

RECOMENDACIÓN DG.2

BÚSQUEDA Y SÍNTESIS DE EVIDENCIA DE EFECTOS DESEABLES E INDESEABLES

Guía de Práctica Clínica Cáncer Colorectal en Personas de 15 años y más - 2018

A. PREGUNTA CLÍNICA

En personas con diagnóstico de cáncer de recto medio e inferior en proceso de etapificación local ¿Se debe realizar resonancia magnética de pelvis en comparación a realizar tomografía computarizada de pelvis?

Análisis y definición de los componentes de la pregunta en formato PICO

Población: Personas con diagnóstico de cáncer de recto medio e inferior en proceso de etapificación local.

Intervención: Resonancia magnética de pelvis.

Comparación: Tomografía computarizada de pelvis.

Desenlace (outcome): Impacto clínico, exactitud diagnóstica.

A. BÚSQUEDA DE EVIDENCIA

Se realizó una búsqueda general de revisiones sistemáticas asociadas al tema de “Colorectal cancer”. Las bases de datos utilizadas fueron: Cochrane database of systematic reviews (CDSR); Database of Abstracts of Reviews of Effectiveness (DARE); PubMed; LILACS; CINAHL; PsychINFO; EMBASE; EPPI-Centre Evidence Library y The JBI Database of Systematic Reviews and implementation Reports. No se aplicaron restricciones en base al idioma o estado de publicación. Dos revisores de manera independiente realizaron la selección de los títulos y los resúmenes, la evaluación del texto completo y la extracción de datos. Un investigador experimentado resolvió cualquier discrepancia entre los distintos revisores¹

Seleccionadas las revisiones sistemáticas y los estudios incluidos en estas, se clasificaron en función de las potenciales preguntas a las que daban respuesta. Al momento de definir la pregunta la evidencia ya se encontraba previamente clasificada según intervenciones comparadas. Los resultados se encuentran alojados en la plataforma Living Overview of the Evidence (L-OVE), sistema que permite la actualización periódica de la evidencia.

¹ Para revisar la metodología, las estrategias y los resultados de la búsqueda, favor revisar el informe “*Búsqueda sistemática de evidencia de los efectos deseables e indeseables*” en la sección de método de la Guía de Práctica Clínica respectiva.

B. SÍNTESIS DE EVIDENCIA

Resumen de la evidencia identificada

En las preguntas que comparan diagnósticos, el equipo metodológico consideró necesario distinguir dos enfoques para abordarlas: *impacto diagnóstico* y *exactitud diagnóstica*. Se estableció priorizar estudios que evaluarán el *impacto diagnóstico del test*, es decir aquellos que comparan los resultados en salud de los pacientes diagnosticados/tratados en función a los resultados de un test. En caso de no encontrar este tipo de estudios, se utilizan estudios que evalúan la *exactitud diagnóstica del test*, es decir aquellos que miden qué tan bien el test clasifica a los pacientes respecto a si tienen o no una condición.²

En este caso, no se identificaron estudios de impacto diagnóstico, por lo cual se amplió la búsqueda a exactitud diagnóstica del test, identificando 7 revisiones sistemáticas que incluyen 119 estudios primarios, todos correspondientes a estudios observacionales. Para más detalle ver “*Matriz de evidencia*”³, en el siguiente link: [Resonancia magnética para la etapificación del cáncer rectal](#).

Tabla 1: Resumen de la evidencia seleccionada

| | |
|----------------------|-------------|
| Revisión sistemática | 7 [1-7] |
| Estudios primarios | 119 [8-126] |

Estimador del efecto

Se realizó un análisis de la matriz de evidencia, identificándose una revisión sistemática [3] que incluye la mayor proporción de estudios relevantes, incluyendo aquellos más recientes, que reflejan de mejor manera la exactitud de las técnicas de resonancia magnética contemporáneas. Se decidió reutilizar sus metanálisis para construir la tabla resumen de resultados, ya que la incorporación de los estudios faltantes no cambiaba las conclusiones de la tabla de resumen de resultados.

Es importante destacar que para calcular la exactitud diagnóstica de un test se debe determinar su rendimiento en comparación con un estándar de oro (*gold standard*) o patrón de referencia, el cual en muchos casos puede incluir la tomografía computada de pelvis, habitualmente en combinación con otros tests, incluyendo el examen clínico y la evolución en muchos casos. Si se compara directamente la resonancia contra un test que no es el estándar de oro (por ejemplo, solo tomografía computarizada de pelvis) existiría un alto riesgo de sesgo de verificación (*verification bias*). Si bien al analizar el conjunto de estudios en que ambos test (resonancia y tomografía) fueron comparados con el estándar de oro en el mismo grupo de pacientes se pierde precisión en el resultado, el estimador se basa en evidencia más directa, por lo que la certeza de la evidencia aumenta.

² Schünemann HJ, Schünemann AHJ, Oxman AD, Brozek J, Glasziou P, Jaeschke R, et al. Grading quality of evidence and strength of recommendations for diagnostic tests and strategies. *BMJ* [Internet]. 2008 May 17 [cited 2018 Aug 1];336(7653):1106–10.

