Indian J Med Res 161, June 2025, pp 601-608
DOI: 10.25259/IJMR_2035_2024

Original Article

Comprehensive biobanking to enhance precision medicine in head & neck cancer through systematic sample collection & data integration

Arunima Bhaduri[1], Komal Mehta[1], Deepak Sharma[1], Bhavya Sharma[1], Mudit Agarwal[2], Ajay Kumar Dewan[2] & Juhi Tayal[1]

[1]Biorepository, Department of Research, & [2]Department of Head & Neck Oncology, Rajiv Gandhi Cancer Institute and Research Centre, New Delhi, India

Received December 9, 2024; Accepted May16, 2025; Published August 8, 2025

Background & objectives: **Head and neck carcinomas (HNCs), including oral cancers (OCs), represent a significant global health issue, especially in India, where they contribute to one-third of the global OC burden. Despite advances in treatment, survival rates remain poor, often due to limited treatment options and underlying research gaps. The Rajiv Gandhi Cancer Institute & Research Centre (RGCIRC) biorepository initiative undertook to address this gap by systematically collecting and storing biological specimens and their derivatives for HNC, fostering translational research and collaborations. The objective of this initiative was to provide critical resources for researchers and aims to bridge the gap between laboratory findings and clinical applications, ultimately contributing to more effective cancer treatment strategies and personalised medicine approaches in oncology.**

Methods: **From 2018 to July 2024, the biobank enrolled HNC patient donors (aged 18+yr) undergoing surgery as a primary mode of treatment at RGCIRC. Following Indian Council of Medical Research (ICMR) and World Health Organization (WHO) guidelines, the biobank collected diverse biosamples, including fresh frozen tissues, plasma, PBMC, FFPE, and more. A robust Laboratory Information Management System (LIMS) ensured systematic sample tracking and efficient disbursal. Complex derivatives were processed to minimise pre analytical variability, supporting high-quality research applications.**

Results: **The HNC biobank successfully enrolled 1, 300 donors during the study period and stored 13,000 biosample aliquots, with buccal mucosa identified as the most prevalent cancer site. A significant proportion of the patients presented with advanced-stage cancers (III and IV), accounting for 62.67 per cent of the biosamples collected, highlighting the critical need for targeted research in this area. Notably, the samples exhibited considerable cellular heterogeneity across different anatomical sites. Additionally, lower cellular viability was observed in samples from gingivobuccalsulcus (GBS) cancers compared to those from other sites. The biobank's 34 per cent sample disbursal rate underscores its role in facilitating diverse research projects, there by contributing valuable insights into HNC biology and treatment strategies.**

Interpretation & conclusions: **The RGCIRC biobank is pivotal for advancing HNC research, enabling genomic and cellular diversity studies, biomarker discovery, and personalised treatments. It has the potential to lay the foundation for multi-omics research and the future of translational efforts in HNC.**

Key words Biorepository - cellular heterogeneity - head & neck cancer - laboratory information management system (LIMS) - personalized treatment - translational research

Head and neck carcinomas (HNCs) represent a significant health burden in Southeast Asia, particularly India, where incidence rates are among the highest globally due to high prevalence of tobacco use and late-stage presentation[1]. It consists of diverse groups of malignancies according to their origin, with oral cancers (OCs) being the most prevalent site. Globally, OCs ranked sixth among all cancers, with India contributing about one-third of the global OC burden[2]. Tobacco consumption, both smokeless tobacco (*e.g*., chewing of betel quid, *panmasala*) and smoking, alcohol consumption, poor oral hygiene, sustained viral infections, *i.e*., human papillomavirus (HPV), are among the key risk factors associated with OC predisposition. Despite the accessibility of the oral cavity for clinical examinations, most cases are presented at later stages, leading to a poor survival outcome. In India, 60-80 per cent of the cases are reported at later stages, which leads to overall poor disease outcomes[2]. Treatment of HNC requires intensive multimodal approaches, including surgery followed by radiotherapy alone or with chemotherapy in most of the primary cases. Despite several improvements in conventional therapy for OC, the overall 5-yr survival rate has not changed significantly[3]. Research is ongoing in different parts of the world for biomarker generation and the development of patient-specific treatments[4,5]. A major challenge in these studies is the limited availability of high-quality biospecimens. Furthermore, an efficient data management system is paramount for efficient sample tracking, retrieval, and large-scale data mining in modern biobanking. The Biorepository of Rajiv Gandhi Cancer Institute & Research Centre (RGCIRC) is one such crucial initiative for comprehensive next-generation biobanking of head and neck cancer samples, thus bridging the gap between clinical and translational research. RGCIRC biobank aimed to store various biological specimens such as fresh frozen tissues, dissociated tumour cells (DTCs), viable tissues (VTs), peripheral blood mononuclear cells (PBMCs), blood, saliva, plasma, FFPE blocks, digital pathological images with integrated clinical, pathological and molecular data from newly diagnosed HNC patients. This initiative facilitated access and visibility of the sample inventory to academic and commercial researchers both in India and internationally, supporting translational research initiatives.

