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RESEARCH

The Role of MRI in the Assessment of the Local Status of Anal Carcinomas and in Their Management

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Abstract This study aims to define the role of Magnetic Resonance (MR) examinations in the assessment and therapy of anal cancer (AC), and to present the main features of the MR examinations and the typical tumor spread pattern. The MR examinations of 67 anal cancer patients with histologically confirmed planocellular cancer were analyzed retrospectively. The tumor size and the signal intensity, the nodal status were examined before and after the treatment, and in recidive tumors (N=13). At the time of the diagnosis the primary tumor was in early stage (Tis, T1, T2) in 71.5 % of the cases, and it was localized in 97 %. In 97.4 % of the cases the tumor had relatively increased signal intensities compared to the adjacent muscles. Patients received chemo-radiotherapy (CRT). After CRT in 26 out of 39 patients (66.7 %) the size of the tumor decreased (in 75 %), and the signal intensity decreased on the T2 weighted (T2w) images. In the residual tumor cases (19/39) verified 6 patients out of 19 had further decrease in size, and signal intensity a year after the end of the therapy. The MR examination plays a key role in the therapy of AC, by assessing the precise local status, the possible recidive tumors, and monitoring the therapy.

Keywords MRI · Anal cancer · Staging of anal cancer · Chemoradiation therapy

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Anal cancers (AC) are rare tumors adding up less than 1 % of colorectal cancers and only 3–3.5 % of anorectal cancers [1, 2] These cancers most frequently occur between the age of 58 and 64 [3, 2, 4, 5]. In Europe and in the US the incidence of AC is 1.5:100 000 per year, one third of the patients being male, and two thirds of them female [3, 2, 4, 1, 6, 7]. The prevalence of AC has been increasing since the mid-1980s, becoming more and more frequent among males younger than 45, elderly females, and homo- and bisexual males, who change their partners frequently [3, 4, 1, 6].

The etiology of AC is multifactorial, amongst them the role of HPV, especially HPV 16 is already identified [6]. Sexually transmitted diseases are also well-known etiological factors, especially HIV positivity. Further etiological factors include smoking (eightfold risk), and benign anorectal conditions, such as fistula, fissure, abscess, and hemorrhoids [6, 5, 1, 3].

Malignant diseases like vulvar, vaginal, and cervical cancers may double the risk of AC. In case of transplanted patients the immune suppressed state is the main risk regarding AC. Beside AC the prevalence of second malignancy increases, mostly bladder, breast, vulvar, vaginal and cervical tumors may occur [6, 5, 1, 3].

The Anatomy of Anus

The anal canal lies between the anorectal junction and the anus. The anorectal junction can be identified at the level of

the origin of the levator ani muscle, the puborectalis muscle (PM). Caudally from the PM lies the pectinate line (dentate line, PL), which is a useful surgical landmark, but it cannot be visualized by MR imaging [5, 8]. The PL is situated 2–3 cm cranially from the anus. The mucosa of the intestinal wall is covered with glandular epithelium above the PL, and with squamous epithelium below the PL. At the level of PL the mucosa is covered with a mixed epithelial tissue consisting of both squamous and glandular epithelial cells called transitional epithelium. The approximately 5-cm-radius pigmented area around the anus is defined as the perianal region [5, 1].

The Histology of ACs

The majority (80 %) of ACs are squamous cell carcinomas (SCC), followed by the less frequent adenocarcinoma (8–15 %), and the rare verrucosus carcinoma. SCCs situated near the anus are mostly keratinizing and well differentiated. The ones located in the anal canal are mostly less differentiated, non-keratinizing. They are also called cloacogenic/basaloid carcinomas, which represent 20 %. These transitional types of carcinomas have the worst prognosis [5, 1].

Neuroendocrin carcinoma is a highly aggressive subtype, which mainly occurs associated with HIV positivity. The more uncommon verrucosus carcinoma appears clinically as a huge condyloma-like lesion (Buschke-Löwenstein tumor), which infiltrates deeply and expansively, but it never metastasizes [3, 1, 4, 5].