³ **Matriz de Evidencia**, tabla dinámica cuyas filas representan las revisiones sistemática y en las columnas los estudios primarios que responden una misma pregunta. Los recuadros en verde corresponden a los estudios incluidos en las respectivas revisiones. La matriz se actualiza periódicamente, incorporando nuevas revisiones sistemáticas pertinentes y los respectivos estudios primarios.

Además, el panel de expertos solicitó evaluar si esta exactitud diagnóstica es proveniente de evaluación sobre el T, N, M o la combinación de estos factores, verificando que proviene de la etapificación T.

Metanálisis

Exactitud diagnóstica

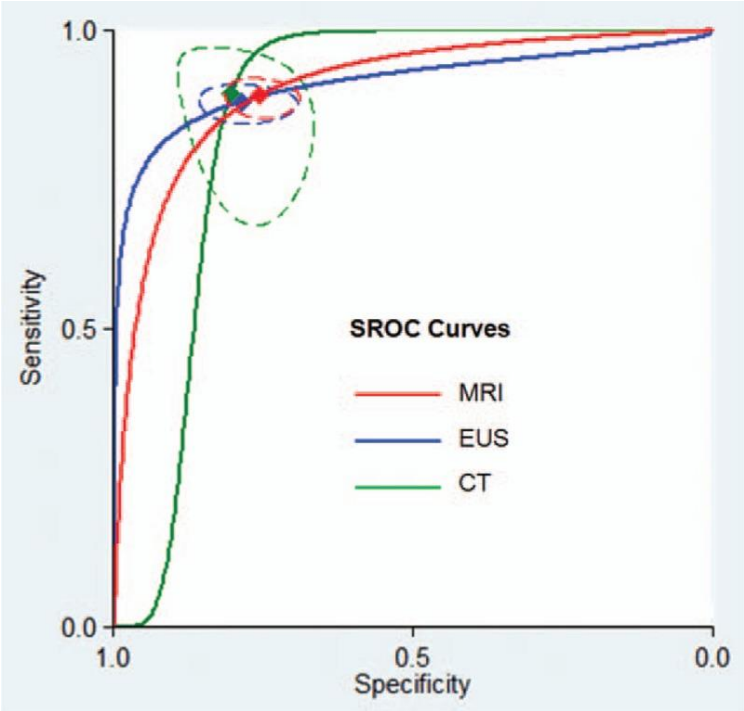


Tabla de Resumen de Resultados (Summary of Findings)

| RESONANCIA MAGNÉTICA DE PELVIS COMPARADO CON TOMOGRAFÍA COMPUTARIZADA DE PELVIS PARA ETAPIFICACIÓN DE CÁNCER DE RECTO MEDIO E INFERIOR. | | | |
|---|---|---|--|
| Pacientes | Personas con diagnóstico de cáncer de recto medio e inferior en proceso de etapificación local. | | |
| Test | Resonancia magnética de pelvis. | | |
| Comparación | Tomografía computarizada de pelvis (ver nota en sección "estimación del efecto") | | |
| Impacto diagnóstico | | | |
| Desenlaces | Efecto | | |
| Morbilidad o mortalidad | No se identificaron estudios evaluando el impacto, por lo que el desenlace se estimó este en base a la exactitud diagnóstica del test, y de las consecuencias esperadas a partir de cada resultado. | | |
| Exactitud diagnóstica | | | |
| Gold standard | Cirugía, biopsia y seguimiento clínico. | | |
| Desenlaces | Efecto por 1000 pacientes testeados (IC 95%) Prevalencia hipotética %* | Certeza de la evidencia (GRADE) | Mensajes clave en términos sencillos |
| Resonancia magnética de pelvis. | | Tomografía computarizada de pelvis. | |
| Sensibilidad: 92% (IC 95% de 71 a 99%) Especificidad: 72% (IC 95% de 37 a 91%) LR (+): 3,29 (IC 95% de 2,13 a 5,06) LR (-): 0,11 (IC 95% de 0,05 a 0,26) | | Sensibilidad: 89% (IC 95% de 49 a 99%) Especificidad: 75% (IC 95% de 54 a 86%) LR (+): 3,56 (IC 95% de 2,23 a 5,68) LR (-): 0,15 (IC 95% de 0,07 a 0,30) | |
| 121 pacientes (3 estudios [13, 86, 87]) Población hipotética de 1000 personas con 550 enfermos con compromiso transmural y 550 localizado. | | | |
| Pacientes con compromiso transmural (verdaderos positivos) | Resonancia | | Al utilizar resonancia comparado con tomografía probablemente se diagnostican correctamente con compromiso transmural a 16 pacientes más de cada 1000 (o 550 enfermos) |
| | 506 (391 a 545) | ⊕⊕⊕○ ¹ Moderada | |
| Tomografía | | | |
| 490 (270 a 545) | ⊕⊕⊕○ ¹ Moderada | | |
| Pacientes con compromiso transmural incorrectamente identificados como sin compromiso (falsos negativos) | Resonancia | | Al utilizar resonancia comparado con tomografía probablemente se diagnostican correctamente sin compromiso transmural a 13 pacientes menos de cada 1000 (o 450 sanos) |
| | 44 (5 a 159) | ⊕⊕⊕○ ¹ Moderada | |
| Tomografía | | | |
| 60 (5 a 280) | ⊕⊕⊕○ ¹ Moderada | | |
| Pacientes sin compromiso transmural correctamente identificados (verdaderos negativos) | Resonancia | | |
| | 324 (166 a 410) | ⊕⊕⊕○ ¹ Moderada | |
| Tomografía | | | |
| 337 (243 a 387) | ⊕⊕⊕○ ¹ Moderada | | |
| Personas sin compromiso transmural incorrectamente clasificadas como con compromiso (falsos positivos) | Resonancia | | |
| | 126 (40 a 284) | ⊕⊕⊕○ ¹ Moderada | |
| Tomografía | | | |
| 113 (63 a 207) | ⊕⊕⊕○ ¹ Moderada | | |
| IC: Intervalo de confianza del 95%. GRADE: grados de evidencia del GRADE Working Group *La prevalencia corresponde a la prevalencia del estudio con más peso [13] **Certeza de exactitud diagnóstica ¹ Se disminuyó un nivel de certeza de evidencia por imprecisión ya que cada extremo del intervalo de confianza conlleva una decisión diferente. | | | |
| Fecha de elaboración de la tabla: Octubre, 2018 | | | |

