

ORIGINAL ARTICLE

Identification of Long Non-Coding RNAs for Predicting Prognosis Among Patients with Thymoma

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SUMMARY

Background: Thymoma is the most common primary anterior mediastinal neoplasm with a high recurrence rate. Long noncoding RNAs (lncRNAs) have recently been indicated to be used as diagnostic and prognostic indicators for different cancers. The aim of this study was to identify new tumor-specific prognostic lncRNA markers that can improve the treatment and follow-up of patients with thymomas.

Methods: One hundred seventeen thymoma patients with clinical information and level 3 RNAseqv2 data were downloaded from The Cancer Genome Atlas. Prognostic lncRNAs were identified using Kaplan-Meier survival analyses and univariate Cox proportional hazards regression analyses. A predictive risk scoring model was subsequently created using independently significant lncRNAs from a multivariate Cox regression analysis.

Results: Masaoka stage and 13 lncRNAs were significantly associated with RFS among 117 thymoma patients, while 59 lncRNAs were significantly associated with OS (all $p < 0.05$). Multivariate analyses revealed that OS was only independently associated with one lncRNA (JPX) and that RFS was only independently associated with three lncRNAs (AFAP1-AS1, LINC00324, and VLDLR-AS1). A risk score model constructed by the three lncRNA expressions showed that the high-risk group was more likely to experience recurrence.

Conclusions: The expression profile for three lncRNAs (AFAP1-AS1, LINC00324, and VLDLR-AS1) could be used to independently predict RFS among thymoma patients, which may be as prognostic biomarkers for thymoma.

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Supplementary Tables and Figures.

Table 1. Annotated lincRNA genes of TCGA dataset.

Gene_ID	Ensemble_ID	Gene_name	Type
404744	ENSG00000197085	NPSR1-AS1	processed_transcript
1E+08	ENSG00000268066	FMR1-AS1	processed_transcript
29994	ENSG00000226266	AC009961.1	lincRNA
400500	ENSG00000262117	BCAR4	lincRNA
497258	ENSG00000245573	BDNF-AS	antisense_RNA
729096	ENSG00000271816	BMS1P4	processed_transcript
60467	ENSG00000232416	BPESC1	lincRNA
55853	ENSG00000232656	IDI2-AS1	antisense_RNA
283025	ENSG00000235931	LINC01553	lincRNA
1E+08	ENSG00000237149	ZNF503-AS2	antisense_RNA
90271	ENSG00000235823	OLMALINC	lincRNA
283303	ENSG00000236301	MRGPRG-AS1	antisense_RNA
283197	ENSG00000181995	LINC00301	lincRNA
283460	ENSG00000241388	HNF1A-AS1	processed_transcript
283422	ENSG00000180861	LINC01559	lincRNA
51275	ENSG00000234608	MAPKAPK5-AS1	lincRNA
283416	ENSG00000221949	LINC01465	lincRNA
283487	ENSG00000255874	LINC00346	lincRNA
55449	ENSG00000215256	DHRS4-AS1	antisense_RNA
283551	ENSG00000214900	LINC01588	lincRNA
387978	ENSG00000186960	LINC01551	lincRNA
1E+08	ENSG00000186615	KTN1-AS1	antisense_RNA
388011	ENSG00000246223	LINC01550	lincRNA
283601	ENSG00000196273	LINC00523	lincRNA
145200	ENSG00000258512	LINC00239	lincRNA
283592	ENSG00000258584	FAM181A-AS1	antisense_RNA
80072	ENSG00000260339	HEXA-AS1	antisense_RNA
414926	ENSG00000259703	LINC00593	lincRNA
283860	ENSG00000180422	LINC00304	lincRNA
284029	ENSG00000178977	LINC00324	lincRNA
339201	ENSG00000267080	ASB16-AS1	antisense_RNA
654434	ENSG00000234912	SNHG20	processed_transcript
23591	ENSG00000267496	FAM215A	lincRNA
84981	ENSG00000186594	MIR22HG	lincRNA
221241	ENSG00000179676	LINC00305	lincRNA
284424	ENSG00000176840	MIR7-3HG	lincRNA
255193	ENSG00000180846	CSNK1G2-AS1	antisense_RNA
200197	ENSG00000175147	TMEM51-AS1	antisense_RNA
574036	ENSG00000203706	SERTAD4-AS1	antisense_RNA
284573	ENSG00000176754	LINC00303	lincRNA
439927	ENSG00000180869	LINC01555	lincRNA
644997	ENSG00000179840	PIK3CD-AS1	antisense_RNA
84852	ENSG00000203865	ATP1A1-AS1	processed_transcript

Table 1. Annotated lncRNA genes of TCGA dataset (continued).