Materials & Methods

Patient cohort: The biobank donors included presurgical HNC patients above 18 who reported to the surgical oncology OPD of RGCIRC. The samples were collected between the period of July 2018 to July 2024, with detailed documentation of the exact numbers and donors. Informed consent from willing donors and ethical approval processes were undertaken in compliance with Indian Council of Medical Research (ICMR) guidelines. This study was approved by the Institutional Review Board (IRB) of Rajiv Gandhi Cancer Institute and Research Centre (RGCIRC). The biobank collected preinduction peripheral blood and residual tumour specimens from surgical resections. Adherence to stringent guidelines, including ISBER[6] and IARC-WHO[7] best practices, ensured high standards for sample collection, processing, and storage to maintain sample integrity and minimise preanalytical variability. Anonymisation and traceability between each sample and its donor were meticulously maintained through a secure and robust Laboratory Information Management System (LIMS). This system ensured precise tracking, ethical compliance, and data reliability, preserving the link between samples and donors while upholding strict confidentiality.

Tumour tissue samples were allocated for cryopreservation or dissociated tumour cells (DTC) preparation based on downstream applications. Cryopreservation was performed using either snap-freezing in liquid nitrogen or controlled-rate freezing methods, tailored to specific research requirements. Tissue collection occurred 60–90 min post-surgery to minimise cold ischaemia time and optimise sample stabilisation. Samples were anonymised prior to final storage to ensure confidentiality and compliance with ethical standards, including the Declaration of Helsinki. Methodologies for the primary derivatives preparation have been summarized in table I. The labelling system assigns a unique sample ID, incorporating an anonymised identification number, indication identifier, derivative details, and allocation ID. For example, in the sample id '00100HNTB', '00100' would indicate the 100th sample of the inventory. 'HN' would denote the sample is of Head and Neck indication, T represents tissue (tumour tissue and/or normal tissue), and B indicates plasma. A separate location ID was also assigned and sample tracking LIMS software helps locate the exact sample in the vast inventory. This systematic approach ensured the biobank's capability to support high-quality translational research while maintaining the integrity and reliability of biospecimens.

Preparation of complex derivatives:

Table I. Preparation methodology and quality check of primary derivatives obtained from head & neck cancer patients

Sample type	Preparation method	Quality control
Plasma & serum	Pre-induction peripheral blood of around 8-10 ml was collected from the patient donors in EDTA vials. The blood samples were centrifuged at 1500 rpm for 15 min, 4˚C. Following the separation, plasma was isolated from the upper layer and stored at -80˚C. For serum isolation, pre-induction blood samples were collected in BD vacutainer SST tubes, followed by centrifugation using the same methodology as described for plasma isolation. The serum was isolated and stored at-80˚C.	Visual haemolysis analysis was done by observing the colour of plasma and serum before storage. Only non-haemolysed samples were preserved for the downstream analysis. 5-6% samples of plasma and serum were discarded due to haemolysis.
Fresh frozen tissue	Tissue samples were collected from the surgical resections under the strict supervision of pathologists to ensure tumour collection from the core areas and adjacent normal tissues. Tissue chunks were then weighed, and about 200-250 mg of tissue chunks were prepared and snap-frozen in liquid nitrogen	Tumour samples were collected from the core areas of the surgical resections. All the samples were identified and collected by the concerned pathologists, ensuring precise collection of the tumour samples. After the procurement, tissue samples were processed either for snap freezing in liquid nitrogen or for DTC preparation with a minimum time lapse to reduce the effect of preanalytical variables like cold ischaemia time (CIT).