Referencias

1. Al-Sukhni E, Milot L, Fruitman M, Beyene J, Victor JC, Schmocker S, Brown G, McLeod R, Kennedy E. Diagnostic accuracy of MRI for assessment of T category, lymph node metastases, and circumferential resection margin involvement in patients with rectal cancer: a systematic review and meta-analysis. *Annals of surgical oncology*. 2012;19(7):2212-23.
2. Bipat S, Glas AS, Slors FJ, Zwinderman AH, Bossuyt PM, Stoker J. Rectal cancer: local staging and assessment of lymph node involvement with endoluminal US, CT, and MR imaging--a meta-analysis. *Radiology*. 2004;232(3):773-83.
3. Li XT, Zhang XY, Sun YS, Tang L, Cao K. Evaluating rectal tumor staging with magnetic resonance imaging, computed tomography, and endoluminal ultrasound: A meta-analysis. *Medicine*. 2016;95(44):e5333.
4. van der Paardt MP, Zagers MB, Beets-Tan RG, Stoker J, Bipat S. Patients who undergo preoperative chemoradiotherapy for locally advanced rectal cancer restaged by using diagnostic MR imaging: a systematic review and meta-analysis. *Radiology*. 2013;269(1):101-12.
5. Wu LM, Zhu J, Hu J, Yin Y, Gu HY, Hua J, Chen J, Xu JR. Is there a benefit in using magnetic resonance imaging in the prediction of preoperative neoadjuvant therapy response in locally advanced rectal cancer?. *International journal of colorectal disease*. 2013;28(9):1225-38.
6. Xie H, Zhou X, Zhuo Z, Che S, Xie L, Fu W. Effectiveness of MRI for the assessment of mesorectal fascia involvement in patients with rectal cancer: a systematic review and meta-analysis. *Digestive surgery*. 2014;31(2):123-34.
7. Zhao RS, Wang H, Zhou ZY, Zhou Q, Mulholland MW. Restaging of locally advanced rectal cancer with magnetic resonance imaging and endoluminal ultrasound after preoperative chemoradiotherapy: a systemic review and meta-analysis. *Diseases of the colon and rectum*. 2014;57(3):388-95.
8. Akasu T, Iinuma G, Takawa M, Yamamoto S, Muramatsu Y, Moriyama N. Accuracy of high-resolution magnetic resonance imaging in preoperative staging of rectal cancer. *Annals of surgical oncology*. 2009;16(10):2787-94.
9. Akin O, Nessar G, Agildere AM, Aydog G. Preoperative local staging of rectal cancer with endorectal MR imaging: comparison with histopathologic findings. *Clinical imaging*. 2004;28(6):432-8.
10. Alberda WJ, Dassen HP, Dwarkasing RS, Willemsen FE, van der Pool AE, de Wilt JH, Burger JW, Verhoef C. Prediction of tumor stage and lymph node involvement with dynamic contrast-enhanced MRI after chemoradiotherapy for locally advanced rectal cancer. *International journal of colorectal disease*. 2013;28(4):573-80.
11. Algebally AM, Mohey N, Szmigielski W, Yousef RR, Kohla S. The value of high-resolution MRI technique in patients with rectal carcinoma: pre-operative assessment of mesorectal fascia involvement, circumferential resection margin and local staging. *Polish journal of radiology*. 2015;80:115-21.
12. Allen SD, Padhani AR, Dzik-Jurasz AS, Glynn-Jones R. Rectal carcinoma: MRI with histologic correlation before and after chemoradiation therapy. *AJR. American journal of roentgenology*. 2007;188(2):442-51.
13. Arai K, Takifuji K, Yokoyama S, Matsuda K, Higashiguchi T, Tominaga T, Oku Y, Tani M, Yamaue H. Preoperative evaluation of pelvic lateral lymph node of patients with lower rectal cancer:

- comparison study of MR imaging and CT in 53 patients. *Langenbeck's archives of surgery*. 2006;391(5):449-54.
14. Baatrup G, Pfeiffer P, Svolgaard B, Jensen HA. Resectability of rectal cancers still fixed after radio-chemotherapy: evaluation by digital rectal examination, MRI, and intraoperative examination. *International journal of colorectal disease*. 2006;21(1):7-10.
 15. Barbaro B, Fiorucci C, Tebala C, Valentini V, Gambacorta MA, Vecchio FM, Rizzo G, Coco C, Crucitti A, Ratto C, Bonomo L. Locally advanced rectal cancer: MR imaging in prediction of response after preoperative chemotherapy and radiation therapy. *Radiology*. 2009;250(3):730-9.
 16. Barbaro B, Valentini V, Manfredi R. Combined modality staging of high risk rectal cancer. *Rays*. 1995;20(2):165-81.
 17. Blomqvist L, Holm T, Nyrén S, Svanström R, Ulvskog Y, Iselius L. MR imaging and computed tomography in patients with rectal tumours clinically judged as locally advanced. *Clinical radiology*. 2002;57(3):211-8.
 18. Blomqvist L, Machado M, Rubio C, Gabrielsson N, Granqvist S, Goldman S, Holm T. Rectal tumour staging: MR imaging using pelvic phased-array and endorectal coils vs endoscopic ultrasonography. *European radiology*. 2000;10(4):653-60.
 19. Blomqvist L, Rubio C, Holm T, Machado M, Hindmarsh T. Rectal adenocarcinoma: assessment of tumour involvement of the lateral resection margin by MRI of resected specimen. *The British journal of radiology*. 1999;72(853):18-23.
 20. Branagan G, Chave H, Fuller C, McGee S, Finnis D. Can magnetic resonance imaging predict circumferential margins and TNM stage in rectal cancer?. *Diseases of the colon and rectum*. 2004;47(8):1317-22.
 21. Brown G, Radcliffe AG, Newcombe RG, Dallimore NS, Bourne MW, Williams GT. Preoperative assessment of prognostic factors in rectal cancer using high-resolution magnetic resonance imaging. *The British journal of surgery*. 2003;90(3):355-64.
 22. Burton S, Brown G, Daniels I, Norman A, Swift I, Abulafi M, Wotherspoon A, Tait D. MRI identified prognostic features of tumors in distal sigmoid, rectosigmoid, and upper rectum: treatment with radiotherapy and chemotherapy. *International journal of radiation oncology, biology, physics*. 2006;65(2):445-51.
 23. Carbone SF, Pirtoli L, Ricci V, Venezia D, Carfagno T, Lazzi S, Mourmouras V, Lorenzi B, Volterrani L. Assessment of response to chemoradiation therapy in rectal cancer using MR volumetry based on diffusion-weighted data sets: a preliminary report. *La Radiologia medica*. 2012;117(7):1112-24.
 24. Chen CC, Lee RC, Lin JK, Wang LW, Yang SH. How accurate is magnetic resonance imaging in restaging rectal cancer in patients receiving preoperative combined chemoradiotherapy?. *Diseases of the colon and rectum*. 2005;48(4):722-8.
 25. Cho YB, Chun HK, Kim MJ, Choi JY, Park CM, Kim BT, Lee SJ, Yun SH, Kim HC, Lee WY. Accuracy of MRI and 18F-FDG PET/CT for restaging after preoperative concurrent chemoradiotherapy for rectal cancer. *World journal of surgery*. 2009;33(12):2688-94.
 26. Chun HK, Choi D, Kim MJ, Lee J, Yun SH, Kim SH, Lee SJ, Kim CK. Preoperative staging of rectal cancer: comparison of 3-T high-field MRI and endorectal sonography. *AJR. American journal of roentgenology*. 2006;187(6):1557-62.
 27. Curvo-Semedo L, Lambregts DM, Maas M, Thywissen T, Mehsen RT, Lammering G, Beets GL, Caseiro-Alves F, Beets-Tan RG. Rectal cancer: assessment of complete response to