Based on the latest literature at the time of the diagnosis more than half of these tumors are at stage I. II. Approximately one third of them have a more than 4-cm-long diameter, and in 15–20 % of the patients the adjacent structures, like vagina, prostate, and ischiorectal fossa are infiltrated. The size of the tumor predicts its outcome: below 4–5 cm the prognosis is mostly good; above this size the prognosis becomes significantly worse [9–11].

The Diagnosis of ACs

The diagnosis of AC is based on proctoscopy and biopsy, which is mainly executed in general anesthesia [10–12]. Diagnostic imaging plays a key role in the assessment of the nodal state, mainly in the case of pararectal and parailiacal nodes, which cannot be evaluated by clinical examinations. Transanal ultrasound (TAUS), computed tomography (CT), and MR imaging are also used to evaluate the extent of the disease. TAUS is an excellent method to assess the local status, but the endoanal insertion of the transducer is painful and it has a limited viewing distance. The TAUS is not capable of assessing the mesorectal nodes, which are far from the intestinal wall [13, 14]. This is also the limiting factor of the MR imaging combined with endoanal coils [15]. The ESMO guideline (2010.) states the MR imaging is the primary imaging modality in assessing the status of ACs [10, 1]. To achieve good quality with high resolution MR images the use of phased array coils is needed. To assess the distant nodal metastases the use of CT is recommended [10, 11, 16, 17].

Staging the Anal Cancers

The T stage of AC is based on the longest diameter of the tumor. Tumors smaller than 2 cm are the T1 stage, between 2 and 5 cm is the T2 stage, and the tumors exceeding 5 cm in diameter are the T3 stage. In case of T4 stage the tumor involves adjacent structures as well, like the vagina, prostate, urethra, bladder, and sacrum. The involvement of the sphincter complex (levator ani, inner and outer sphincters, puborectal muscle) and the perianal skin is not considered as T4 stage.

The nodal state is not based on the number of the nodes but on their localization, mainly on the distance of the affected nodes and the primary tumor.

In case there is no visible regional node the N stage is N0. When pararectal nodes are affected the N stage is N1. N2 is the N stage when on one side a parailiacal or an inguinal node is affected. In case of affected pararectal node and/or parailiacal or inguinal nodes affected on both sides the N stage is N3. In case of distant metastatic node it is called M1 stage [18, 19].

At the time of the ACs diagnosis the nodes are affected in 25–45 % of the cases. Affected nodes have a significantly negative prognostic value [10, 11, 20–22].

Treatment of the ACs

Until the mid 1980s surgery was the dominant therapy. Today the treatment is multimodal; the standard therapy is chemo-radio therapy (CRT), which, in the majority of the cases, is definitive. The role of surgery as a primary therapy is limited, local excision is only recommended in the case of small-size (less the 2 cm) low stage (T1N0M0) tumors [23, 10, 11]. In the event of higher T stages the risk of nodal metastases increase, therefore combined CRT is needed [24–29]. Surgery plays a key role in cases of ileus, in tumors not responding to CRT, or in case of recidive tumors [10, 11]. The main surgery types include excision, abdominoperineal resection, or in cases of advanced tumors, pelvic exenteration.

The standard chemotherapy is the combination of 5-flurouracil and mitomycin-C. The radiotherapy (RT) includes the irradiation of the primary tumor, and the primary locoregional lymph nodes, and based on the CT planning additional boost field RT is delivered. The management of

the recidive tumors is also multimodal, if possible surgery with additional chemotherapy and with RT (if still possible) [30, 31].

Materials and Methods

Patients

151 MR examinations of 67 patients with histologically verified AC were analyzed retrospectively in our Institute between 2006 and 2012. All patients had a primary staging examination. 39 patients out of 67 had follow-up scans besides primary staging, being altogether 137 scans.

