nature portfolio

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Reporting Summary

Nature Portfolio wishes to improve the reproducibility of the work that we publish. This form provides structure for consistency and transparency in reporting. For further information on Nature Portfolio policies, see our Editorial Policies and the Editorial Policy Checklist.

Statistics

For all statistical analyses, confirm that the following items are present in the figure legend, table legend, main text, or Methods section.

n/a	Confirmed	
☐	☒	The exact sample size (*n*) for each experimental group/condition, given as a discrete number and unit of measurement
☐	☒	A statement on whether measurements were taken from distinct samples or whether the same sample was measured repeatedly
☐	☒	The statistical test(s) used AND whether they are one- or two-sided *Only common tests should be described solely by name; describe more complex techniques in the Methods section.*
☐	☒	A description of all covariates tested
☒	☐	A description of any assumptions or corrections, such as tests of normality and adjustment for multiple comparisons
☐	☒	A full description of the statistical parameters including central tendency (e.g. means) or other basic estimates (e.g. regression coefficient) AND variation (e.g. standard deviation) or associated estimates of uncertainty (e.g. confidence intervals)
☐	☒	For null hypothesis testing, the test statistic (e.g. *F*, *t*, *r*) with confidence intervals, effect sizes, degrees of freedom and *P* value noted *Give P values as exact values whenever suitable.*
☒	☐	For Bayesian analysis, information on the choice of priors and Markov chain Monte Carlo settings
☒	☐	For hierarchical and complex designs, identification of the appropriate level for tests and full reporting of outcomes
☐	☒	Estimates of effect sizes (e.g. Cohen's *d*, Pearson's *r*), indicating how they were calculated

Our web collection on statistics for biologists contains articles on many of the points above.

Software and code

Policy information about availability of computer code

Data collection	Microsoft Excel
Data analysis	R version 4.4.0("survminer" package, "survival" package, "ggplot2" package), Python version 3.13("pandas" package, "numpy" package, "matplotlib" package, "seaborn" package, "os" package, "sklearn" package, "tabpfn" package, "scipy" package, "openpyxl" package), Python version 3.11("statsmodels.imputation.MICE" package'')

For manuscripts utilizing custom algorithms or software that are central to the research but not yet described in published literature, software must be made available to editors and reviewers. We strongly encourage code deposition in a community repository (e.g. GitHub). See the Nature Portfolio guidelines for submitting code & software for further information.

Data

Policy information about availability of data

All manuscripts must include a data availability statement. This statement should provide the following information, where applicable:

- Accession codes, unique identifiers, or web links for publicly available datasets
- A description of any restrictions on data availability
- For clinical datasets or third party data, please ensure that the statement adheres to our policy

The study protocol is available in the Supplementary Information. The clinical datasets generated and/or analyzed during the current study are not publicly available due to institutional and ethical restrictions. Researchers who wish to access individual deidentified participant data should contact the corresponding author with a detailed research proposal. Data sharing will be considered on a case-by-case basis and requires approval from the institutional review board and completion of a

data sharing agreement.

Research involving human participants, their data, or biological material

Policy information about studies with human participants or human data. See also policy information about sex, gender (identity/presentation), and sexual orientation and race, ethnicity and racism.

Reporting on sex and gender	Both male and female patients were eligible for enrollment. Sex was self-reported. The number of male (n=26) patients prospectively enrolled in this study is reported in Table 1. The number of male (n=14) patients retrospectively enrolled in this study is reported in Supplementary Table 1.
Reporting on race, ethnicity, or other socially relevant groupings	There are no analyses based on race or ethnicity reported in this manuscript.
Population characteristics	Baseline patient demographics and disease characteristics for patients in this study are reported in Table 1 and Supplementary Table 3.
Recruitment	Since the recruitment process relies on whether patients are willing and able to visit our hospital, there may be a certain degree of self-selection bias! This is because the research sample may include patients with better health conditions or higher motivation. Moreover, since all the participants are of Chinese ethnicity, the research results may not be fully applicable to patients of other ethnicities or populations outside of China.
Ethics oversight	The study was approved by the ethics committee of Tianjin Medical University Cancer Institute and Hospital (approval ID:E20210172) and was conducted in accordance with the principles of the Declaration of Helsinki.

Note that full information on the approval of the study protocol must also be provided in the manuscript.

Field-specific reporting

Please select the one below that is the best fit for your research. If you are not sure, read the appropriate sections before making your selection.

☒ Life sciences ☐ Behavioural & social sciences ☐ Ecological, evolutionary & environmental sciences

For a reference copy of the document with all sections, see nature.com/documents/nr-reporting-summary-flat.pdf

Life sciences study design

All studies must disclose on these points even when the disclosure is negative.