- preoperative combined radiation therapy with chemotherapy--conventional MR volumetry versus diffusion-weighted MR imaging. *Radiology*. 2011;260(3):734-43.
28. Dalton RS, Velineni R, Osborne ME, Thomas R, Harries S, Gee AS, Daniels IR. A single-centre experience of chemoradiotherapy for rectal cancer: is there potential for nonoperative management?. *Colorectal disease : the official journal of the Association of Coloproctology of Great Britain and Ireland*. 2012;14(5):567-71.
 29. Dar, RA, Chowdri NA, Parray FQ, et al. Role of endorectal coil magnetic resonance imaging in local staging of rectal cancer: Experience from a single center. *Clinical Cancer Investigation Journal*. 2013;2(3):223-228.
 30. de Lange EE, Fechner RE, Edge SB, Spaulding CA. Preoperative staging of rectal carcinoma with MR imaging: surgical and histopathologic correlation. *Radiology*. 1990;176(3):623-8.
 31. Denecke T, Rau B, Hoffmann KT, Hildebrandt B, Ruf J, Gutberlet M, Hünerbein M, Felix R, Wust P, Amthauer H. Comparison of CT, MRI and FDG-PET in response prediction of patients with locally advanced rectal cancer after multimodal preoperative therapy: is there a benefit in using functional imaging?. *European radiology*. 2005;15(8):1658-66.
 32. Dinter DJ, Hofheinz RD, Hartel M, Kaehler GF, Neff W, Diehl SJ. Preoperative staging of rectal tumors: comparison of endorectal ultrasound, hydro-CT, and high-resolution endorectal MRI. *Onkologie*. 2008;31(5):230-5.
 33. Donmez FY, Tunaci M, Yekeler E, Balik E, Tunaci A, Acunas G. Effect of using endorectal coil in preoperative staging of rectal carcinomas by pelvic MR imaging. *European journal of radiology*. 2008;67(1):139-45.
 34. Dresen RC, Beets GL, Rutten HJ, Engelen SM, Lahaye MJ, Vliegen RF, de Bruïne AP, Kessels AG, Lammering G, Beets-Tan RG. Locally advanced rectal cancer: MR imaging for restaging after neoadjuvant radiation therapy with concomitant chemotherapy. Part I. Are we able to predict tumor confined to the rectal wall?. *Radiology*. 2009;252(1):71-80.
 35. Drew PJ, Farouk R, Turnbull LW, Ward SC, Hartley JE, Monson JR. Preoperative magnetic resonance staging of rectal cancer with an endorectal coil and dynamic gadolinium enhancement. *The British journal of surgery*. 1999;86(2):250-4.
 36. Engelen SM, Beets-Tan RG, Lahaye MJ, Lammering G, Jansen RL, van Dam RM, Konsten J, Leijtens JW, van de Velde CJ, Beets GL. MRI after chemoradiotherapy of rectal cancer: a useful tool to select patients for local excision. *Diseases of the colon and rectum*. 2010;53(7):979-86.
 37. Feng Q, Yan YQ, Zhu J, Xu JR. T staging of rectal cancer: accuracy of diffusion-weighted imaging compared with T2-weighted imaging on 3.0 tesla MRI. *Journal of digestive diseases*. 2014;15(4):188-94.
 38. Ferri M, Laghi A, Mingazzini P, Iafrate F, Meli L, Ricci F, Passariello R, Ziparo V. Pre-operative assessment of extramural invasion and sphincteral involvement in rectal cancer by magnetic resonance imaging with phased-array coil. *Colorectal disease : the official journal of the Association of Coloproctology of Great Britain and Ireland*. 2005;7(4):387-93.
 39. Fuchsjäger MH, Maier AG, Schima W, Zebedin E, Herbst F, Mittlböck M, Wrba F, Lechner GL. Comparison of transrectal sonography and double-contrast MR imaging when staging rectal cancer. *AJR. American journal of roentgenology*. 2003;181(2):421-7.
 40. Fütterer JJ, Yakar D, Strijk SP, Barentsz JO. Preoperative 3T MR imaging of rectal cancer: local staging accuracy using a two-dimensional and three-dimensional T2-weighted turbo spin echo sequence. *European journal of radiology*. 2008;65(1):66-71.