To Assess the Distant Metastases CT was Performed

All the 67 patients were treated with CRT, which consisted of 25 fractions of radiotherapy (45 Gy), and then after CT planning boost field radiotherapy was performed on the primary tumor, and around its environment (54–58,5 Gy). Parallel with RT, chemotherapy was performed as well, with the combination of 5-fluoroacil (100 mg/m$^{2)}$, and mitomycin-C (7 mg/m^2).

Diagnostic Imaging

All the MRI scans were performed on a 1,5 Tesla Magnetom Symphony (Siemens), and pelvic phased-array coils were used to obtain high resolution images. There were no special preparations before the scans. To decrease the motion artifacts originating from the bowel movements an intravenous or intramuscular injection of Buscopan was used in 20 to 40 mg dose directly before the examination. If needed it was repeated during the scan.

T1 weighted, T2 weighted and STIR sequences were used with 300 mm field of view (FOV), and with a slice thickness of 5 mm. To plan the thin slice sequences sagital T2w sequences were performed with 250 mm FOV and a slice thickness of 4 mm. Then coronal and axial T2 w sequences were performed with a high resolution technique, 180 mm FOV and a slice thickness of 3 mm.

The axial slices were performed orthograde to the anal canal, the coronal sequences were performed parallel to the anal canal. Then intravenous gadolinium based contrast material was used (0,1 ml/kg). After that 3D T1w fat suppressed sequences were performed. The average time of examination was 35 min Table 1.

The CT scans were performed with a Siemens Somatom Emotion 16-slice scanner with the use of IV contrast material and also oral CM to visualize the bowels.

Data Analysis

The examinations were reviewed by two experienced radiologists independently from each other.

The Patients Were Analyzed in Multiple Groups

Group A The age and gender distribution of the 67 patients with histologically verified squamous cell carcinoma were examined, together the size, stage and histology of the tumor. The tumor treatment methods, the malignant tumors before and after the time of AC diagnosis, and the recidive tumors were studied. The localization of the metastases, as well as the results of the anatomical and functional imaging was followed, and metastases and recidives which developed during the follow-ups were registered.

In case of the patients (n=13) whose recidive tumor was diagnosed during the follow-up, we examined the time of the occurrence compared to the termination of the primary tumor treatment. The T and N stages and the invasiveness of the recidive tumor were compared to those of the original primary tumors.

Group B The AC patients (39) who had MRI examinations to assess the primary tumor stage and also follow-up MRI scans after CRT, the regression rate of the tumor were evaluated.

The age and gender distribution, and the histology of the tumor were also analyzed in this group. Additionally, the signal intensity of the tumors was also analyzed in this group before and after the treatment. After the treatment in those cases which showed signal intensity suggestive of residual tumor —depending on the clinical status— biopsy or follow-up imaging was performed every 3 months.

Evaluation Criteria of the MRI Images

At the initial MRI examinations the size, the tumor stadium, the MRI signal intensity of the anal carcinoma, the infiltration of the adjacent organs and structures as well as the nodal metastasis were observed. The maximal extent of the tumor was measured by millimeters accuracy on T2 weighted images.

The local tumor status (T status) was also observed according to the UICC/AICC 7th ed. TNM criteria [18, 19].

T2 weighted images were acquired to measure the signal intensity of the tumor (tSI). The tSI was compared to that of the gluteal muscle and considered as hypointens (−), isointens (o) or hyperintens. The hyperintens category was divided into minor (+), moderate (++) or strong (+++) subcategories.

The relation of the tumor to the adjacent structures was examined as well. The infiltration of the rectum, the external and internal anal sphincter muscles, the levator muscle, the ischiorectal fossa, the ventral urogential space (vagina,

Table 1 MR imaging protocols for imaging anal canal tumors

Imaging planes	Sequence	Fat suppression	TR (ms)	TE (ms)	NEX	Field of view (mm)	Imaging matrix	Slice thickness (mm) [gap]
Sagital	T2TSE	No	7670	97	4	250	256	4[1]
Coronal-angled to the anal canal	T2TSE	No	3200	92	4	180	256	3[1]
Axial- angled to anal canal	T2TSE	No	5170	92	4	180	256	3[1]

prostate), the perianal subcutaneous tissue, and the perianal skin were examined as well.