Gene_ID	Ensemble_ID	Gene_name	Type
148898	ENSG00000249087	ZNF436-AS1	antisense_RNA
400798	ENSG00000213057	C1orf220	lincRNA
441951	ENSG00000177410	ZFAS1	antisense_RNA
140828	ENSG00000259974	LINC00261	lincRNA
84996	ENSG00000256073	URB1-AS1	lincRNA
150142	ENSG00000237232	ZNF295-AS1	lincRNA
150147	ENSG00000184385	UMODL1-AS1	sense_overlapping
150135	ENSG00000236384	LINC00479	lincRNA
284835	ENSG00000226496	LINC00323	antisense_RNA
387486	ENSG00000224924	LINC00320	lincRNA
728409	ENSG00000229086	LINC01548	lincRNA
84536	ENSG00000183250	LINC01547	lincRNA
282566	ENSG00000260583	AP000223.1	antisense_RNA
114036	ENSG00000227456	LINC00310	lincRNA
114038	ENSG00000185186	LINC00313	lincRNA
114041	ENSG00000184809	B3GALT5-AS1	antisense_RNA
246705	ENSG00000178457	LINC00314	lincRNA
25775	ENSG00000128254	C22orf24	processed_transcript
150291	ENSG00000235989	MORC2-AS1	antisense_RNA
348645	ENSG00000188511	C22orf34	lincRNA
646023	ENSG00000178803	ADORA2A-AS1	antisense_RNA
151477	ENSG00000181798	LINC00471	lincRNA
285154	ENSG00000232973	CYP1B1-AS1	antisense_RNA
23434	ENSG00000198685	LINC01565	lincRNA
84657	ENSG00000231177	LINC00852	antisense_RNA
711	ENSG00000281708	ERC2-IT1	sense_intronic
646600	ENSG00000163915	IGF2BP2-AS1	antisense_RNA
677779	ENSG00000214381	LINC00488	lincRNA
317648	ENSG00000249673	NOP14-AS1	antisense_RNA
439934	ENSG00000231782	LINC00575	lincRNA
404201	ENSG00000180769	WDFY3-AS2	processed_transcript
152641	ENSG00000251359	WWC2-AS2	lincRNA
10141	ENSG00000082929	LINC01587	processed_transcript
202299	ENSG00000236882	LINC01554	lincRNA
116349	ENSG00000221990	EXOC3-AS1	antisense_RNA
401288	ENSG00000229214	LINC00242	lincRNA
26238	ENSG00000146521	LINC01558	lincRNA
653483	ENSG00000198221	AFDN-AS1	lincRNA
90632	ENSG00000223414	LINC00473	lincRNA
154386	ENSG00000164385	LINC01600	lincRNA
80069	ENSG00000231690	LINC00574	lincRNA
1E+08	ENSG00000231028	LINC00271	lincRNA
401253	ENSG00000197251	LINC00336	lincRNA
1E+08	ENSG00000224843	LINC00240	lincRNA

Table 1. Annotated lncRNA genes of TCGA dataset (continued).

Gene_ID	Ensemble_ID	Gene_name	Type
79992	ENSG00000279355	AGPAT4-IT1	TEC
129790	ENSG00000182648	LINC01006	lincRNA
285958	ENSG00000232956	SNHG15	lincRNA
64433	ENSG00000279418	LINC00244	lincRNA
27099	ENSG00000279078	SND1-IT1	lincRNA
83656	ENSG00000184608	FAM167A-AS1	antisense_RNA
286122	ENSG00000177335	C8orf31	processed_transcript
55472	ENSG00000279331	RBM12B-AS1	TEC
78998	ENSG00000254389	RHPN1-AS1	antisense_RNA
157556	ENSG00000236939	BAALC-AS2	antisense_RNA
26138	ENSG00000215117	LINC00588	lincRNA
619351	ENSG00000251191	LINC00589	lincRNA
286103	ENSG00000255559	ZNF252P-AS1	antisense_RNA
286333	ENSG00000231528	FAM225A	lincRNA
1E+08	ENSG00000225684	FAM225B	lincRNA
1E+08	ENSG00000175611	LINC00476	processed_transcript
85026	ENSG00000203993	ARRDC1-AS1	antisense_RNA
81571	ENSG00000236901	MIR600HG	sense_intronic
84850	ENSG00000237009	GLIS3-AS1	antisense_RNA
255082	ENSG00000177640	CASC2	antisense_RNA
1E+08	ENSG00000240498	CDKN2B-AS1	antisense_RNA
1E+08	ENSG00000185837	HDHD5-AS1	antisense_RNA
116828	ENSG00000281026	N4BP2L2-IT2	sense_intronic
116933	ENSG00000239265	CLRN1-AS1	antisense_RNA
150384	ENSG00000277232	GTSE1-AS1	lincRNA
11068	ENSG00000271858	CYB561D2	antisense_RNA
25786	ENSG00000273311	DGCR11	sense_intronic
26220	ENSG00000283406	DGCR5	processed_transcript
25787	ENSG00000273032	DGCR9	lincRNA
653645	ENSG00000267104	TBC1D3P1-DHX40P1	processed_transcript
26077	ENSG00000261439	DKFZP434H168	antisense_RNA
26070	ENSG00000124915	DKFZP434K028	lincRNA
26082	ENSG00000225930	LINC02249	lincRNA
93429	ENSG00000268460	AC006262.1	processed_transcript
374387	ENSG00000205106	DKFZp779M0652	lincRNA
10301	ENSG00000176124	DLEU1	processed_transcript
259234	ENSG00000233316	DSCR10	sense_intronic
257203	ENSG00000230366	DSCR9	lincRNA
29940	ENSG00000240050	AL590542.1	lincRNA
1E+08	ENSG00000235947	EGOT	lincRNA
114794	ENSG00000243902	ELFN2	sense_overlapping
196047	ENSG00000229847	EMX2OS	antisense_RNA
654412	ENSG00000226516	FAM138B	lincRNA
677784	ENSG00000249054	FAM138D	lincRNA

Table 1. Annotated lncRNA genes of TCGA dataset (continued).