RNA isolation: Total of 120 fresh frozen tissue samples of OC were screened from the repository. RNA was isolated from the fresh frozen tissue sample using the QIAGEN All Prep DNA/RNA Extraction Kit (Qiagen, Germany) according to the manufacturer's protocol. The quality of RNA was initially assessed in Qubit, followed by an analysis in Tape Station (Agilent 4150, Germany). All the RIN values were assessed for the downstream application. From this, 44 samples were initially selected for the transcriptomics analysis.

Dissociated tissue cells (DTCs) preparation: Tissue samples were collected from various sites of head and neck cancer (buccalmucosa-10, tongue-5, alveolus-11, gingivobuccalsulcus-GBS-4) to prepare single-cell suspensions, enabling the assessment of intra-tumoral heterogeneity's impact on treatment outcomes. Fresh tumour chunks (Table II for start-up tissue) obtained from surgical resections at RGCIRC were rinsed in DMEM-F12 medium with 5X-Antibiotics, finely minced, and digested with collagenase (50–200 units/ml) and DNase (1 mg/ml) at 37°C for 3–3.5 h. After digestion, samples were centrifuged at 300 g for 10 min, treated with RBC lysis buffer if needed, and filtered through a 70 µm strainer to remove debris followed by PBS wash. This optimised enzymatic digestion and processing steps facilitated the efficient dissociation and isolation of viable tumour cells from heterogeneous head and neck tissues.

PBMC preparation: Prospectively, 10 ml of pre-induction whole blood was collected in an EDTA vacutainer from head and neck cancer patients. Histopaque1077 was used as a density gradient medium for PBMC isolation, which aided in the rapid recovery of mononuclear cells from small volumes of blood samples. The blood was first mixed with 1X phosphate buffered saline (PBS) in 1:1 ratio, forming a homogenising mixture. Subsequently, this diluted blood was layered onto the Histopaque 1077 in an equal volume. The tube was then centrifuged at 400 g for 40 min, with the brakes off and minimal acceleration at room temperature.

After centrifugation, the mononuclear cells were carefully isolated between the plasma and histopaque interface, followed by a PBS wash. In case of RBC contamination, an RBC lysis buffer was encountered for 8-10 min at RT, followed by centrifugation at 400 x g for 10 min. After spin, the second fraction was collected and washed with PBS for 10 min at 400 g. PBMCs were then resuspended in PBS for cell enumeration. PBMCs were finally cryopreserved in the same medium used for DTC and stored at ultra-low temperature in liquid nitrogen (-196˚C) for future use.

Quality check of DTCs and PBMCs:

Enumeration and cellular viability check: Cell enumeration and cellular viability were assessed using the trypan blue dye and quantified with Olympus cell

Table II. Initial tissue amount for the formation of single-cell suspension

Head & neck site	Amount of start-up tissue
Buccal mucosa	>600 mg
Alveolus	>700 mg
Tongue	>650 mg
GBS	>750 mg

Table III. Patients' demographic details archived in RGCIRC biorepository

Characteristics/parameters	Frequency (%)
Gender	
Male	84.78
Female	14.6
Age group (yr)	
<40	16.38
40 – 60	60.17
>60	23.44
Region	
North India	82.33
East India	11.39
Central India	3.27
West India	1.56
Tobacco Exposure	
Chewing	34.04
Smoking	6.12
Chewing+Smoking	28.49
None	26.35
Not Available	4.9
Alcohol Exposure	
Present	33.34
Absent	58.68
Unknown	7.97
Chewing+Smoking+Alcohol	16.23%
Sample Type Distribution	
Tumour+Plasma	27.39
Only Tumour	6.92%
Only Plasma	53
Tumour+Adjacent Normal+Plasma	2.15
DTC	2.3
PBMC	1.92

counters (Supplementary Figure). Both DTCs and PBMCs were cryopreserved in a medium consisting of 90 per cent foetal bovine serum (FBS) and 10 per cent dimethyl sulfoxide (DMSO) to ensure long-term preservation.

