# Water enema CT examination of rectum cancer by reduced amount of water

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***Summary.*** **Objective:** To define whether volume of water, administered during water enema CT (WE-CT) for local staging of rectal cancer, may be reduced without compromising the diagnostic value of the examination. **Materials and Methods:** 29 patients with rectum cancer underwent preoperative WE-CT. Contrast-enhanced CT (equilibrium phase) measurements were performed after i. v. injection of smooth muscle relaxant and rectal administration of 400 – 500 ml lukewarm tap water. Quality of the obtained scans was evaluated and the images were analyzed for depth of tumor invasion. Results of the CT examinations were compared to findings at surgery. **Results:** Despite reduced dose of water enema, 19/29 examinations were of excellent quality, 6/29 good, and 4/29 poor, but still diagnostic. We achieved sensitivity (90.1), specificity (70.1) and accuracy (86.2) in differentiating tumors confined to the bowel wall from those extending beyond it. **Conclusion:** Large volume of water enema administered during CT examination of the rectum may cause complaints and increases the risk of complications. Our results prove that using lower amount of water does not impair the quality of examination and accuracy of local staging of rectum carcinomas.

**Key words:** Staging of rectum cancer – Computed tomography

***Hydro-CT des Rektumkarzinoms mit reduzierter Wassermenge.*** **Zielsetzung:** Beurteilen, ob die in der Hydro-CT (H-CT) rektal applizierte Wassermenge reduziert werden kann, ohne den diagnostischen Wert der Untersuchung im lokal-Staging des Rektumkarzinoms zu mindern. **Material und Methode:** 29 Patienten mit Rektumkarzinom wurden präoperativ mit H-CT untersucht. Nach i.v. Prämedikation zur Darmparalyse wurden rektal ca. 400 – 500 ml lauwarmes Wasser appliziert, und i.v. kontrastverstärkte CT-Untersuchungen durchgeführt. Die Qualität der CT-Scans und die Tiefe der Invasion des Tumors in die Darmwand wurden analysiert. Die computertomographischen Befunde wurden mit den Operationsbefunden verglichen. **Ergebnisse:** Trotz der reduzierten Menge des Einlaufswassers, 19/29 Untersuchungen hatten ausgezeichnete, 6/29 gute, und 4/29 schwache aber noch bewertbare Qualität. Wir erreichten 90,1 % Sensitivität, 70,1 % Spezifität und 86,2 % Treffsicherheit in der Differenzierung zwischen den sich an die Darmwand beschränkenen bzw. die Darmwand übertretenen Tumoren. **Schlussfolgerung:** Große Einlaufswassermenge in der H-CT kann zu Beschwerden führen und steigert das Wagnis von Komplikationen. Unsere Ergebnisse beweisen, dass die reduzierte Wassermenge verschlimmert die Qualität der Untersuchung und die Genauigkeit von local-Staging des Rektumkarzinoms nicht.

**Key words:** Staging des Rektumkarzinoms – Computertomographie

## Introduction

Rectum malignancies are usually diagnosed on the basis of clinical examination, endoscopy and/or barium enema study. Optimal management of rectal tumors requires accurate preoperative staging to select patients who may benefit from less aggressive surgery or adjuvant therapy (preoperative radiation therapy, improved chemotherapy regimens) [1 – 3]. Because of inaccuracy of local staging by clinical examinations, cross-sectional imaging modalities – computed tomography (CT), transrectal ultrasound (TRUS), and magnetic resonance imaging (MRI) – are used for this purpose. The accuracy of CT examination may be significantly variable, depending on technical parameters of the examination (rectal distention, endoluminal and intravenous contrast material, smooth muscle relaxant, etc.) [1,4]. In the recent decade many authors described their experience with performing CT of the rectum with aqueous distention to improve visualization of the bowel wall. The generally used dose of water enema, as described in these publications, is in the range of 1000 – 2000 ml, however, it must be emphasized that several of these studies described the examination of the entire colon [3, 5 – 9], while others referred to the optimal visualization of the rectum [1,2,10].

We have routinely performed water enema CT (WE-CT) examination for the evaluation of rectal cancer and other pelvic diseases in the last 4 years with protocols similar to that of the above-mentioned authors. The relative incidence of complaints like abdominal discomfort, pain, incontinence was in close correlation with the amount of water administered rectally during the examination. The purpose of our study is to answer the question whether it is possible to perform a WE-CT of good diagnostic quality with significantly less water.

## Material and Methods

The study group consisted of 29 patients (13 women, 16 men, mean age 65 years) with rectum carcinoma, diagnosed by endoscopy and/or double contrast barium enema examination.