Gene_ID	Ensemble_ID	Gene_name	Type
1E+08	ENSG00000248893	FAM138E	lincRNA
641702	ENSG00000282591	FAM138F	lincRNA
285512	ENSG00000248019	FAM13A-AS1	antisense_RNA
284800	ENSG00000125804	FAM182A	processed_transcript
1E+08	ENSG00000154537	FAM27C	lincRNA
284123	ENSG00000178130	FAM27E5	lincRNA
284593	ENSG00000230368	FAM41C	lincRNA
26240	ENSG00000238158	AL391422.2	sense_overlapping
440078	ENSG00000226711	FAM66C	antisense_RNA
1E+08	ENSG00000225725	FAM66E	lincRNA
401507	ENSG00000215112	FAM74A1	lincRNA
1E+08	ENSG00000223839	FAM95B1	lincRNA
387742	ENSG00000205866	FAM99A	lincRNA
1E+08	ENSG00000205865	FAM99B	antisense_RNA
54508	ENSG00000278921	EPB41L4A-AS2	lincRNA
440101	ENSG00000248265	FLJ12825	lincRNA
79667	ENSG00000231160	KLF3-AS1	processed_transcript
79857	ENSG00000177340	FLJ13224	antisense_RNA
1E+08	ENSG00000275620	FLJ16779	antisense_RNA
401237	ENSG00000272168	CASC15	lincRNA
148231	ENSG00000167459	LINC00905	processed_transcript
401082	ENSG00000228980	LINC01205	lincRNA
400710	ENSG00000204666	AC010624.1	sense_overlapping
146512	ENSG00000280278	FLJ30679	TEC
150538	ENSG00000225953	SATB2-AS1	antisense_RNA
401172	ENSG00000250490	LINC02145	lincRNA
644873	ENSG00000245937	LINC01184	lincRNA
285759	ENSG00000175967	FO393415.1	antisense_RNA
401491	ENSG00000236404	VLDLR-AS1	antisense_RNA
284124	ENSG00000276399	FLJ36000	lincRNA
729614	ENSG00000179743	FLJ37453	antisense_RNA
285668	ENSG00000178722	C5orf64	processed_transcript
439931	ENSG00000230513	THAP7-AS1	antisense_RNA
1E+08	ENSG00000223764	AL645608.1	lincRNA
202020	ENSG00000263327	TAPT1-AS1	antisense_RNA
388685	ENSG00000274020	LINC01138	processed_transcript
285962	ENSG00000228775	WEE2-AS1	antisense_RNA
1E+08	ENSG00000235295	LINC01634	lincRNA
388182	ENSG00000189419	SPATA41	lincRNA
401105	ENSG00000279891	FLJ42393	TEC
441094	ENSG00000237187	NR2F1-AS1	antisense_RNA
440556	ENSG00000177133	LINC00982	antisense_RNA
378805	ENSG00000231721	LINC-PINT	antisense_RNA
400624	ENSG00000204283	LINC01973	lincRNA

Table 1. Annotated lncRNA genes of TCGA dataset (continued).

Gene_ID	Ensemble_ID	Gene_name	Type
400242	ENSG00000235706	DICER1-AS1	antisense_RNA
399717	ENSG00000197308	GATA3-AS1	lincRNA
440465	ENSG00000226137	BAIAP2-AS1	lincRNA
60674	ENSG00000234741	GAS5	processed_transcript
118425	ENSG00000251321	PCAT4	lincRNA
1E+08	ENSG00000240288	GHRLOS	antisense_RNA
149775	ENSG00000235590	GNAS-AS1	antisense_RNA
283120	ENSG00000130600	H19	processed_transcript
768097	ENSG00000231133	HAR1B	lincRNA
493812	ENSG00000228223	HCG11	lincRNA
285834	ENSG00000228789	HCG22	lincRNA
253018	ENSG00000206344	HCG27	lincRNA
10255	ENSG00000204625	HCG9	lincRNA
10866	ENSG00000206337	HCP5	sense_overlapping
790952	ENSG00000265992	ESRG	sense_intronic
1E+08	ENSG00000228630	HOTAIR	antisense_RNA
221883	ENSG00000240990	HOXA11-AS	antisense_RNA
3222	ENSG00000273046	AC012531.2	processed_transcript
93668	ENSG00000253521	HPYR1	lincRNA
283902	ENSG00000260880	HCCAT5	lincRNA
728655	ENSG00000251164	HULC	lincRNA
57061	ENSG00000283122	HYMAI	non_coding
51214	ENSG00000099869	IGF2-AS	antisense_RNA
8552	ENSG00000224975	INE1	sense_intronic
8551	ENSG00000281371	INE2	antisense_RNA
641516	ENSG00000267313	KC6	lincRNA
55539	ENSG00000237941	KCNQ1DN	antisense_RNA
10984	ENSG00000269821	KCNQ1OT1	antisense_RNA
9808	ENSG00000122548	KIAA0087	lincRNA
57291	ENSG00000226950	DANCR	processed_transcript
9834	ENSG00000226777	FAM30A	lincRNA
57653	ENSG00000255036	AL512590.3	processed_transcript
114796	ENSG00000230487	PSMG3-AS1	lincRNA
64788	ENSG00000260807	AC009041.2	lincRNA
1E+08	ENSG00000256628	ZBTB11-AS1	antisense_RNA
1E+08	ENSG00000232803	SLCO4A1-AS1	antisense_RNA
1E+08	ENSG00000239219	AC008040.1	antisense_RNA
1E+08	ENSG00000257167	TMPO-AS1	antisense_RNA
1E+08	ENSG00000204241	AP000911.1	lincRNA
1E+08	ENSG00000214043	LINC02347	lincRNA
1E+08	ENSG00000229589	ACVR2B-AS1	antisense_RNA
1E+08	ENSG00000227392	HPN-AS1	antisense_RNA
1E+08	ENSG00000205913	SRRM2-AS1	antisense_RNA
1E+08	ENSG00000233642	GPR158-AS1	antisense_RNA

Table 1. Annotated lncRNA genes of TCGA dataset (continued).