Microbial check: After enzymatic digestion and isolation of mononuclear cells, from tissue and blood, respectively, a sample volume of 100-200 µl of the cellelute was incubated in a CO_2 incubator to monitor for any unwanted cellular growth under controlled conditions. Simultaneously, a separate portion of the elute was sent to the microbiology laboratory for a detailed assessment of potential microbial contamination. This dual approach, direct observation of growth in the incubator and laboratory testing for microbial presence, provided a thorough quality evaluation, ensuring the reliability of the samples and meeting the stringent standards of the pharmaceutical industry and academic research.

Results

During the study period the the RGCIRC biorepository archived samples from 1300 patient donors, and about 13,000 biosample aliquots were cryopreserved, excluding the FFPE blocks, as they ranged to ~2 lakhs. Within this time, around 6400 head and neck cancer patients were treated in this hospital, of which 22 per cent have been biobanked in our biobank. The other samples could not be procured either due to small tumour size, underlying comorbidities like chronic heart disease, or positive viral markers at the time of collection. Patients unwilling to give consent were also removed from our cohort. The median age of the patients was 52 yr, with an age range of 18 to 93 yr. Most donors were male (male *vs.* female=84.78 *vs.* 14.60%; Table III). The median age at diagnosis was 57 yr in females, where as in males, it was 51 yr. The biosample types mainly included plasma, serum, fresh frozen tissue samples, DTC, PBMC, and FFPE blocks, of which 27.39 per cent had paired plasma and tumour tissues, and for 53 per cent of samples, only plasma samples were stored (Fig. 1). The other sample types included saliva (n=10) and tumour educated platelets (TEP) (n=70). For the frozen tissue collection, typically1-2 vials from tumour core, each approximately 200 mg, and 0-1 vial of adjacent normal tissues were collected from each patient. The biorepository has stored tissue samples from different sites of head and neck cancers, buccal mucosa being the most common site among them (38%), followed by tongue (32%), alveolus (15%), and other sites (retro molartrigone, GBS, floor of mouth, *etc*.) of the oral cavity (Fig. 2). Routine p16 IHC testing for HPV detection was not performed for all OCs, because its role in oral cavity cancers is still under investigation. Testing was clinically advised for some cases where the clinician suspected an oropharyngeal origin of the

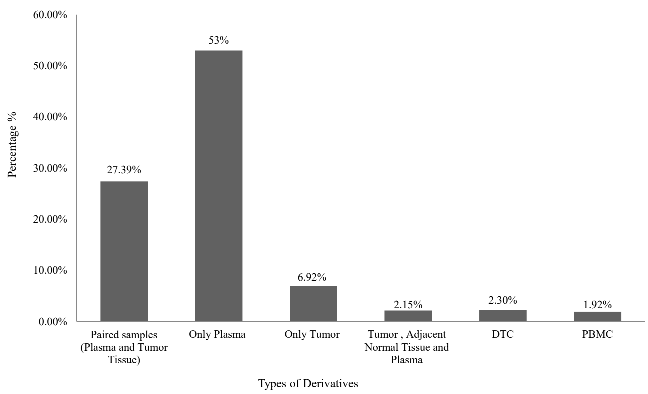

Fig. 1. Types of derivatives archived in the HNC biorepository of RGCIRC between 2018 - July 2024.

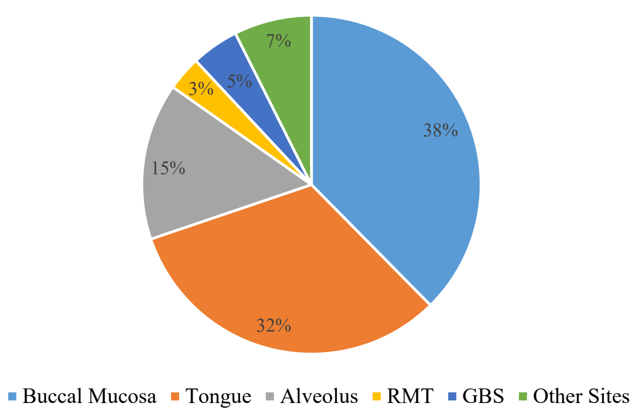

Fig. 2. Archived samples from different sites of oral cancers.