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Prior to tumor resection all patients underwent WE-CT examination.

The CT protocol included small bowel opacification by oral administration of contrast material (diluted iodinated water soluble contrast material or diluted barium suspension). Previous colon cleansing was not used. 1 ml Buscopan or 0.5 mg Glucagon was administered intravenously at the time of examination and subsequently 400 – 500 ml lukewarm tap water enema was given. Intravenous contrast material (100 – 120 ml at 2.5 ml/s) was administered to all patients. Scanning was initiated 30 s after the start of the bolus. The abdominal examination was performed (depending on the equipment used) by helical mode (collimation: 10 mm, pitch: 1) in 23 patients, and by incremental measurements (slice: 10 mm, feed: 10 mm) in 6 patients. The pelvic scans were obtained by incremental mode in all patients (5 mm slice thickness and slice interval in 11 patients and 10 mm in 18 patients, depending on the size of the lesion), without any gantry tilt, from the aortic bifurcation level to the perineum. The measurements were performed on a Siemens Somatom Plus 4 (23 patients) or a Siemens Somatom AR HP (6 patients) scanner.

Acceptance of the enema by the patient, the volume of water, and the degree of bowel distension were registered. Computed tomography was prospectively evaluated by board-certified radiologists who were informed about the results of the barium enema and endoscopy. For purposes of this study we analyzed image quality and the local T stage [9] separately. The quality of the examination was classified as excellent, if the bowel was appropriately distended and homogeneously filled with water; good, if the distention was adequate, but the rectum contained significant amount of gas in addition to the water; and poor, if the distention was inadequate and/or only a minimal amount of water remained in the rectum by the time of examination. A bowel wall thickening greater than 3 mm was considered abnormal. Tumors confined to the bowel wall were classified as T1 – T2. Any strand of tissue on adjacent fat, a spicular, or irregular appearance of the external contour of the rectum wall were taken as signs of perirectal invasion and ranked the tumor as T3. Loss of fat planes or infiltration of adjacent organs was considered as evidence of T4 stage. Surgical and pathologic proof was obtained in all cases and was correlated with the results of the WE-CT interpretation.

The N and M stage of the tumors were not evaluated in this study.

## Results

The examinations were tolerated well and without any major complaints (pain, colic, collapse, etc.) by all patients, except two, who experienced severe pain and were unable to hold the water enema for the duration of scanning. No complication related to the WE-CT occurred in this study group. 7 tumors were confined to the lower third of the rectum, 16 to the middle third and 6 to the cranial third and the recto-sigmoid region, respectively. Size of maximal diameter of tumors found at surgery was 2.1 – 8.9 cm (mean 6.8 cm). Pathological examination diagnosed adenocarcinoma in 25 cases and malignant villous adenoma in 4. 7 tumors were confined to the bowel wall (T1 and T2), 19 corresponded to stage T3 and three to T4.

The bowel distention and the filling of the lumen by water were excellent in 19 cases (65.5%). In 6 patients (20.7%) the distention was good but significant amount of gas was found in the bowel lumen together with the water. The quality of the examination was defined as poor in 4 cases (13.8%) because of inadequate distention or insufficient opacification of the bowel lumen. All of these 4 patients had highly stenotic tumors and two of them could not hold the enema during the examination. Despite the poor quality of these examinations the size and extent of the tumor could be well estimated (Figs. **1 – 5**).

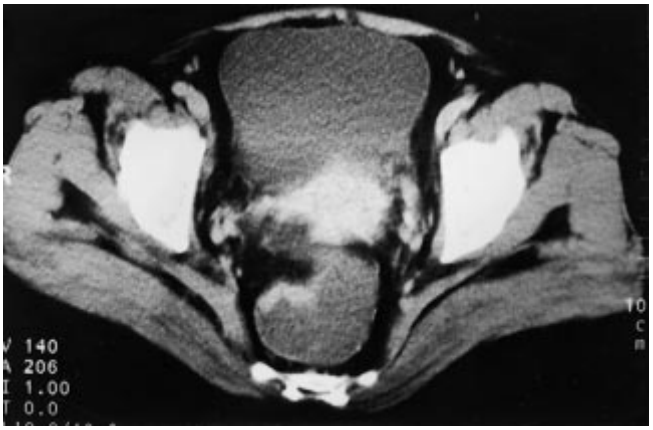


**Fig. 1** WE-CT examination of the rectum (500 ml water enema) results in appropriate distention and good filling with water. Minor circumscribed thickening of the anterior wall represents a T1 stage carcinoma. The surrounding structures are not affected.


