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Automated detection of microsatellite status in early colon cancer (CC) using artificial intelligence (AI) integrated infrared (IR) imaging on unstained samples from the AIO ColoPredictPlus 2.0 (CPP) registry study

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Background

Label-free Quantum Cascade Laser (QCL) based IR imaging combined with AI provides spatially and molecularly resolved alterations in unstained cancer tissue thin sections. For example, molecular alterations such as the microsatellite status (MS) can be classified. To verify the method exemplarily for MS classification, tissue samples from the prospective multicentre AIO CPP registry study were analysed (Nöpel-Dünnebacke et al., ESMO 2020).

Methods

IR images of tissue thin sections taken in 30 min with QCL IR microscopes are classified by AI (convolutional neural networks, CNN). An in-house developed segmenting CNN (U-Net) localizes tumour regions and a second CNN (VGG-Net) classifies the MS. Endpoints were area under curve of receiver operating characteristic (AUC-ROC) and area under precision recall curve (AUPRC).

Results

The multicentre clinical cohort includes 491 pts. (tumour-free 100 / tumour 391). Baseline characteristics including BRAF mutation were equally distributed among test cohorts (Table). The U-Net was verified on 491 pts. (train n=294, test n=100, validation n=97) resulting in an AUC-ROC of 0.99 for the validation dataset. The MS classifier was verified on 391 pts. (train n=245, test n=73, validation n=73) presently reaching an AUC-ROC of 0.83 and an AUPRC of 0.64. Further significant improvement is expected during longer training phase. Table: 3850

Cohort details

		Tumour detector (tumour tumour-free)			MS classifier					
		Train	Test	Validation	Train		Test		Validation	
					MSI	MSS	MSI	MSS	MSI	MSS
Age	N	240 54	75 25	76 21	71	174	19	54	12	61
	mean	68 68	70 72	73 72	76	68	72	69	77	68
Sex	f/m in %	48/52 54/46	52/48 32/68	53/47 52/48	78/22	41/59	68/32	30/70	75/25	48/53
UICC	I (%)	0	0	1 (1)	0	1 (0)	0	0	0	0
	II (%)	46 (19)	16 (21)	41 (54)	32 (45)	32 (30)	7 (13)	13 (24)	6 (50)	13 (21)
	III (%)	194 (81)	59 (79)	34 (45)	39 (55)	141 (70)	12 (87)	41 (76)	6 (50)	48 (77)
Location	left (%)	96 (40)	31 (41)	30 (40)	8 (11)	93 (53)	2 (11)	26 (48)	2 (17)	26 (43)
	right (%)	141 (59)	44 (59)	46 (60)	63 (89)	80 (46)	17 (89)	28 (52)	10 (83)	33 (54)
	other (%)	3 (1)	0	0	0	1 (1)	0	0	0	2 (3)

Conclusions

QCL IR imaging combined with AI can automatically classify unstained tumour tissue accurately in 30 min with an AUC-ROC of 0.99. Further, it provides concurrently molecular tumour classification, as shown here for the MS. Based on the morphological and molecular alterations encoded in the IR images, AI models will be extended to issues such as prognosis and response

prediction to facilitate precision oncology.

Legal entity responsible for the study

The authors.

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Disclosure

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