252	PDE8A	15	4	20	delT	3
2261248094	FANCI	15	2	19	insC	3
2261584966	C15orf42	15	7	21	insT	3
2270957952[a]	LOC145814	15	4	23	insC	4
2271092254[a]	SYNM	15	1	19	insG	3
2274046312[a]	C16orf35	16	12	89	insG	4
2274304546	AXIN1	16	1	20	delC	3
2277509768[a]	NLRC3	16	7	81	delG	1
2285935013[a]	LOC729978	16	4	20	delAT	4
2285935014[a]	LOC729978	16	4	44	delT	1
2292434768	NOMO2	16	24	22	insG	3
2294397443	ACSM2A	16	9	23	delA	3
2294883814	DNAH3	16	53	18	insC	3
2304906998	HSD3B7	16	6	48	delC	2
2332868773	CLEC18C	16	3	24	insA	3
2333553555[a]	HYDIN	16	68	29	delA	4
2338969142[a]	CNTNAP4	16	1	82	insT	1
2351412465[a]	LOC100289580	16	2	67	delC	2
2354387432	PRPF8	17	4	11	insG	3
2356396572[a]	P2RX5	17	3	13	delG	1
2359357840	C17orf100	17	1	14	insG	2
2360272579[a]	SENP3	17	6	20	delA	4
2361527508[a]	PIK3R6	17	16	42	insG	1
2363416732	C17orf48	17	3	19	insA	3
2371198121	LGALS9C	17	9	16	insA	4
2376394518[a]	SEBOX	17	1	29	insG	4
2376430014[a]	SLC46A1	17	4	15	delA	1

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Reference position	Gene	Chromosome	Coding sequence	Coverage	Allele change	Patient no.
2382300534	CCL7	17	2	24	insT	3
2383802642[a]	MMP28	17	4	28	insC	4
2384283858	TBC1D3C	17	13	31	insG	1
2388631071	KRT10	17	1	14	delC	3
2392844842[a]	PLCD3	17	10	24	insC	1
2393016586[a]	MAP3K14	17	4	16	insG	2
2407377091	CLTC	17	3	28	insT	3
2409792732	MED13	17	2	24	insA	3
2411313186[a]	WDR68	17	5	42	delG	1
2412151377	DDX5	17	8	23	insT	3
2434290839	MYOM1	18	8	16	insA	3
2448603454	RBBP8	18	14	22	insC	3
2451555232	LOC100287386	18	2	31	insA	1
2471234235	SLC14A2	18	4	39	delC	3
2492044315	CDH19	18	11	24	insA	3
2501962862	ZNF516	18	2	27	delG	2
2508173565[a]	SPPL2B	19	7	26	insC	2
2510788089	UHRF1	19	14	13	insC	3
2514792389	MUC16	19	3	18	insA	3
2514803399	MUC16	19	3	29	insT	3
2518236406	ZNF799	19	4	25	insA	3
2521463907[a]	CYP4F8	19	4	79	insC	1
2522001621[a]	HSH2D	19	5	71	delA	2
2538892348	C19orf55	19	9	17	delG	2
2543188059	ZNF780B	19	2	24	insC	3
2543756504[a]	LTBP4	19	24	14	insG	1
2544255517[a]	CYP2F1	19	1	53	insC	4
2544853028	CEACAM5	19	4	26	insT	3
2547650400[a]	CEACAM20	19	8	54	delT	1
2547930257[a]	CBLC	19	8	18	insC	3
2552076265[a]	DHDH	19	4	55	insG	2
2552600822	ALDH16A1	19	10	73	insC	2
2554469302[a]	LOC147645	19	10	37	insG	4
2555437083[a]	ZNF480	19	1	51	delG	1
2555750854	ZNF83	19	1	26	insG	3
2559350849	ZSCAN5C	19	1	50	insA	2
2560590155	ZNF749	19	3	34	insA	1
2560866399	ZNF671	19	4	14	insA	3
2561351770[a]	ZNF274	19	4	78	insG	2
2562070563	DEFB126	20	2	20	delCC	3
2562070564	DEFB126	20	2	20	delC	3
2567847490[a]	CHGB	20	4	28	delGA	2
2567847491[a]	CHGB	20	4	70	delA	2
2580083985	CSRP2BP	20	4	17	insG	3
2583130413[a]	NCRNA00153	20	7	49	insG	1
2606534089	DDX27	20	4	21	insA	3
2608270909	MOCS3	20	1	23	insG	3
2640900547[a]	KRTAP7-1	21	1	27	delA	4
2643647262[a]	SON	21	12	40	insA	1
2643647273[a]	SON	21	12	33	delA	4
2654166830	TRAPPC10	21	21	24	insT	3
2656193953[a]	LOC100288508	21	5	14	insC	1
2670991039	HORMAD2	22	2	23	insG	3
2681753989	DNAJB7	22	1	66	insA	1
2683020374	CYP2D6	22	5	18	insG	4
2701397266	WWC3	X	7	15	insG	3
2708217926	RBBP7	X	2	16	insC	3
2709924320	CDKL5	X	4	26	insC	3
2711314268	CXorf23	X	3	22	delG	3
2713575280	PHEX	X	19	29	insG	3
2736210225	KDM6A	X	17	17	insC	3