Gene_ID	Ensemble_ID	Gene_name	Type
1E+08	ENSG00000261455	LINC01003	lincRNA
1E+08	ENSG00000237372	UNQ6494	lincRNA
1E+08	ENSG00000273033	LINC02035	lincRNA
1E+08	ENSG00000281357	ARRDC3-AS1	lincRNA
1E+08	ENSG00000279873	LINC01126	lincRNA
1E+08	ENSG00000279685	MAPT-IT1	sense_intronic
1E+08	ENSG00000179447	AL049647.1	antisense_RNA
1E+08	ENSG00000237250	AL359924.1	antisense_RNA
1E+08	ENSG00000279770	LINC00552	TEC
1E+08	ENSG00000267270	PARD6G-AS1	antisense_RNA
1E+08	ENSG00000188825	LINC00910	lincRNA
1E+08	ENSG00000213963	AC019080.1	sense_overlapping
1E+08	ENSG00000255737	AGAP2-AS1	antisense_RNA
1E+08	ENSG00000228544	CCDC183-AS1	antisense_RNA
1E+08	ENSG00000241769	LINC00893	antisense_RNA
1E+08	ENSG00000267882	AL031666.2	antisense_RNA
1E+08	ENSG00000214145	LINC00887	lincRNA
1E+08	ENSG00000267858	MZF1-AS1	antisense_RNA
1E+08	ENSG00000204949	FAM83A-AS1	antisense_RNA
1E+08	ENSG00000231609	AC009501.1	antisense_RNA
1E+08	ENSG00000214106	PAXIP1-AS2	antisense_RNA
1E+08	ENSG00000226416	MRPL23-AS1	antisense_RNA
1E+08	ENSG00000236423	LINC01134	lincRNA
1E+08	ENSG00000267064	UXT-AS1	antisense_RNA
1E+08	ENSG00000231327	LINC01816	lincRNA
1E+08	ENSG00000267278	MAP3K14-AS1	antisense_RNA
1E+08	ENSG00000260231	JHDM1D-AS1	antisense_RNA
1E+08	ENSG00000239332	LINC01119	lincRNA
1E+08	ENSG00000240889	NDUFB2-AS1	antisense_RNA
1E+08	ENSG00000205559	CHKB-AS1	antisense_RNA
1E+08	ENSG00000258647	LINC00930	lincRNA
1E+08	ENSG00000237675	TEX36-AS1	antisense_RNA
1E+08	ENSG00000238121	LINC00426	lincRNA
1E+08	ENSG00000237737	DCTN1-AS1	antisense_RNA
1E+08	ENSG00000197291	RAMP2-AS1	lincRNA
1E+08	ENSG00000214039	LINC02418	lincRNA
1E+08	ENSG00000253661	ZFH4-AS1	antisense_RNA
1E+08	ENSG00000226757	PP12613	antisense_RNA
1E+08	ENSG00000266149	AP001094.3	antisense_RNA
1E+08	ENSG00000231298	LINC00704	lincRNA
1E+08	ENSG00000247774	PCED1B-AS1	processed_transcript
1E+08	ENSG00000204758	AC008429.1	antisense_RNA
1E+08	ENSG00000235703	LINC00894	antisense_RNA
1E+08	ENSG00000258057	BCDIN3D-AS1	antisense_RNA

Table 1. Annotated lncRNA genes of TCGA dataset (continued).

Gene_ID	Ensemble_ID	Gene_name	Type
1E+08	ENSG00000230000	AC006455.5	processed_transcript
1E+08	ENSG00000268996	MAN1B1-AS1	antisense_RNA
1E+08	ENSG00000224687	RASAL2-AS1	lincRNA
1E+08	ENSG00000242759	LINC00882	lincRNA
1E+08	ENSG00000224281	SLC25A5-AS1	processed_transcript
116437	ENSG00000204603	LINC01257	lincRNA
126536	ENSG00000205396	LINC00661	processed_transcript
127841	ENSG00000280924	LINC00628	lincRNA
144486	ENSG00000278916	CEP83-AS1	lincRNA
144571	ENSG00000245105	A2M-AS1	antisense_RNA
144742	ENSG00000281196	LINC00934	lincRNA
144776	ENSG00000231674	LINC00410	lincRNA
145820	ENSG00000259134	LINC00924	lincRNA
146336	ENSG00000261713	SSTR5-AS1	processed_transcript
147727	ENSG00000267100	ILF3-AS1	lincRNA
148145	ENSG00000267339	LINC00906	lincRNA
148189	ENSG00000261824	LINC00662	lincRNA
148413	ENSG00000224870	AL391244.1	processed_transcript
149837	ENSG00000205181	LINC00654	lincRNA
150197	ENSG00000236499	LINC00896	lincRNA
150568	ENSG00000235597	LINC01102	lincRNA
151174	ENSG00000186235	AC016757.1	processed_transcript
151534	ENSG00000257702	LBX2-AS1	antisense_RNA
151658	ENSG00000241469	LINC00635	lincRNA
152024	ENSG00000224074	LINC00691	lincRNA
152225	ENSG00000214407	LINC02085	lincRNA
153684	ENSG00000215068	AC025171.2	antisense_RNA
153910	ENSG00000236366	AL359313.1	lincRNA
154449	ENSG00000230960	AL109910.1	antisense_RNA
154822	ENSG00000231419	LINC00689	processed_transcript
157381	ENSG00000249816	LINC00964	lincRNA
157627	ENSG00000253230	LINC00599	lincRNA
158572	ENSG00000234390	USP27X-AS1	lincRNA
202781	ENSG00000273344	PAXIP1-AS1	lincRNA
221122	ENSG00000254654	AC068858.1	lincRNA
254312	ENSG00000229240	LINC00710	processed_transcript
254559	ENSG00000255571	MIR9-3HG	lincRNA
255025	ENSG00000239589	LINC00879	lincRNA
255167	ENSG00000250056	LINC01018	lincRNA
256880	ENSG00000245322	AC097460.1	antisense_RNA
25845	ENSG00000188242	PP7080	antisense_RNA
26102	ENSG00000262075	DKFZP434A062	lincRNA
283050	ENSG00000224596	ZMIZ1-AS1	antisense_RNA
283174	ENSG00000280237	MIR4697HG	TEC

Table 1. Annotated lncRNA genes of TCGA dataset (continued).