**Fig. 2** WE-CT examination of the rectum (500 ml water enema) shows moderate thickening of the anterior-left lateral wall (T2 stage carcinoma) without any sign of extension beyond the bowel wall.

All tumors were identified at the CT examination. 7 tumors belonged to the surgical T1/T2 stage, 5 of which were correctly classified as confined to the bowel wall. Two patients belonging to the surgical T1/T2 group were overstaged, due to inflammatory reaction adjacent to the tumor. WE-CT correctly identified 16 neoplasms of the 19 invading the perirectal space (T3), understaged two and overstaged one. The CT staging was correct in two of three patients with tumor infiltrating adjacent organs [14]. One patient of the 14 group was understaged; the WF-CT examination failed to recognize the invasion of the perineum. However, we involved the overestimated T3 and the underestimated T4 in the group of the correctly staged cases

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**Fig. 3** WE-CT examination of the rectum (500 ml water enema) results in satisfactory distention, but the water does not fill completely the bowel lumen, there is a small amount of gas behind the anterior wall, nevertheless the excavated tumor, confined to the posterior wall is well visible. The perirectal fat is not infiltrated.

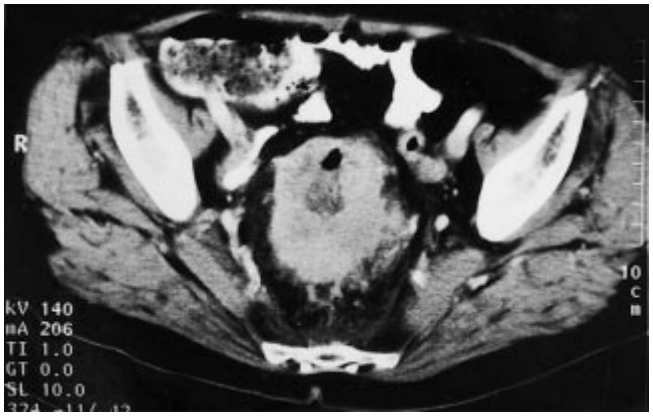


**Fig. 4** WE-CT examination of the rectum (500 ml water enema): the advanced (T3 stage) carcinoma of the rectum invades the surrounding fat tissue.

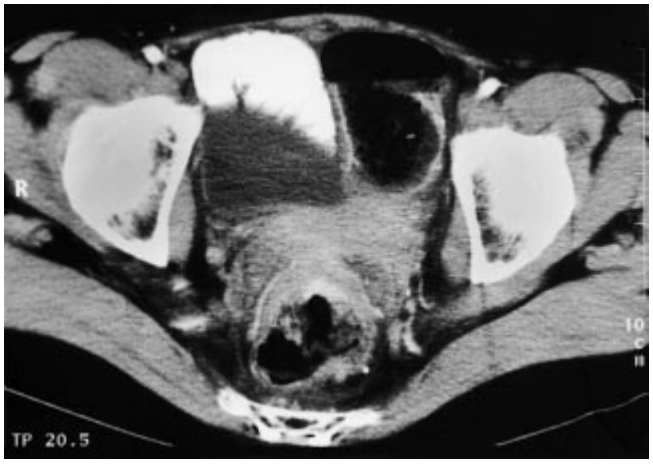


**Fig. 5** WE-CT examination of the rectum (500 ml water enema): the tumor of the anterior rectum wall invades the posterior wall of the vagina (T4 stage).

because they both remained within the limits of the T3/T4 group (Table **1**).

**Table 1** Comparison of surgical stage of 29 rectum tumors with results of WE-CT.

| Surgical stage | CT correct | CT overstage | CT understage |
|---|---|---|---|
| T1/T2 (n = 7) | 5 | 2 | 0 |
| T3/T4 (n = 22) | 20 | 0 | 2 |

The statistical analysis of the WE-CT results for the T1/T2 group showed 71.4% sensitivity, 90.9% specificity and 86.2% accuracy. The positive predictive value was 71.4% and the negative predictive value 90.9%. The respective figures in the T3/T4 group were: sensitivity 90.9%, specificity 71.4%, accuracy 86.2%, positive predictive value 90.9%, negative predictive value 71.4%. Fecal material in the lumen of the bowel could be detected in most of the cases, but its gas content helped to differentiate it from solid masses.