The size and structure of the lymph nodes were also investigated. A lymph node was considered malignant if the shortest diameter exceeded 0.5 cm in the perianal, or 1 cm in the inguinal or parailiacal regions. A lymph node was considered metastatic if signs of central necrosis or sheath damage were present.

It has to be mentioned that according to histopathological examinations, almost half of the metastatic lymph nodes in anal carcinoma were smaller than 0.5 cm, which is similar to that of the rectum tumors [32].

The lymph node status was observed according to the UICC/AICC 7th ed. TNM criteria as well.

The rate of the tumor regression after the chemotherapy was estimated according to the Response Evolution Criteria in Solid Tumors (RECIST) 1.1 criteria. The tumor size and the signal intensities were calculated as well.

Results

Group A

There were 52 female (78 %) and 15 male patient (age: 61 years±SD) with histologically verified squamous cell carcinoma. Planocellular carcinoma occurred in 53 cases (79 %), basal cell carcinoma in 13 cases (19.5 %) and verrucosus carcinoma occurred in 1 case (1.5 %).

The average size of the primer anus carcinomas was 3.1 cm. Early tumor (Tis, T1, T2) was found in 48 patients (71.5 %). In situ carcinoma occurred in 1 patient (1.5 %), whereas in 10 patients (15 %) the tumor was in T1 stadium and in 37 patients (55 %) a tumor with T2 stadium was diagnosed. In 13 patients (19.5 %) the tumor was in T3, and in 9 patients (9 %) the tumor achieved the T4 stadium. (The details are shown on Table 2).

Forty-five patients did not have metastatic lymph nodes, whereas pararectal lymph node metastasis was present in 11 cases (16 %), N2 status was in 8 (12 %) and N3 status was observed in 3 patients (5 %).

In the majority of the patients (45 out of 67, 51 %), the tumor was localized at the time of the diagnosis. In 2 cases distant metastases were detected. In both patients the metastasis was localized in the sacrum and in the os coccygeum. The distribution of the metastatic lymph nodes and the localization of the metastases are shown on Table 3.

In 51 % of the patients the adjacent structures were infiltrated. The sphincter complex was infiltrated in 9 patients, in 10 cases the anterior urogenital triangulum (prostate, vagina, urethra), in 5 patients the rectum, in 4 cases the levator ani, in 1 patient the ischiorectal fossa, in 3 cases the perianal subcutis and in 2 patients the perianal skin was found infiltrated as well (Fig. 1).

Previous malignant disease was present in the anamnesis of 9 patients (1 larynx tumor, 1 soft tissue sarcoma, 3 breast tumors, 2 ovary tumors, and 2 cervix carcinomas).

In 10 patients during the follow-up period, distant metastases were developed. Dissemination was observed in the liver and in the bone (4–4 patients). Metastases were found in the lung and in the retroperitoneum in other 2 patients. In other patients metastases in the abdominal skin, in the gluteal muscle and in the adrenal gland were diagnosed as well.

The development of a second primer tumor was found only in 2 cases: in the first case a lower extremity melanoma malignum and in the second case a vulva tumor were also diagnosed.

Tumor recurrence was observed in 13 patients (19.5 %). The average time of developing tumor recidive after the last treatment was 34 months (11–60 months). The stage and the

Table 2 Staging of primary and metastatic anal cancers

Primer anal cancer staging 67 patients					
T	Tis	T1	T2	T3	T4
Number of cases	1	10	37	13	6
%	1, 5 %	15 %	55 %	19,5 %	9 %
N	N0	N1	N2	N3	
Number of cases	45	11	8	3	
%	67 %	16 %	12 %	5 %	
Relapses 13 patients					
T	Tis	T1	T2	T3	T4
Number of cases	2	1	3	3	4
%	15,4 %	7,7 %	23,1 %	23,1 %	30,7 %
N	N0	N1	N2	N3	
Number of cases	6	1	1	5	
%	46,1 %	7,7 %	7,7 %	38,5 %	