Gene_ID	Ensemble_ID	Gene_name	Type
283267	ENSG00000280798	LINC00294	lincRNA
283314	ENSG00000205885	C1RL-AS1	antisense_RNA
283332	ENSG00000258135	LINC02396	lincRNA
283392	ENSG00000236333	TRHDE-AS1	processed_transcript
283404	ENSG00000258279	LINC00592	lincRNA
283663	ENSG00000247982	LINC00926	lincRNA
283731	ENSG00000248540	AC010931.2	lincRNA
283856	ENSG00000246379	AC007495.1	lincRNA
283867	ENSG00000261742	LINC00922	lincRNA
283914	ENSG00000259841	LINC01566	lincRNA
284276	ENSG00000263812	LINC00908	lincRNA
284632	ENSG00000230023	AL590683.1	lincRNA
284661	ENSG00000235054	LINC01777	lincRNA
284688	ENSG00000224286	LINC01142	lincRNA
284749	ENSG00000235621	LINC00494	lincRNA
284788	ENSG00000204684	AL133464.1	lincRNA
284798	ENSG00000230725	AL035252.2	lincRNA
284837	ENSG00000215458	AATBC	antisense_RNA
284900	ENSG00000235954	TTC28-AS1	processed_transcript
285045	ENSG00000230876	LINC00486	lincRNA
285205	ENSG00000240423	LINC00636	lincRNA
285370	ENSG00000226567	LINC00606	lincRNA
285375	ENSG00000224514	LINC00620	antisense_RNA
285401	ENSG00000244342	LINC00698	lincRNA
285419	ENSG00000249464	LINC01091	lincRNA
285456	ENSG00000234492	RPL34-AS1	lincRNA
285501	ENSG00000231171	LINC01098	lincRNA
285593	ENSG00000253955	AC008663.2	antisense_RNA
285627	ENSG00000253298	LINC01845	lincRNA
285629	ENSG00000253417	LINC02159	lincRNA
285692	ENSG00000249781	LINC02112	lincRNA
285696	ENSG00000215196	AC026790.1	antisense_RNA
285740	ENSG00000235740	PHACTR2-AS1	antisense_RNA
285780	ENSG00000216863	LY86-AS1	antisense_RNA
285796	ENSG00000281692	PACRG-AS1	antisense_RNA
285830	ENSG00000214922	HLA-F-AS1	processed_transcript
285954	ENSG00000224116	INHBA-AS1	antisense_RNA
286094	ENSG00000254083	LINC01591	lincRNA
286135	ENSG00000253279	LINC02209	lincRNA
286238	ENSG00000228189	AL592486.1	lincRNA
286467	ENSG00000213468	FIRRE	lincRNA
29034	ENSG00000280837	CPS1-IT1	sense_intronic
338651	ENSG00000233930	KRTAP5-AS1	antisense_RNA
338758	ENSG00000271614	ATP2B1-AS1	lincRNA

Table 1. Annotated lncRNA genes of TCGA dataset (continued).

Gene_ID	Ensemble_ID	Gene_name	Type
338799	ENSG00000212694	LINC01089	lincRNA
339290	ENSG00000263753	LINC00667	lincRNA
339524	ENSG00000267272	LINC01140	lincRNA
339535	ENSG00000215808	LINC01139	lincRNA
339568	ENSG00000230324	LINC01734	lincRNA
339788	ENSG00000235665	LINC00298	lincRNA
340017	ENSG00000234111	LINC02433	lincRNA
340074	ENSG00000251045	LINC01959	lincRNA
340094	ENSG00000215231	LINC01020	lincRNA
340357	ENSG00000254813	AC123777.1	lincRNA
344595	ENSG00000243701	DUBR	lincRNA
348021	ENSG00000232685	LINC00442	antisense_RNA
388387	ENSG00000213373	LINC00671	lincRNA
388796	ENSG00000196756	SNHG17	processed_transcript
389458	ENSG00000273313	RBAKDN	lincRNA
389634	ENSG00000226091	LINC00937	lincRNA
389791	ENSG00000232850	PTGES2-AS1	lincRNA
400043	ENSG00000250742	LINC02381	lincRNA
400657	ENSG00000264247	LINC00909	lincRNA
400752	ENSG00000281912	LINC01144	lincRNA
400794	ENSG00000237463	AL157714.2	antisense_RNA
400804	ENSG00000234754	C1orf140	lincRNA
400931	ENSG00000197182	MIRLET7BHG	lincRNA
401093	ENSG00000229619	MBNL1-AS1	antisense_RNA
401431	ENSG00000204934	ATP6V0E2-AS1	antisense_RNA
401463	ENSG00000254102	AC090136.3	antisense_RNA
401588	ENSG00000230844	ZNF674-AS1	lincRNA
440173	ENSG00000269994	AL513318.2	lincRNA
440925	ENSG00000222033	LINC01124	lincRNA
440944	ENSG00000206573	THUMP3-AS1	antisense_RNA
441177	ENSG00000281832	LINC00602	lincRNA
541471	ENSG00000172965	MIR4435-2HG	lincRNA
550112	ENSG00000248049	UBA6-AS1	antisense_RNA
572558	ENSG00000224958	PGM5-AS1	antisense_RNA
642929	ENSG00000278849	AL513478.2	lincRNA
643763	ENSG00000274956	UG0898H09	lincRNA
643837	ENSG00000228794	LINC01128	processed_transcript
645323	ENSG00000245526	LINC00461	lincRNA
646982	ENSG00000215483	LINC00598	lincRNA
647946	ENSG00000267374	AC016205.1	lincRNA
647979	ENSG00000260032	NORAD	lincRNA
648691	ENSG00000220891	LL22NC03-63E9.3	antisense_RNA
654433	ENSG00000189223	PAX8-AS1	processed_transcript
678655	ENSG00000215039	CD27-AS1	processed_transcript

Table 1. Annotated lncRNA genes of TCGA dataset (continued).