## Discussion

Barium enema and colonoscopy provide little information concerning the depth of tumor invasion or the extent of disease beyond the bowel wall [3]. Computed tomography has the potential to determine the extent of colorectal malignancies by directly visualizing the intraluminal, mural, and extraintestinal structures [3,6,10]. For obtaining reliable results from the CT scans, the complete distention of the rectum is the most important precondition [5]. Only when the rectum is sufficiently distended, it is possible to examine the walls properly and to recognize neoplastic involvement of the perirectal fat or the serosa [2]. To better visualize the lumen, the mucosal surface, the true thickness of the wall, and its relationship to the surrounding structures, the lumen should be opacified [6,10,12]. To achieve optimal opacification and distention, various contrast materials (water-soluble iodinated contrast materials or diluted barium suspension [13], air enema [14], oil emulsion [15], and recently water enema [1 – 3,5 – 10]) have been used. The advantage of using water as a contrast agent is that it is less prone to cause artifacts and obviates the need viewing images with different window settings for adequate reading [1 – 3,6,10].

The various WE-CT examination protocols described in the literature uniformly include the administration of smooth muscle relaxant and the use of intravenously injected contrast material. Most authors proposed to perform a bowel-cleansing regimen prior to the WE-CT examination [2,3,5 – 9], while some others did not apply it regularly [1,12]. The amount of water, introduced into the rectum during the examination was between 1000 and 2000 ml [1 – 3,5 – 9]. We did not use any previous cleansing. We are aware of that, nevertheless feces always contains small bubbles of gas [7], it still can easily be misinterpreted as tumor [5], but we examined patients with diagnosed rectum cancer and the purpose of the examination was not the detection, but the staging of the tumor. Similarly to Caseiro-Alves et al. [1] and Gazelle et al. [3], we found that certain patients did not tolerate well the administration of water volume exceeding a certain level. To avoid patient discomfort and decrease risk of complication we decided to

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perform WE-CT examinations with a reduced dose (400–500 ml) of water in those cases when the primary pathologic process was localized to the rectum. The application of this examination protocol in our study group, consisting of 29 patients with rectum cancer, resulted in unsatisfactory distention and opacification of the rectum in only 4 cases (13.8%). These 4 patients had highly stenotic tumors and probably would not tolerate higher amount of water anyway. In the majority of cases (86.2%) we achieved good/excellent distention and opacification. 5 mm slice thickness and interval was used in patients with small lesions while 10 mm was applied to evaluate large masses, by additional reevaluation of the region of interest by 5 mm scans if necessary.

The accuracy of CT used for staging rectal cancer is still a matter of debate [4,12,16–18]. CT cannot show the difference between a tumor confined to the mucosa and one involving the muscular structure of the rectum (T1 vs. T2), because it is not possible to distinguish the single layers composing the wall [2], and CT is not reliable for identifying T4 stage [1]. Hundt et al. recently described a two-phase (arterial and venous) helical CT examination technique, owing to which layers of the intestinal wall could be differentiated. Volumetric scanning has contributed to the quality of examination by eliminating motion artifacts and better utilization of bolus contrast enhancement, but still the evaluation of the T1 stage was not very reliable [5]. For treatment planning the differentiation of localized rectal cancer from invasive stages of the disease is important. Since suitable candidates for local radiotherapy are those presenting with deeply invasive and locally advanced lesions, it is necessary to identify those patients with transmural growth of the tumor [1]. Prior studies using higher volume of endoluminal water for CT evaluation of transmural tumor extension rendered conflicting results: the reported accuracy was in the range of 74–97.6% [1,2,18]. In the present study we achieved a sensitivity of 90.9% and a specificity of 71.4% in the differentiation of small and locally advanced tumor (T1–T2 vs. T3–T4), the overall accuracy was 86.2%. The positive and negative predictive values were 90.9% and 71.4%, respectively. These results correspond well with the above-mentioned, relevant data of the literature. The most likely reason why our sensitivity, specificity and accuracy values are higher than those of Zerhouni et al. [18], is that in our patient group the rate of advanced (T3, T4) cancers is significantly higher (75.8%).

The reduced dose of water enema does not allow the complete CT evaluation of the entire large bowel, but in our protocol for the preoperative evaluation of rectum cancer patients this is the task of either the colonoscopic, or – in highly stenotic tumor cases – the double contrast barium enema examination.

It remains a matter of continuing discussion whether the level of accuracy achievable by CT examinations in local staging of rectum neoplasms is really helpful in the management of an individual patient. Ongoing efforts are necessary, on the one hand to improve the accuracy of these examinations, on the other hand to minimize their level of discomfort and risk of complications. Our results prove that if the WE-CT examination is performed for the evaluation of known rectum disorders, the limited volume of water will not impair the quality and accuracy of the examination and may decrease the number of complaints and the possibility of complications.

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