Supplementary Table 5. Continued

Reference position	Gene	Chromosome	Coding sequence	Coverage	Allele change	Patient no.
2736225869	KDM6A	X	24	16	insA	3
2737802282	SLC9A7	X	7	21	insC	3
2739406485	SSX1	X	6	45	insT	3
2739444455[a]	SSX9	X	2	11	delC	2
2741301867[a]	DGKK	X	22	55	insG	1
2743920170	SSX2B	X	6	35	insC	3
2745406637	WNK3	X	16	40	insA	3
2755460714	OPHN1	X	8	18	insC	3
2757668459	KIF4A	X	28	24	insG	3
2758547967	NONO	X	6	22	insT	3
2761842615	RLIM	X	3	18	insG	3
2771580011	HDX	X	5	18	insA	3
2779112744	PCDH11X	X	2	18	insT	3
2788398590	CENPI	X	20	19	insC	3
2789376503	TCEAL6	X	1	24	insG	2
2789554171	NXF2	X	7	14	insT	3
2789554906	NXF2	X	10	29	insA	3
2802179110	IL13RA2	X	4	18	insT	3
2823639589	ARHGEF6	X	18	16	insA	3
2840930428[a]	LCAP	X	1	57	insC	2
2841794077	MPP1	X	7	14	insG	3

[a]These indels commonly occurred in more than one HCC.

Supplementary Table 6. List of 81 Nucleotide Positions in 77 Genes With Indels at a Frequency of >20% of Reads in 4 Nontumorous Tissues From 4 Patients

Reference position	Gene	Chromosome	Coding sequence	Coverage	Allele change	Patient no.
36247083	THRAP3	1	4	18	delG	1
75174421	SLC44A5	1	16	19	delT	1
114430296	TRIM33	1	20	23	delC	1
133132499	YY1AP1	1	7	37	insT	1
133844355	RHBG	1	9	48	delC	4
201121914	CAPN2	1	3	14	delC	1
201173637	TP53BP2	1	13	22	delG	1
247664301	C2orf43	2	4	18	delA	2
319394229	SNRNP200	2	37	20	delA	1
322653290	AFF3	2	14	35	delA	1
331834049	RANBP2	2	20	16	delG	1
332901065	RGPD5	2	20	22	delT	1
374789589	NEB	2	4	37	insT	4
382950536	LY75	2	5	19	delA	4
401635744	TTN	2	274	25	delA	1
409835043	FAM171B	2	8	17	delT	1
412064501	COL3A1	2	14	21	insA	4
454784716	PTMA	2	4	14	delT	1
463724350[a]	AQP12B	2	1	27	delC	3
463734336	AQP12A	2	2	14	delG	2
503335742	DLEC1	3	4	20	delT	1
503335743	DLEC1	3	4	20	delA	1
735406533	CNOT6L	4	10	21	delG	1
785877214	LARP2	4	14	23	delA	1
798021293	SCOC	4	1	18	insC	1
810971969	TRIM2	4	5	18	delC	1
883256725	PRLR	5	3	29	delG	4
939146286	ANKRD32	5	16	15	insC	1
985314450[a]	LOC100288105	5	1	27	delC	3
1033746568	BMP6	6	5	24	delC	1
1068664364	KIAA0240	6	4	17	insT	4
1193244025	FAM120B	6	1	43	insA	1
1222659823	KIAA0644	7	1	463	delC	4
1282877394	CDK6	7	3	21	delA	1
1289880816	CYP3A4	7	12	45	delG	1
1333766765	LOC441294	7	1	13	delA	4
1340012514	SSPO	7	76	53	delA	3
1356372261	XKR5	8	6	130	delA	4
1490189877[a]	JRK	8	1	29	delC	3
1490189878[a]	JRK	8	1	15	delA	2
1492082552[a]	RECQL4	8	14	43	delG	3
1505961686	MPDZ	9	2	28	insG	4
1526015264	NFX1	9	3	36	delT	1
1573925487	GABBR2	9	17	59	insT	4
1580509237	ABCA1	9	4	24	insT	1
1637516682	ARMC3	10	18	19	delT	1
1637516683	ARMC3	10	18	19	delT	1
1657313100[a]	AGAP4	10	7	19	delT	2
1657313101[a]	AGAP4	10	7	14	delT	3
1807397040	SYVN1	11	7	15	insA	1
1832107207	LOC642446	11	1	18	delT	4
1855967268	ZW10	11	8	40	delC	1
1861246651	SLC37A4	11	3	143	delC	4
1884320486	ATN1	12	4	15	delA	1
1929584670	KIAA0748	12	6	31	delC	4
1955959709	PPFIA2	12	18	52	delA	4
1994379801	CIT	12	17	28	delG	1
1995110709	DYNLL1	12	2	14	delG	1
1997144069	KNTC1	12	2	31	delC	4
2105624179	RNASE4	14	1	15	delC	1