Gene_ID	Ensemble_ID	Gene_name	Type
723809	ENSG00000225329	LHFPL3-AS2	processed_transcript
727677	ENSG00000246228	CASC8	antisense_RNA
727924	ENSG00000280709	LINC02203	lincRNA
728190	ENSG00000223482	NUTM2A-AS1	antisense_RNA
728606	ENSG00000265369	PCAT18	lincRNA
729121	ENSG00000230651	RGPD4-AS1	lincRNA
729467	ENSG00000224609	HSD52	processed_transcript
729678	ENSG00000245060	LINC00847	lincRNA
730668	ENSG00000280424	BX537318.2	TEC
730811	ENSG00000225619	MYT1L-AS1	antisense_RNA
731779	ENSG00000253595	LINC01300	antisense_RNA
732275	ENSG00000168367	LINC00917	lincRNA
80054	ENSG00000267296	CEBPA-AS1	antisense_RNA
84740	ENSG00000272620	AFAP1-AS1	antisense_RNA
84856	ENSG00000185904	LINC00839	lincRNA
84931	ENSG00000280409	LINC01101	TEC
84989	ENSG00000272767	JMJD1C-AS1	antisense_RNA
91149	ENSG00000228016	RAPGEF4-AS1	antisense_RNA
91316	ENSG00000228315	GUSBP11	processed_transcript
91948	ENSG00000251209	LINC00923	lincRNA
92249	ENSG00000235437	LINC01278	processed_transcript
92659	ENSG00000265688	MAFG-AS1	antisense_RNA
93622	ENSG00000170846	AC093323.1	lincRNA
503693	ENSG00000205791	LOH12CR2	lincRNA
642946	ENSG00000198468	FLVCR1-AS1	lincRNA
114044	ENSG00000215424	MCM3AP-AS1	antisense_RNA
55384	ENSG00000214548	MEG3	lincRNA
84815	ENSG00000266709	AC005224.4	lincRNA
84793	ENSG00000237424	FOXD2-AS1	antisense_RNA
84983	ENSG00000255650	FAM222A-AS1	antisense_RNA
197003	ENSG00000259458	MGC15885	antisense_RNA
84848	ENSG00000223749	MIR503HG	lincRNA
85001	ENSG00000246731	MGC16275	antisense_RNA
113691	ENSG00000161149	TUBA3FP	processed_transcript
389741	ENSG00000278175	GLIDR	lincRNA
196872	ENSG00000258701	LINC00638	lincRNA
197187	ENSG00000260630	SNAI3-AS1	antisense_RNA
149047	ENSG00000237413	MGC27382	processed_transcript
79100	ENSG00000225826	LINC00626	lincRNA
440823	ENSG00000225783	MIAT	lincRNA
1E+08	ENSG00000268654	MIMT1	lincRNA
114614	ENSG00000234883	MIR155HG	lincRNA
407975	ENSG00000215417	MIR17HG	processed_transcript
10408	ENSG00000233718	MYCNOS	antisense_RNA

Table 1. Annotated lncRNA genes of TCGA dataset (continued).

Gene_ID	Ensemble_ID	Gene_name	Type
79804	ENSG00000237125	HAND2-AS1	antisense_RNA
140875	ENSG00000233354	LINC00028	lincRNA
619434	ENSG00000254008	LINC00051	antisense_RNA
145978	ENSG00000259527	LINC00052	lincRNA
1E+08	ENSG00000225194	LINC00092	lincRNA
283932	ENSG00000260852	FBXL19-AS1	antisense_RNA
359822	ENSG00000280650	KCNIP4-IT1	lincRNA
54089	ENSG00000232401	LINC00112	antisense_RNA
54088	ENSG00000225298	LINC00113	lincRNA
400866	ENSG00000223806	LINC00114	lincRNA
79854	ENSG00000225880	LINC00115	lincRNA
348808	ENSG00000248724	NPHP3-AS1	antisense_RNA
112597	ENSG00000222041	CYTOR	lincRNA
54072	ENSG00000185433	LINC00158	lincRNA
54064	ENSG00000230978	LINC00160	lincRNA
118421	ENSG00000226935	LINC00161	lincRNA
378825	ENSG00000275874	PICRAR	lincRNA
1E+08	ENSG00000196668	LINC00173	processed_transcript
285908	ENSG00000179406	LINC00174	processed_transcript
378832	ENSG00000183535	COL18A1-AS1	antisense_RNA
503538	ENSG00000268895	A1BG-AS1	antisense_RNA
1E+08	ENSG00000230590	FTX	lincRNA
554203	ENSG00000225470	JPX	lincRNA
125144	ENSG00000175061	LRRC75A-AS1	processed_transcript
193629	ENSG00000215533	LINC00189	sense_overlapping
399706	ENSG00000229205	LINC00200	lincRNA
319085	ENSG00000258730	ITPK1-AS1	antisense_RNA
286967	ENSG00000272681	FAM223B	lincRNA
388910	ENSG00000187012	LINC00207	lincRNA
283131	ENSG00000245532	NEAT1	lincRNA
1E+08	ENSG00000225391	NHEG1	lincRNA
145624	ENSG00000279050	PWAR1	TEC
8123	ENSG00000279192	PWAR5	TEC
25859	ENSG00000152931	PART1	lincRNA
50652	ENSG00000225937	PCA3	antisense_RNA
64002	ENSG00000227418	PCGEM1	lincRNA
283970	ENSG00000196696	PDXDC2P-NPIP14P	processed_transcript
441263	ENSG00000265479	DTX2P1-UPK3BP1-PMS2P11	processed_transcript
84820	ENSG00000214783	POLR2J4	processed_transcript
29018	ENSG00000259073	FOXN3-AS2	antisense_RNA
1E+08	ENSG00000204528	PSORS1C3	sense_intronic
5820	ENSG00000249859	PVT1	lincRNA
791114	ENSG00000259905	PWRN1	lincRNA
8490	ENSG00000232995	RGS5	antisense_RNA

Table 1. Annotated lncRNA genes of TCGA dataset (continued).