Table IV. Group staging of H&N cancer patients of RGCIRC biorepository.

Stage	Male n (%)	Female n (%)	Total (%)
I	91 (7.4)	19 (1.5)	110 (9.06)
II	192 (15.8)	38 (3.1)	230 (18.94)
III	228 (18.78)	37 (3.04)	265 (21.82)
IVA	336 (27.67)	50 (4.1)	386 (31.79)
IVB	197 (16.22)	23 (1.89)	223 (18.36)

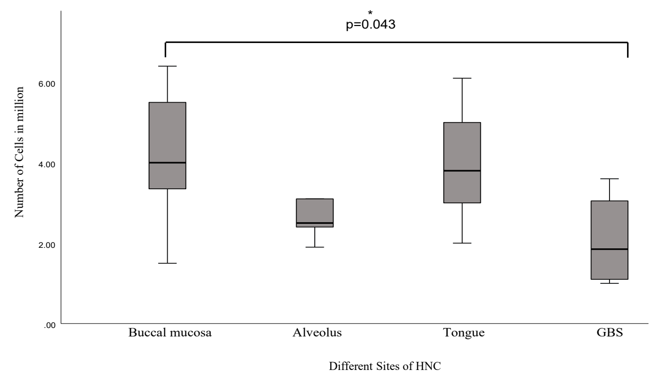

Fig. 3. This plot illustrates the distribution of dissociated tumour cell count data across different sites. One-way ANOVA indicates a statistically significant difference among the sites, with a closest-to-significant mean difference specifically observed between the Buccal mucosa and Gingivobuccal sulcus(GBS).

tumour, poorly differentiated squamous cell carcinoma of unknown primary origin, or for stratification of patients for research or clinical trials[8]. Among 1300 patients, 30 cases (2.3%) were tested for HPV using p16 IHC method, and all were reported as negative. Groups tagging was done in 1214 patients according to the American Joint Committee on Cancer's (AJCC) 8th edition Guidelines[9] (Table IV).

Statistical analysis: A one-way ANOVA was conducted to compare cell counts and cellular viability across four head and neck sites. For cell counts, the analysis revealed a significant difference among the groups ($F(3,22)=3.206$, $P=0.043$), suggesting at least one group differed from the others. However, Tukey's HSD post hoc comparisons showed no significant pairwise differences, with the closest being between buccal mucosa and GBS (mean difference=2.154, $P=0.087$), possibly due to small sample sizes. The homogeneous subsets analysis grouped the means as follows: Buccal mucosa (2.07), Alveolus (2.60), Tongue (3.97), and GBS (4.23), with an overall P value of 0.063 (Fig. 3).

For cellular viability, a separate One-Way ANOVA indicated a significant main effect ($F(3,22)=24.138$, $P<0.001$). Post hoc comparisons using Tukey's HSD test revealed substantial differences between Buccal mucosa vs. Alveolus ($P=0.045$)(*), Buccal mucosa vs. GBS ($P<0.001$)(**), Alveolus *vs*. GBS ($P<0.001$) (***), and Tongue vs. GBS ($P<0.001$)(****). The homogeneous subsets analysis identified buccal mucosa (mean=90.79) as significantly different from the other groups, tongue (mean=86.78) as distinct from GBS, and alveolus (mean=81.02) and GBS (mean=61.00) as similar. In conclusion, significant differences in cellular viability were observed, with the buccal mucosa, tongue, and alveolus differing from GBS, and the buccal mucosa differing from the alveolus (Fig. 4).

The PBMC yields were varied among patients, ranging from 3-8.5 million cells/ml. Notably the cell viability remained stable during the retrieval processes, reflecting effectiveness of preservation methods.