Table 3 Metastatic lymph node localization and metastases

Lymph node involvement, number of cases(%)Primer anal cancer, 67 patients	
Perirectal	17 (43.6)
Left iliac	10 (25.6)
Right iliac	3 (7.7)
Left inguinal	11 (28.2)
Right inguinal	13 (33.3)
Metastatic disease, number of cases	
Liver	0
Bone	2
Peritoneum	0
Lung	0
Cutaneous	0
Muscle	0
Suprarenal gland	0
Lymph node involvement, number of cases (%)Relapses, 13 patients	
Perirectal	7 (53)
Left iliac	5 (38,5)
Right iliac	3 (23.1)
Left inguinal	2 (15,4)
Right inguinal	1 (7,7)
Metastatic disease, number of cases	
Liver	2
Bone	2
Peritoneum	1
Lung	1
Cutaneous	0
Muscle	0
Suprarenal gland	0

lymph node status of the recidive tumors were different than that of the primer tumors. Amongst the recidive tumors more advanced stages (T3, T4) were found in 53.8 %, early stages (Tis, T1, T2) were found only in 46.2 % of the patients. Metastases were found in 53.9 % of the locoregional nodes. In case of recidive tumors, the parailiacal and pararectal nodes were affected in significantly higher numbers than the inguinal nodes, compared to the primary tumors.

The data summary of the recidive tumors are also shown in Table 2.

Group B

The gender, and age distribution of the patients (n=39), who had beside the primary staging examination follow-up scans as well, is not significantly different from the ones who only had primary staging examinations (Group A). There were 32 female, and 7 male patients (82 %/18 % respectively), and the mean age was 61.1 years±SD. At the time of the primary staging examination the diagnosed tumor average size was 4.7 cm.

The histological distribution in this group was as follows: squamous cell carcinoma 79.5 %, basaloid carcinoma (20.5 %). All the patients received CRT. After the therapy follow up scans were performed 4–18 (average 7.6 weeks) weeks later. The size and signal intensity of the tumor were compared before and after the treatment.

The average size of the tumors was 4.7 cm, and in 38 patients out of 39 the tumor had higher signal intensity on T2W images than the surrounding muscles. In one case the signal intensity was nearly the same as the surrounding muscles, so the tumor was differentiated carefully observing the local distortions it caused in the anus. Among the hyperintens tumors in five cases the T2 weighted sequences showed inhomogeneous signal intensities.

The tumor size decreased after the CRT, the average rate was 76.4 %, compared to its original size. In 26 cases (66.7 %) the regression was excellent, the regression rate was more than 75 % and in 20 cases (51.3 %) total regression (100 %) could be observed. One patient did not respond to the therapy, and after the CRT, in this case the tumor size increased minimally.

In responding, early stage (T1, T2) cases, 20 patients out of the 26 patients (76.9 %) had an excellent regression rate, even exceeding 75 % (97.5 %). The regression rate in size and in percentage, and the signal intensity changes are shown in Table 4.

19 out 39 patients' tumor were hyperintens after CRT, 8 out of the 39 were isointens and 10 out 39 patients were

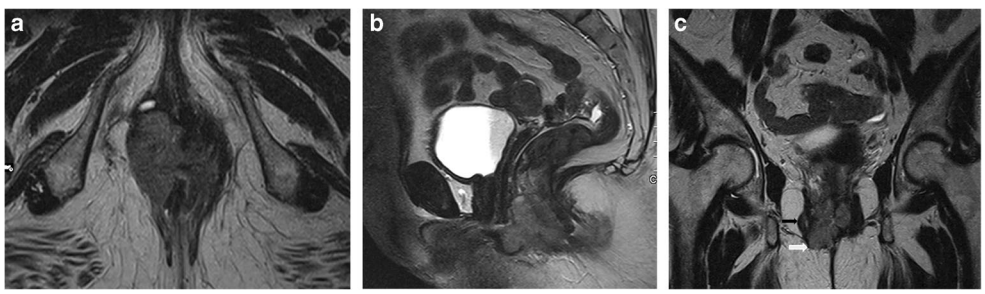

Fig. 1 Local tumor spread. T2w image **a**: axial plane, **b** sagital and **c**: coronal plane. Visible tumor in the wall of anus with right sided dominance. Tumor spread into the wall of vagina (**a**, **b**) infiltration of the levator (*white arrow*) and and the inner spinchter (*black arrow*). Tumor spread also visible into the lower third of the rectum (**c**)