Gene_ID	Ensemble_ID	Gene_name	Type
6023	ENSG00000269900	RMRP	lincRNA
196475	ENSG00000255794	RMST	processed_transcript
286411	ENSG00000203930	LINC00632	lincRNA
653390	ENSG00000103472	RRN3P2	processed_transcript
677769	ENSG00000267322	SNHG22	antisense_RNA
619383	ENSG00000254911	SCARNA9	antisense_RNA
727956	ENSG00000242086	LINC00969	lincRNA
94009	ENSG00000172250	SERHL	processed_transcript
207107	ENSG00000225383	SFTA1P	lincRNA
9597	ENSG00000164621	SMAD5-AS1	antisense_RNA
140771	ENSG00000226746	SMCR5	antisense_RNA
128439	ENSG00000174365	SNHG11	processed_transcript
85028	ENSG00000197989	SNHG12	antisense_RNA
23642	ENSG00000255717	SNHG1	processed_transcript
8420	ENSG00000242125	SNHG3	sense_intronic
387066	ENSG00000203875	SNHG5	processed_transcript
84973	ENSG00000233016	SNHG7	antisense_RNA
1E+08	ENSG00000269893	SNHG8	lincRNA
735301	ENSG00000255198	SNHG9	lincRNA
221178	ENSG00000228741	SPATA13	lincRNA
93653	ENSG00000227199	ST7-AS1	antisense_RNA
93654	ENSG00000226367	ST7-AS2	antisense_RNA
338069	ENSG00000214188	ST7-OT4	sense_intronic
7955	ENSG00000236548	RNF217-AS1	antisense_RNA
23118	ENSG00000228408	AL031056.1	lincRNA
27004	ENSG00000187621	TCL6	processed_transcript
1E+08	ENSG00000236311	TLX1NB	processed_transcript
283673	ENSG00000212766	EWSAT1	lincRNA
11257	ENSG00000182165	TP53TG1	lincRNA
9383	ENSG00000270641	TSIX	lincRNA
246119	ENSG00000229236	TTY10	lincRNA
83866	ENSG00000180910	TTY11	lincRNA
83867	ENSG00000237048	TTY12	lincRNA
83868	ENSG00000184991	TTY13	lincRNA
64595	ENSG00000233864	TTY15	lincRNA
252948	ENSG00000225520	TTY16	lincRNA
252949	ENSG00000228240	TTY17A	lincRNA
474151	ENSG00000227439	TTY17B	lincRNA
252950	ENSG00000233699	TTY18	lincRNA
252952	ENSG00000232419	TTY19	lincRNA
1E+08	ENSG00000129816	TTY1B	lincRNA
252951	ENSG00000232808	TTY20	antisense_RNA
252953	ENSG00000228890	TTY21	lincRNA
252954	ENSG00000224075	TTY22	lincRNA

Table 1. Annotated lincRNA genes of TCGA dataset (continued).

Gene_ID	Ensemble_ID	Gene_name	Type
252955	ENSG00000239225	TTY23	lincRNA
474148	ENSG00000280961	TTY3B	lincRNA
474150	ENSG00000228296	TTY4C	lincRNA
83863	ENSG00000215560	TTY5	lincRNA
441543	ENSG00000131548	TTY6B	antisense_RNA
84672	ENSG00000131538	TTY6	lincRNA
246122	ENSG00000147753	TTY7	lincRNA
84673	ENSG00000183385	TTY8	lincRNA
425057	ENSG00000131007	TTY9B	antisense_RNA
652995	ENSG00000214049	UCA1	processed_transcript
139538	ENSG00000259849	VENTXP1	lincRNA
51352	ENSG00000183242	WT1-AS	antisense_RNA
7503	ENSG00000229807	XIST	lincRNA
594840	ENSG00000248492	ZFAT-AS1	antisense_RNA

Table 2. Kaplan-Meier survival and univariate Cox proportional hazards regression analyses associated with PFS.

lincRNA	KM_p-value	Univariate Cox_p-value
LINC00324	0.028876228	0.036
ATP1A1-AS	0.044728391	<u>0.053</u>
AP000223.1	0.005279501	0.012
FLJ13224	0.040249749	0.048
VLDLR-AS1	0.021621749	0.029
LINC00887	0.041838475	0.051
AATBC	0.023428549	0.03
LINC02159	0.008391225	0.013
AC026790.1	0.021929982	0.03
LINC01139	0.036567595	0.045
LINC00909	0.018286484	0.024
MIRLET7BHG	0.027651181	0.036
AFAP1-AS1	0.001037149	0.003

Table 3. Kaplan-Meier survival and univariate Cox proportional hazards regression of lncRNAs associated with OS.