Tapestation for RNA integrity: RNA was extracted from different sites of the oral cavity, including three significant sites of buccal mucosa (n=51), Tongue (n=33), and alveolus (n=21). The average RNA integrity

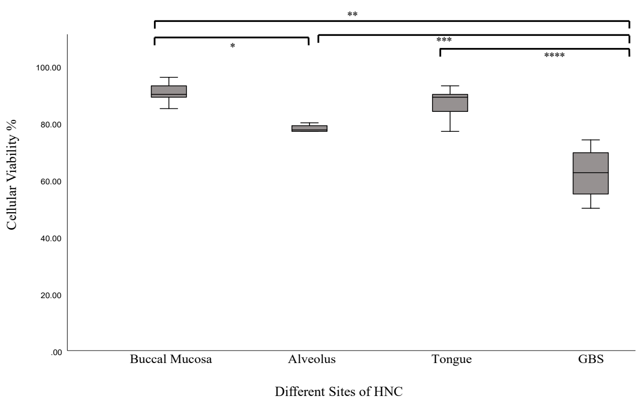

Fig. 4. This plot shows the average cellular viability obtained from different sites. Viability obtained using this methodology exceeded 80 per cent in all head and neck sites except for the GBS. In GBS, cellular enrichment was lower, resulting in reduced viability and increased dead cells.

number (RIN) value from buccal mucosa, tongue, and alveolus showed similar patterns with values of 5.4, 5.2, and 5.49, respectively . While comparing the RIN values between tobacco users and non-users, it has been seen that the RIN value is higher in tobacco users than in non-tobacco users (Avg Value: 5.49 *vs*. 5.22).

These well-characterised samples and clinical data of the RGCIRC biorepository were actively utilised in various scientific projects in collaboration with academic and commercial entities. In a cohort of 330 patients, all demographic, clinicopathological, treatment, and outcome details were comprehensively documented (Supplementary Table I).

The disbursal rate was about 34 per cent, with an acceptance rate of 92-95 per cent. Various derivatives, including DTC, PBMC, whole blood, FFPE blocks, and blood derivatives (Table V), were shared with the collaborators. These samples were successfully utilised for drug discoveries, molecular studies, assay validation, and other translational research purposes, leading to significant scientific publications[10].

Discussion

Cancer biology research has transformed towards single-cell genomics, offering profound insights into disease biology. Biobanks have played a pivotal role in facilitating translational research and supporting the development of personalised treatment approaches. The biorepository at RGCIRC has excelled in cryopreserving over 1000 patient samples of head and neck cancer, adhering rigorously to stringent SOPs and ensuring best laboratory practices. This biorepository data can also give an overall idea of the demographic pattern (gender and age distribution, socio-economic background, risk factor exposure, *etc*.) of the patient population reporting to this tertiary care centre. The median age of diagnosis for head and neck cancers in this study was found to be notably lower, with most cases (60.32%) occurring in the age group of 40 to 60 yr. This is in contrast with previous studies on Indian population, which reported a higher prevalence in individuals over 60 yr old[11]. In our analysis, the highest incidence was indeed within the 40-60 age range (60.17%), followed by those over 60 yr (23.44%) and those under 40 yr (16.38%). Furthermore, our biorepository data revealed that 62.67 per cent of the cases were diagnosed at advanced stages (stage III and IV), while only nine per cent were identified in earlier stages (stage I). This distribution highlights the urgent need for improved early detection strategies and targeted interventions for head and neck cancer, particularly among younger populations.

The well-characterised data of 330 patients gave valuable insights into the demographics, clinical characteristics, and treatment outcomes. It showed that chewing was the most common form of tobacco exposure (36.96%), followed by combined exposure of both chewing and smoking in 30.3 per cent of patients. The majority were diagnosed at advanced stages (stage III:21.21%, stage IV:43.63%). Among these advanced-stage cohorts, the majority of the patients received adjuvant therapies after surgery, either radiotherapy (49.06%) or concurrent radiotherapy and chemotherapy (41.58%). The disease-free survival was notably lower in advanced cases (stage III & IV) with a median of 9.44 months compared to 17.2 months in early stage (stage I and II) cases (Supplementary Table I).