Table 4 Summary of MRI features in all 39 patients

Patient	Gender	Age	Tumor size (cm)	yTumor size (cm)	*Reduction in tumor size (%)*	Histology	Tumor signal intensity	*yTumor signal intensity*	controll time after CRT (week)
1.	F	76	4	0	100	planocell.	+	0	6
2.	F	57	3,9	0	100	planocell..	++	−	8
3.	F	65	2,5	0	100	planocell.	+++	++	9
4.	F	66	7	3	57,1	planocell.	+,++,+++	++,+++	12
5.	F	54	5	0,5	90	planocell.	+	−	7
6.	F	50	2	0	100	planocell.	++	o	7
7.	F	68	5	0	100	basaloid cc	++,+++	o +	12
8.	M	70	2,5	0,8	68	planocell.	++	++	8
9.	M	56	10	10	0	planocell.	+	++, +++	6
10.	F	48	4	0	100	planocell.	++	−	6
11.	F	36	2,6	0	100	planocell.	++	−	6
12.	F	68	5,8	5	13,8	planocell.	+++	++	8
13.	F	59	3	2,7	10	planocell.	++	++	7
14.	F	56	2	0	100	basaloid cc	++	o	10
15.	F	60	4,2	0	100	basaloid cc	+++	−	7
16.	F	72	8	0	100	planocell.	+++	o	13
17.	F	48	3,5	0	100	planocell.	++	o	9
18.	F	57	7,5	0	100	planocell.	+++	−	9
19.	F	61	2	1,4	30	basaloid cc	++, +++	++, +++	8
20.	F	70	2,6	0	100	planocell.	++	o	6
21.	F	65	6	0	100	planocell.	++	−	16
22.	F	65	5	3,5	30	planocell.	−	−	4
23.	F	62	7,6	0	100	basaloid cc	++	o	6
24.	F	59	3	0	100	planocell.	++	−	3
25.	M	70	8	2,3	71,3	planocell.	++	++, +++	3
26.	F	62	4	0	100	planocell.	++	o	6
27.	F	67	4,8	1,2	75	planocell.	++	o,+	12
28.	F	38	5	1,7	66	basaloid cc	++	− o +	8
29.	F	75	2,5	0	100	planocell.	++	−	6
30.	M	38	4	1	75	planocell.	+++	+, ++	6
31.	F	67	2	1,8	10	planocell.	+++	++	4
32.	M	56	9,8	9	8,2	planocell.	+++	o, +, ++	8
33.	M	66	6	0	100	planocell.	++	−, o	7
34.	F	85	4	1	75	basaloid cc	++	o, +	6
35.	F	70	7	1,4	80	planocell.	++, +++	−, o, +	5
36.	F	66	8	1,2	85	planocell.	++	−, o, +	8
37.	M	57	2	0	100	planocell.	++	−, o	10
38.	F	57	6	1	83,3	planocell.	+, ++	o, +	5
39.	F	61	4	2	50	basaloid cc	++	+	8

hypointens on T2w sequences. In the other cases regarding the original site of the primary tumor inhomogeneous signal intensities were found.

Residual tumor was observed on MRI in 19 patients out of the 39 (48 %). In this patient group biopsy was performed, in 8 cases out of 9 residual tumor was confirmed, and in one case the histology showed only fibrosis and signs of inflammation.