lncRNA	ID	KM_p-value	Univariate COX_p-value
ERC2-IT1	711	0.030914368	0.064
PVT1	5820	0.035781145	0.055
RGS5	8490	0.024995797	0.042
HCP5	10866	0.000882262	0.998
SNHG1	23642	0.016624622	0.045
C22orf24	25775	0.015312139	0.043
SND1-IT1	27099	0.013362346	0.04
EPB41L4A-AS2	54508	0.037474465	0.057
IDI2-AS1	55853	0.032577451	0.066
LINC00115	79854	0.023660122	0.055
LINC00852	84657	0.004369906	0.022
AFAP1-AS1	84740	0.014608365	0.042
FOXD2-AS1	84793	0.009860797	0.034
MIR503HG	84848	0.007756564	0.03
MIR22HG	84981	0.007526434	0.03
MGC16275	85001	0.004380788	0.022
SERHL	94009	0.03117061	0.064
TUBA3FP	113691	0.016227571	0.031
FLJ30679	146512	0.046024421	0.06
UMODL1-AS1	150147	0.005961198	0.026
AC025171.2	153684	0.000419918	0.998
LINC00689	154822	0.048664306	0.07
TMEM51-AS1	200197	0.010008053	0.022
HCG27	253018	0.001359552	0.998
CASC2	255082	0.012579422	0.026
LINC00494	284749	0.036363157	0.056
AL035252.2	284798	0.004233408	0.022
AATBC	284837	0.046933523	0.068
RPL34-AS1	285456	0.005206334	0.024
AC008663.2	285593	0.009069758	0.033
LINC00174	285908	0.011469643	0.037
FIRRE	286467	0.010545851	0.035
LINC01089	338799	0.008162681	0.03
LINC01550	388011	0.009857308	0.034
LINC00937	389634	0.035853884	0.07
LINC00909	400657	0.00096272	0.998
MBNL1-AS1	401093	0.007389003	0.03
CASC15	401237	0.003270981	0.017
ZNF674-AS1	401588	0.002806549	0.017
THAP7-AS1	439931	0.043442939	0.064
DTX2P1-UPK3BP1-PMS2P11	441263	0.045611752	0.067
A1BG-AS1	503538	0.013163955	0.04
JPX	554203	0.012434164	0.039
SERTAD4-AS1	574036	0.028339987	0.061

Table 3. Kaplan-Meier survival and univariate Cox proportional hazards regression of lncRNAs associated with OS (continued).

lncRNA	ID	KM_p-value	Univariate COX_p-value
LINC00051	619434	0.029549096	0.047
FLVCR1-AS1	642946	0.001122737	0.01
LINC01128	643837	0.003603232	0.998
AC016205.1	647946	0.047738276	0.067
UCA1	652995	0.04674611	0.067
LHFPL3-AS2	723809	0.003492997	0.998
FLJ37453	729614	0.036772978	0.056
ZBTB11-AS1	100009676	0.0320597	0.051
TMPO-AS1	100128191	0.021219434	0.037
FAM225B	100128385	0.036380417	0.056
LINC01003	100128822	0.00016634	0.998
LINC02035	100129550	0.041433759	0.062
CCDC183-AS1	100131193	0.033588659	0.054
LINC00426	100188949	0.00960645	0.034
FTX	100302692	0.022175579	0.04

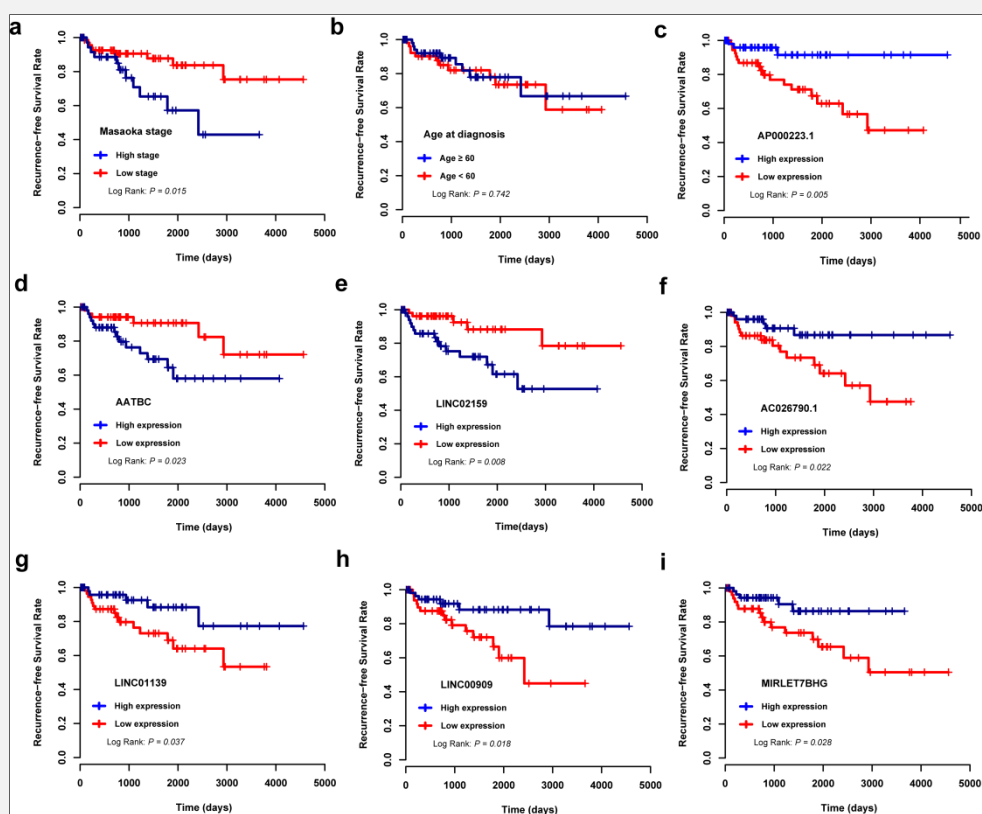


Figure 1. Kaplan-Meier curves for recurrence-free survival among thymoma patients.

The patients were divided into groups according to their (a) Masaoka stage (stage IIb - IV vs. stage I - IIa), (b) age at diagnosis, (c) AP000223.1 expression level, (d) AATBC expression level, (e) LINC02159 expression level, (f) AC026790.1 expression level, (g) LINC01139 expression level, (h) LINC00909 expression level, (i) MIRLET7BHG expression level.