In the era of next-gen biobanking, RGCIRC has taken crucial steps towards developing living cell biobanking. DTC and PBMC are potent tools for living cell biobanking with the potential to study pharmacokinetics in patient-derived cancer (PDC) models. Previous studies have shown that cryopreserved DTCs can be retrieved for successful primary cell culture, reflecting the potentiality for functional studies[12]. Our result showed variability in the cellular counts among different OC sites, with significantly higher cell counts from buccal mucosa than GBS (Buccal mucosa *vs*. GBS *P=0.043*). Moreover, significant variation in cellular viability was observed among different tumour sites, reflecting heterogeneous cellularity. Notably, calcification and fibrosis in tumour tissues from different OC sites posed

Table V. Collaborations with academic and commercial organisations in head and neck cancer research, detailing research areas and sample types utilised for various studies.

Academic organisations		
Organisation	Research areas	Sample types
Academic institutions in collaboration (IIIT-D, IIT-Ropar, IGIB,	Biomarker development in oral cancer	Saliva
	Study on novel microRNAs to develop diagnostic & therapeutic markers of oral squamous cell carcinoma	Saliva
	Molecular atlas of oral cavity cancers	Whole blood, fresh tissue & RNA
	Large scale validation & characterisation of 'tumour educated platelet' based liquid biopsy assay in H&N cancer	Whole blood for TEP (Tumour educated platelets) isolation
RGCIRC (in-house project)	Next-generation sequencing of oral carcinoma among Indian patients	FFPE blocks
Commercial Organizations		
Organization	Research areas	Sample Types
International CROs National CROs and Startups	Functional analysis and assay validation. Training of AI algorithms.	DTC, PBMC, Digital Pathology Images
	Metastasis-focused drug discovery & diagnostic	Paired fresh tissue & whole blood
	Development of a clinically validated oncology drug efficacy platform	Fresh frozen tissue
	Assay development for early detection of oral cancer	FFPE blocks
	Development of a compact device using multispectral terahertz and fluorescence technology for in-situ real-time cancer margin detection.	FFPE, fresh tissue blocks

significant challenges while isolating the single-cell suspension, resulting in heterogeneous cell counts. To evaluate these factors, we aim to analyse many samples. This study also highlighted the relatively uniform RNA integrity across different sites of the oral cavity and a comparatively higher RIN value in tobacco users than non-users (Average value: 5.49 *vs*. 5.22).

Advanced biobanking is shifting from sample-driven to data-driven approach, so integration of data with biosamples is becoming the most important tool in biomedical research[13]. This comprehensive biobanking approach of RGCIRC ensures the storage and maintenance of high-quality biospecimens along with well-characterized data. The LIMS-based data management system is robust for prompt data access, sample tracking, and disbursal. The vast array of clinically annotated, well-characterised biospecimens can serve as a potential source for researchers to study omics and functional assays. The successful utilisation of these archived samples, including fresh tumour tissues, plasma, saliva, DTCs, PBMCs, and RNA by various academic and commercial entities for downstream applications in multi-omics studies, has proven the operational sustainability of this biobank[10]. These investigations have revealed novel insights into the heterogeneity of head and neck cancers, paving the way for developing personalised treatment strategies that better align with the unique characteristics of individual tumours.

The total set up cost was ~4 crore INR. The maintenance cost per sample per year is about 83 INR, which encompasses setup cost, storage infrastructure, equipment servicing, IT support, and quality assurance processes. All revenue generated through external collaborations is fully reinvested into the biobank operations, including manpower recruitments, infrastructure maintenance, personnel training, annual LIMS charges, and expansion of biospecimen collections, thereby ensuring the biobank's long-term sustainability and adherence to ethical and regulatory standards.