41. Gagliardi G, Bayar S, Smith R, Salem RR. Preoperative staging of rectal cancer using magnetic resonance imaging with external phase-arrayed coils. *Archives of surgery (Chicago, Ill. : 1960)*. 2002;137(4):447-51.
42. Ghieda U, Hassanen O, Eltomey MA. MRI of rectal carcinoma: Preoperative staging and planning of sphincter-sparing surgery. *Egyptian Journal of Radiology and Nuclear Medicine*. 2014;45(1):1-5.
43. Giusti S, Buccianti P, Castagna M, Fruzzetti E, Fattori S, Castelluccio E, Caramella D, Bartolozzi C. Preoperative rectal cancer staging with phased-array MR. *Radiation oncology (London, England)*. 2012;7:29.
44. Gualdi GF, Casciani E, Guadalaxara A, d'Orta C, Polettini E, Pappalardo G. Local staging of rectal cancer with transrectal ultrasound and endorectal magnetic resonance imaging: comparison with histologic findings. *Diseases of the colon and rectum*. 2000;43(3):338-45.
45. Hadfield MB, Nicholson AA, MacDonald AW, Farouk R, Lee PW, Duthie GS, Monson JR. Preoperative staging of rectal carcinoma by magnetic resonance imaging with a pelvic phased-array coil. *The British journal of surgery*. 1997;84(4):529-31.
46. Halefoglu AM, Atasoy ST, Sakiz D, Baykan A. Accuracy of thin-section magnetic resonance imaging with a pelvic phased-array coil in the local staging of rectal cancer. *Journal of computer assisted tomography*. 2013;37(1):58-64.
47. Halefoglu AM, Yildirim S, Avlanmis O, Sakiz D, Baykan A. Endorectal ultrasonography versus phased-array magnetic resonance imaging for preoperative staging of rectal cancer. *World journal of gastroenterology*. 2008;14(22):3504-10.
48. Hodgman CG, MacCarty RL, Wolff BG, May GR, Berquist TH, Sheedy PF, Beart RW, Spencer RJ. Preoperative staging of rectal carcinoma by computed tomography and 0.15T magnetic resonance imaging. Preliminary report. *Diseases of the colon and rectum*. 1986;29(7):446-50.
49. Hoffmann KT, Rau B, Wust P, Stroszczynski C, Hünerbein M, Schneider U, Felix R. Restaging of locally advanced carcinoma of the rectum with MR imaging after preoperative radio-chemotherapy plus regional hyperthermia. *Strahlentherapie und Onkologie : Organ der Deutschen Röntgengesellschaft ... [et al]*. 2002;178(7):386-92.
50. Hünerbein M, Pegios W, Rau B, Vogl TJ, Felix R, Schlag PM. Prospective comparison of endorectal ultrasound, three-dimensional endorectal ultrasound, and endorectal MRI in the preoperative evaluation of rectal tumors. Preliminary results. *Surgical endoscopy*. 2000;14(11):1005-9.
51. Iannicelli E, Di Renzo S, Ferri M, Pillozzi E, Di Girolamo M, Sapori A, Ziparo V, David V. Accuracy of high-resolution MRI with lumen distention in rectal cancer staging and circumferential margin involvement prediction. *Korean journal of radiology*. 2014;15(1):37-44.
52. Jiang JB, Dai Y, Zhang XM, Li CF, Jin ZT, Bi DS, Sun JZ. [Accuracy of preoperative magnetic resonance imaging in prediction of pathological stage and circumferential resection margin in rectal cancer]. *Zhonghua yi xue za zhi*. 2006;86(14):961-4.
53. Johnston DF, Lawrence KM, Sizer BF, Arulampalam TH, Motson RW, Dove E, Lacey N. Locally advanced rectal cancer: histopathological correlation and predictive accuracy of serial MRI after neoadjuvant chemotherapy. *The British journal of radiology*. 2009;82(976):332-6.
54. Jung SH, Heo SH, Kim JW, Jeong YY, Shin SS, Soung MG, Kim HR, Kang HK. Predicting response to neoadjuvant chemoradiation therapy in locally advanced rectal cancer: diffusion-weighted 3 Tesla MR imaging. *Journal of magnetic resonance imaging : JMRI*. 2012;35(1):110-6.

55. Kam MH, Wong DC, Siu S, Stevenson AR, Lai J, Phillips GE. Comparison of magnetic resonance imaging-fluorodeoxy- glucose positron emission tomography fusion with pathological staging in rectal cancer. *The British journal of surgery*. 2010;97(2):266-8.
56. Karatağ O, Karatağ GY, Özkurt H, Değirmenci HK, Avlanmış Ö, Başak M, Baykan A. The ability of phased-array MRI in preoperative staging of primary rectal cancer: correlation with histopathological results. *Diagnostic and interventional radiology (Ankara, Turkey)*. 2012;18(1):20-6.
57. Kim CK, Kim SH, Choi D, Kim MJ, Chun HK, Lee SJ, Lee JM. Comparison between 3-T magnetic resonance imaging and multi-detector row computed tomography for the preoperative evaluation of rectal cancer. *Journal of computer assisted tomography*. 2007;31(6):853-9.
58. Kim CK, Kim SH, Chun HK, Lee WY, Yun SH, Song SY, Choi D, Lim HK, Kim MJ, Lee J, Lee SJ. Preoperative staging of rectal cancer: accuracy of 3-Tesla magnetic resonance imaging. *European radiology*. 2006;16(5):972-80.
59. Kim H, Lim JS, Choi JY, Park J, Chung YE, Kim MJ, Choi E, Kim NK, Kim KW. Rectal cancer: comparison of accuracy of local-regional staging with two- and three-dimensional preoperative 3-T MR imaging. *Radiology*. 2010;254(2):485-92.
60. Kim IY, Cha SW, Ahn JH, Kim YW. Factors affecting the restaging accuracy of magnetic resonance imaging after preoperative chemoradiation in patients with rectal cancer. *European journal of surgical oncology : the journal of the European Society of Surgical Oncology and the British Association of Surgical Oncology*. 2015;41(4):493-8.
61. Kim MJ, Lim JS, Oh YT, Kim JH, Chung JJ, Joo SH, Kim NK, Lee KY, Kim WH, Kim KW. Preoperative MRI of rectal cancer with and without rectal water filling: an intraindividual comparison. *AJR. American journal of roentgenology*. 2004;182(6):1469-76.
62. Kim NK, Kim MJ, Park JK, Park SI, Min JS. Preoperative staging of rectal cancer with MRI: accuracy and clinical usefulness. *Annals of surgical oncology*. 2000;7(10):732-7.
63. Kim NK, Kim MJ, Yun SH, Sohn SK, Min JS. Comparative study of transrectal ultrasonography, pelvic computerized tomography, and magnetic resonance imaging in preoperative staging of rectal cancer. *Diseases of the colon and rectum*. 1999;42(6):770-5.
64. Kim SH, Lee JM, Hong SH, Kim GH, Lee JY, Han JK, Choi BI. Locally advanced rectal cancer: added value of diffusion-weighted MR imaging in the evaluation of tumor response to neoadjuvant chemo- and radiation therapy. *Radiology*. 2009;253(1):116-25.
65. Kim SH, Lee JM, Lee MW, Kim GH, Han JK, Choi BI. Diagnostic accuracy of 3.0-Tesla rectal magnetic resonance imaging in preoperative local staging of primary rectal cancer. *Investigative radiology*. 2008;43(8):587-93.
66. Kim SH, Lee JM, Park HS, Eun HW, Han JK, Choi BI. Accuracy of MRI for predicting the circumferential resection margin, mesorectal fascia invasion, and tumor response to neoadjuvant chemoradiotherapy for locally advanced rectal cancer. *Journal of magnetic resonance imaging : JMRI*. 2009;29(5):1093-101.
67. Kim SH, Lee JY, Lee JM, Han JK, Choi BI. Apparent diffusion coefficient for evaluating tumour response to neoadjuvant chemoradiation therapy for locally advanced rectal cancer. *European radiology*. 2011;21(5):987-95.
68. Kim YC, Lim JS, Keum KC, Kim KA, Myoung S, Shin SJ, Kim MJ, Kim NK, Suh J, Kim KW. Comparison of diffusion-weighted MRI and MR volumetry in the evaluation of early treatment outcomes after preoperative chemoradiotherapy for locally advanced rectal cancer. *Journal of magnetic resonance imaging : JMRI*. 2011;34(3):570-6.