In those cases where the clinical examinations showed complete remission, but on the MR images residual tumor could be observed, the follow-up MR scans after 1 year (after CRT 6. 9. 12 months) in 6 patients showed further regression in size, and in signal intensity. 5 patients showed steady-state residual signal intensity changes, which was very similar compared to the baseline post CRT state signal intensities in

4 cases. In 1 case where imaging (6, 9 months after treatment) suspected residual tumor, but clinical examinations, and repeated biopsies didn't confirmed that, surgery was performed, and the histology was gastrointestinal stromal tumor (GIST) in the rectovaginal septum.

Discussion

Squamous cell carcinoma of the anus is rare, representing only 1.5 % of the lower gastrointestinal tract tumors. The AC is only somewhat similar to the rectal cancers in its location, but in any other way differs from them, because it has a unique histology, clinical behavior, diagnostics, and therapy. Furthermore, AC shows a good response to CRT [23, 10, 11, 24, 28, 27].

Based on the literature, at the time of the AC's diagnosis in 75 % of the cases the stage is T1-T2, and the nodes are affected in 25 to 45 % of the cases [3, 30, 10, 11]. In our study early stage tumor could be observed in 71 % of the cases, and the nodes were affected in 33 % of the cases, which is similar to the data found in the literature. The adjacent structures were infiltrated in a slightly higher number in our study than in the literature: 51 % versus 25–45 % [24, 31]. At the time of the diagnosis the presence of distant metastasis is rare; in our study only two patients (3 %) had distant metastasis, in both cases it was situated in bones.

Our study showed a slightly more female dominance in the gender distribution than the literature data. Regarding the international data males are affected in 33.3 % and females in 66.6 % [10, 11, 4], in our study males were affected in 22 %, and females in 78 %. Our findings correlated with the latest publications regarding the distribution of the age and histopathology. The histopathology was squamous cell carcinoma in 53 cases (79 % similar to the literature data of 80 %), basaloid cell carcinoma in 13 cases (19.5 % vs. the literature data of 20 %) [3, 27] and verrucosus carcinoma was observed only in one case.

In our study the cancers were mainly locoregional (94 %, 65 patients), and the majority of the patients were definitely treated with CRT. Locoregional relapse was observed in 19 % (13 out of the 67 patients) and distant metastasis was observed in 15 % (10 patients). According to the National Cancer Register in the UK it can be observed in 12 % of the cases [25], in our study it was 15 %.

Based on the literature data, in the case of ACs which exceed the 4 cm in diameter at the time of diagnosis, where affected node is present, and the histology is basaloid cell carcinoma have a higher chance to relapse locoregional [5, 27, 28]. We observed similar tendency in our study, in 4 cases out of the 13 relapse case, the histology was basaloid cell carcinoma. Among all the cases basaloid carcinoma was present in 19.4 %.

In case of the local recidives the primary tumor average size was larger in diameter than the cases which were relapse free 4.7 cm vs. 2.3 cm.

The recidive tumor and the nodal state were also in a more advanced stage in the cases when relapse was present. While 71 % of the primary tumors were in early stage Tis,T1, T2, among the recidive tumors the more advanced cases(T3,T4) were dominant (53 %). In 67 % of the primary ACs there were no affected nodes. In case of the recidive tumors the nodes were affected in 53.9 %. In case of recidive tumors, the parailiac and pararectal nodes were affected in significantly higher numbers than the inguinal nodes, compared to the primary tumors.

The data summary of the recidive and primary tumors are shown in Table 2.

4–8 weeks after CRT complete regression is a good prognostic sign in terms of locoregional control [28, 11]. Earlier studies showed the regression rate of higher than 80 % is a good predicting factor of a 2-year tumor-free survival, it can take 3–6 months after CRT to complete regression [31, 27, 33]. The explanation of this can be the differences between the