Sample size	At the time this study was designed in 2021,the data deficit regarding the perioperative treatment with anti-PD-1 monoclonal antibody plus tyrosine kinase inhibitor in patients with resectable HCC introduced uncertainty regarding their efficacy and safety. Based on the feasibility of enrollment, the sample size was set to 30 to evaluate the preliminary safety and efficacy.
Data exclusions	The exclusion criteria were pre-established in the study protocol (Shown in the Supplementary Information). A total of 44 patients were recruited and screened and finally 27 patients were enrolled in this study.The reason for exclusion and the study flow were shown in Figure 1A in the manuscript.
Replication	We have retained the original data for all patients, along with the code used for data analysis, ensuring the reproducibility of the results.
Randomization	This was a single-armed trial, so the randomization was not relevant to our study.
Blinding	This was a single-armed trial, so the enrollment did not involve blinding procedure.

Reporting for specific materials, systems and methods

We require information from authors about some types of materials, experimental systems and methods used in many studies. Here, indicate whether each material, system or method listed is relevant to your study. If you are not sure if a list item applies to your research, read the appropriate section before selecting a response.

Materials & experimental systems

n/a	Involved in the study
☒	☐ Antibodies
☒	☐ Eukaryotic cell lines
☒	☐ Palaeontology and archaeology
☒	☐ Animals and other organisms
☐	☒ Clinical data
☒	☐ Dual use research of concern
☒	☐ Plants

Methods

n/a	Involved in the study
☒	☐ ChIP-seq
☒	☐ Flow cytometry
☒	☐ MRI-based neuroimaging

Clinical data

Policy information about clinical studies

All manuscripts should comply with the ICMJE guidelines for publication of clinical research and a completed CONSORT checklist must be included with all submissions.

Clinical trial registration	This study was prospectively registered at ClinicalTrials.gov, NCT04834986.
Study protocol	The study protocol is available in the appendix.
Data collection	Based on the feasibility of enrollment, the sample size was set to 30 to evaluate the preliminary safety and efficacy. Eligible patients between 7 September 2021 and 5 June 2023 were aged 18-75 years(No restrictions on gender) at the time of recruitment and had an initial diagnosis of resectable HCC. Key inclusion criteria included: (1) ECOG PS score of 0 or 1, (2) Child-Pugh A liver function, (3) China Liver Cancer (CNLC) stage Ⅰb-Ⅲa, (4) adequate organ and bone marrow function, (5) at least one risk factor for tumor recurrence, and (6) at least one evaluable lesion per RECIST v1.1. Risk factors for recurrence were defined as follows: (a) for CNLC stage Ⅰb: single tumor with a size >6.5 cm or 2-3 tumors with a maximum size ≤3 cm, (b) for CNLC stage Ⅱa: 2-3 tumors with a maximum size >3 cm, (c) for CNLC stage Ⅱb: ≥4 tumors, and (d) for CNLC stage Ⅲa: tumors with macroscopic evidence of vascular invasion.
Outcomes	The primary endpoints were the safety and feasibility of the treatment. Based on the National Cancer Institute Common Toxicity Criteria for Adverse Events v5.0, safety was determined by the incidence of grade 3-4 TRAEs. Feasibility was determined by the incidence of surgical delays, defined as a delay of no more than 49 days from the scheduled surgery time, including a maximum delay of 42 days and a 7-day waiting period for surgery. The secondary endpoints included the ORR per RECISTv1.1 and mRECIST, 1-year and 2-year DFS, pCR, DFS, and the incidence of AEs and serious AEs. The ORR was calculated as the sum of CR and partial response rates. pCR was defined as the absence of residual cancer cells in the resected tissue. DFS was defined as the time from surgery to the first diagnosis of recurrent tumor or death, whichever occurred first.The exploratory endpoints included the analysis of prognostic predictors.

Plants

Seed stocks	*Report on the source of all seed stocks or other plant material used. If applicable, state the seed stock centre and catalogue number. If plant specimens were collected from the field, describe the collection location, date and sampling procedures.*
Novel plant genotypes	*Describe the methods by which all novel plant genotypes were produced. This includes those generated by transgenic approaches, gene editing, chemical/radiation-based mutagenesis and hybridization. For transgenic lines, describe the transformation method, the number of independent lines analyzed and the generation upon which experiments were performed. For gene-edited lines, describe the editor used, the endogenous sequence targeted for editing, the targeting guide RNA sequence (if applicable) and how the editor was applied.*
Authentication	*Describe any authentication procedures for each seed stock used or novel genotype generated. Describe any experiments used to assess the effect of a mutation and, where applicable, how potential secondary effects (e.g. second site T-DNA insertions, mosiacism, off-target gene editing) were examined.*