69. Kim YW, Cha SW, Pyo J, Kim NK, Min BS, Kim MJ, Kim H. Factors related to preoperative assessment of the circumferential resection margin and the extent of mesorectal invasion by magnetic resonance imaging in rectal cancer: a prospective comparison study. *World journal of surgery*. 2009;33(9):1952-60.
70. Kim YW, Kim NK, Min BS, Kim H, Pyo J, Kim MJ, Cha SH. A prospective comparison study for predicting circumferential resection margin between preoperative MRI and whole mount sections in mid-rectal cancer: significance of different scan planes. *European journal of surgical oncology : the journal of the European Society of Surgical Oncology and the British Association of Surgical Oncology*. 2008;34(6):648-54.
71. Kocaman O, Baysal B, Şentürk H, et al. Staging of rectal carcinoma: MDCT, MRI or EUS. Single center experience.. *Staging of rectal carcinoma: MDCT, MRI or EUS. Single center experienc.* *Turk J Gastroenterol.* 2014;25(6):669-673.
72. Koh DM, Chau I, Tait D, Wotherspoon A, Cunningham D, Brown G. Evaluating mesorectal lymph nodes in rectal cancer before and after neoadjuvant chemoradiation using thin-section T2-weighted magnetic resonance imaging. *International journal of radiation oncology, biology, physics*. 2008;71(2):456-61.
73. Kulkarni T, Gollins S, Maw A, Hobson P, Byrne R, Widdowson D. Magnetic resonance imaging in rectal cancer downstaged using neoadjuvant chemoradiation: accuracy of prediction of tumour stage and circumferential resection margin status. *Colorectal disease : the official journal of the Association of Coloproctology of Great Britain and Ireland*. 2008;10(5):479-89.
74. Kuo LJ, Chern MC, Tsou MH, Liu MC, Jian JJ, Chen CM, Chung YL, Fang WT. Interpretation of magnetic resonance imaging for locally advanced rectal carcinoma after preoperative chemoradiation therapy. *Diseases of the colon and rectum*. 2005;48(1):23-8.
75. Lahaye MJ, Beets GL, Engelen SM, Kessels AG, de Bruïne AP, Kwee HW, van Engelshoven JM, van de Velde CJ, Beets-Tan RG. Locally advanced rectal cancer: MR imaging for restaging after neoadjuvant radiation therapy with concomitant chemotherapy. Part II. What are the criteria to predict involved lymph nodes?. *Radiology*. 2009;252(1):81-91.
76. Lambrecht M, Vandecaveye V, De Keyzer F, Roels S, Penninckx F, Van Cutsem E, Filip C, Haustermans K. Value of diffusion-weighted magnetic resonance imaging for prediction and early assessment of response to neoadjuvant radiochemotherapy in rectal cancer: preliminary results. *International journal of radiation oncology, biology, physics*. 2012;82(2):863-70.
77. Lambregts DM, Beets GL, Maas M, Kessels AG, Bakers FC, Cappendijk VC, Engelen SM, Lahaye MJ, de Bruïne AP, Lammering G, Leiner T, Verwoerd JL, Wildberger JE, Beets-Tan RG. Accuracy of gadofosveset-enhanced MRI for nodal staging and restaging in rectal cancer. *Annals of surgery*. 2011;253(3):539-45.
78. Lambregts DM, Maas M, Riedl RG, Bakers FC, Verwoerd JL, Kessels AG, Lammering G, Boetes C, Beets GL, Beets-Tan RG. Value of ADC measurements for nodal staging after chemoradiation in locally advanced rectal cancer-a per lesion validation study. *European radiology*. 2011;21(2):265-73.
79. Lambregts DM, Vandecaveye V, Barbaro B, Bakers FC, Lambrecht M, Maas M, Haustermans K, Valentini V, Beets GL, Beets-Tan RG. Diffusion-weighted MRI for selection of complete responders after chemoradiation for locally advanced rectal cancer: a multicenter study. *Annals of surgical oncology*. 2011;18(8):2224-31.