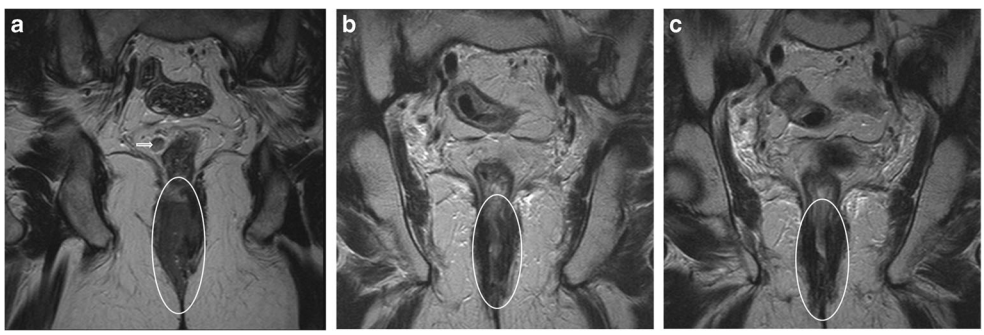

Fig. 2 Regression after CRT. **a** Irregular hyperintens thickening is visible in the wall of the anus on T2w images and suspected malignant pararectal lymph node can be observed on the right side. **b** Considerable level of regression is visible 8 weeks after the treatment, but at the site of the original tumor lower signal intensity (isointens) can be observed. **c** Hypontens signal intensity is visible at the site of the original tumor after 12 months, which suggesting scar tissue

radio-sensitivities of the anal carcinomas. The most sensitive to irradiation is the basaloid cell carcinoma, which could be observed also in our study, even the extreme sized basaloid cell carcinomas showed complete remission 6–8 weeks after the CRT.

In the UK the study of The Council of Cancer Research [25] showed that in 70 % of the patients in whom the remission was not complete 6 weeks after the therapy, the tumor showed more regression after further follow-up scans. In our study the same result could be observed, after the primary treatment. When the MR examinations showed residual tumors, the final local status could be observed only after 1 year.

Our study is supporting the few studies available which recommend the use of external phased-array coils during MR examination [15, 13, 34], stating it is an excellent method to assess the local status of anal cancers, and to monitor the therapy.

Most of the anal cancers showed high signal intensity, and involved mainly the sphincter complex and the rectum, according to the earlier published studies [34, 15, 35]. Tumor spread into the urogenital tract (vagina, prostata) in these tumors was not typical.

At the time of the diagnosis the local nodal involvement was not rare (34 %). Affected node could be observed in the parailiac, parainguinal, and also in the pararectal region.

After CRT (average 7.6 weeks) most of the patients showed good regression with MR examination, and in 26 out of 39 patients the rate of regression was over 75 %. The evaluation of regression was based on the RECIST 1.1 criteria, and the signal intensity changes on T2w images had supportive information to that. The follow-up scans showed even more regression after 6 months (Fig. 2).

Where residual tumor was present (19 patients in our study) during the follow-**up** scans the MR signal intensity was stable in 5 patients —in one of them another primary tumor was verified— 6 showed further regression, and only 8 patients had histologically confirmed residual tumor.

Regarding MR examinations the coronal and axial T2w images were the most useful ones in assessing the AC's local status, and size, and to assess the infiltration of the adjacent anatomical structures.

In case of recidive tumors, the local tumor spread and the infiltration of the adjacent anatomical structures were increased comparing to the primary tumor. Also the parailiacal, pararectal, and presacral nodes were affected in significantly higher numbers than the inguinal nodes, compared to the primary tumors.

These data show the growing importance of MR examinations in the assessment of the local status of AC. Today the MR examination is not routinely part of the clinical examinations, the diagnosis is still based on clinical findings. The growing use and availability of intensity modulated radiation therapy (IMRT) in the therapy of AC, the more precise tumor localization, and the assessment of the exact nodal state is playing a key role. The high resolution MR examination allows more precise radiotherapy planning, and affects the overall outcome of the AC.

Conclusion

The MR examination plays a key role in the therapy of the AC by assessing the precise local status. On the high resolution MR images the radiotherapy can be planned precisely. The MR examination is the first choice to monitor the therapy, and to assess the possible residual tumors. It also serves as a baseline study to monitor the therapy. With the baseline study during the follow-up scans the residual, or recidive tumor can be discovered earlier, which improves the long time survival of these patients.

Conflict of Interest There are no conflicts of interest to declare.

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