There were, however, some challenges and shortcomings in this study. Serial collection of samples could not be performed, because in our centre, routine re-biopsies are not done in relapsed or advanced cases unless there is a specific diagnostic uncertainty or a clinical trial enrolment. However, we recognise the importance of longitudinal sample collection and therefore we aim to incorporate structured protocols for serial tumour tissue collection in advanced disease settings as part of future prospective studies. The integrative biobanking approach fostered international collaborations and enabled researchers to address complex questions across diverse patient populations. Ultimately, the clinical utility of such a well-structured biobank is evident. It has aligned biospecimen data with treatment outcomes, which can help clinicians make more informed decisions, such as predicting poor prognosis in younger patients presenting with advanced-stage disease and modifying early interventions accordingly. Thus, the findings from this study reaffirm the biobank's role as a pillar of evidence-based, patient-centric cancer care.

Financial support & sponsorship: None.

Conflicts of Interest: None.

Use of Artificial Intelligence (AI)-Assisted Technology for manuscript preparation: The authors confirm that there was no use of AI-assisted technology for assisting in the writing of the manuscript and no images were manipulated using AI.

References

1. Bray F, Ferlay J, Soerjomataram I, Siegel RL, Torre LA, Jemal A. Globalcancerstatistics 2018: GLOBOCAN estimates of incidence and mortality world wide for 36 cancers in 185 countries. *CA Cancer J Clin* 2018; *68* : 394-42.
2. Borse V, Konwar AN, Buragohain P. Oral cancer diagnosis and perspectives in India. *Sens Int* 2020; *1* : 100046.
3. Sathishkumar K, Sankarapillai J, Santhappan S, Mathew A, Nair RA, Gangane, *et al*. Geographic disparities in oral cancer survival from 10 population-based cancer registries in India. *JAMA Netw Open* 2025; *8* : e253910.
4. Feldman R, Gatalica Z, Knezetic J, Reddy S, Nathan CA, Javadi N, *et al*. Molecular profiling of head and neck squamous cell carcinoma. *Head Neck* 2016; *38 Suppl 1* : E1625-38.
5. Li Q, Tie Y, Alu A, Ma X, Shi H. Targeted therapy for head and neck cancer: Signaling pathways and clinical studies. *Signal Transduct Target Ther* 2023; *8* : 31.
6. International Society for Biological and Environmental Repositories. *ISBER best practices: Recommendations for repositories*. 5th edition. Available from: *https://www.isber.org/page/BPR*, accessed on May 14, 2024.
7. Mendy M, Caboux E, Lawlor RT, Wright J, Wild CP. Common minimum technical standards and protocols for biobanks dedicated to cancer research. IARC Technical Publication No 44. Lyon (FR): International Agency for Research on Cancer; 2017.
8. Lewis JS, Beadle B, Bishop JA, Chernock RD, Colasacco C, Kalicanin T, *et al*. Human papillomavirus testing in head and neck carcinomas: Guideline update. *Arch Pathol Lab Med* 2025.
9. Keung EZ, Gershenwald JE. The eighth edition American Joint Committee on Cancer (AJCC) melanoma staging system: implications for melanoma treatment and care. *Expert Rev Anticancer Ther* 2018; *18* : 775-84.
10. Saproo S, Sarkar SS, Gautam V, Konyak CW, Dass G, Karmakar A, *et al*. Salivary protein kinase C alpha and novel microRNAs as diagnostic and therapeutic resistance markers for oral squamous cell carcinoma in Indian cohorts. *Front Mol Biosci* 2023; *9* : 1106963.
11. Ashwinirani SR, Ajay PR, Nayak A, Suragimath G, Kamala KA, Sande A, *et al*. Oral cancer prevalence in Western population of Maharashtra, India, for a period of 5 years. *J Oral Res Rev* 2018; *10* : 11.
12. Godoy JM, Sewell A, Johnston B, Brown BT, Lu X, Sinard RJ, *et al*. Viable biobanking of primary head and neck squamous cell carcinoma. *Laryngoscope* 2013; *123* : 641-5.
13. Brancato V, Esposito G, Coppola L, Cavaliere C, Mirabelli P, Scapicchio C, *et al*. Standardizing digital biobanks: Integrating imaging, genomic, and clinical data for precision medicine. *J Transl Med* 2024; *22* : 136.

For correspondence: Dr Juhi Tayal, Biorepository, Department of Research, Rajiv Gandhi Cancer Institute and Research Centre, New Delhi 110 085, India
e-mail: juhitayal76@gmail.com