80. Larsen SG, Wiig JN, Emblemvaag HL, Grøholt KK, Hole KH, Bentsen A, Dueland S, Vetrhus T, Giercksky KE. Extended total mesorectal excision in locally advanced rectal cancer (T4a) and the clinical role of MRI-evaluated neo-adjuvant downstaging. *Colorectal disease : the official journal of the Association of Coloproctology of Great Britain and Ireland*. 2009;11(7):759-67.
81. MERCURY Study Group. Diagnostic accuracy of preoperative magnetic resonance imaging in predicting curative resection of rectal cancer: prospective observational study. *BMJ (Clinical research ed.)*. 2006;333(7572):779.
82. MERCURY Study Group. Extramural depth of tumor invasion at thin-section MR in patients with rectal cancer: results of the MERCURY study. *Radiology*. 2007;243(1):132-9.
83. Maretto I, Pomerri F, Pucciarelli S, Mescoli C, Belluco E, Burzi S, Rugge M, Muzzio PC, Nitti D. The potential of restaging in the prediction of pathologic response after preoperative chemoradiotherapy for rectal cancer. *Annals of surgical oncology*. 2007;14(2):455-61.
84. Martellucci J, Scheiterle M, Lorenzi B, Roviello F, Cetta F, Pinto E, Tanzini G. Accuracy of transrectal ultrasound after preoperative radiochemotherapy compared to computed tomography and magnetic resonance in locally advanced rectal cancer. *International journal of colorectal disease*. 2012;27(7):967-73.
85. Martling A, Holm T, Bremner S, Lindholm J, Cedermark B, Blomqvist L. Prognostic value of preoperative magnetic resonance imaging of the pelvis in rectal cancer. *The British journal of surgery*. 2003;90(11):1422-8.
86. Mathur P, Smith JJ, Ramsey C, Owen M, Thorpe A, Karim S, Burke C, Ramesh S, Dawson PM. Comparison of CT and MRI in the pre-operative staging of rectal adenocarcinoma and prediction of circumferential resection margin involvement by MRI. *Colorectal disease : the official journal of the Association of Coloproctology of Great Britain and Ireland*. 2003;5(5):396-401.
87. Matsuoka H, Nakamura A, Masaki T, Sugiyama M, Takahara T, Hachiya J, Atomi Y. A prospective comparison between multidetector-row computed tomography and magnetic resonance imaging in the preoperative evaluation of rectal carcinoma. *American journal of surgery*. 2003;185(6):556-9.
88. McNicholas MM, Joyce WP, Dolan J, Gibney RG, MacErlaine DP, Hyland J. Magnetic resonance imaging of rectal carcinoma: a prospective study. *The British journal of surgery*. 1994;81(6):911-4.
89. Mezzi G, Arcidiacono PG, Carrara S, Perri F, Petrone MC, De Cobelli F, Gusmini S, Staudacher C, Del Maschio A, Testoni PA. Endoscopic ultrasound and magnetic resonance imaging for restaging rectal cancer after radiotherapy. *World journal of gastroenterology : WJG*. 2009;15(44):5563-7.
90. Murano A, Sasaki F, Kido C, Nakamura T, Kobayashi S, Kato T, Hirai T, Kimura K. Endoscopic MRI using 3D-spoiled GRASS (SPGR) sequence for local staging of rectal carcinoma. *Journal of computer assisted tomography*. 1995;19(4):586-91.
91. Muñoz E, Granero-Castro P, Frasson M, Escartin J, Esclapez P, Campos S, Flor-Lorente B, Garcia-Granero E. Modified Wong's classification improves the accuracy of rectal cancer staging by endorectal ultrasound and MRI. *Diseases of the colon and rectum*. 2013;56(12):1332-8.
92. Nougaret S, Rouanet P, Molinari N, Pierredon MA, Bibeau F, Azria D, Lemanski C, Assenat E, Duffour J, Ychou M, Reinhold C, Gallix B. MR volumetric measurement of low rectal cancer

helps predict tumor response and outcome after combined chemotherapy and radiation therapy. *Radiology*. 2012;263(2):409-18.

93. Oberholzer K, Junginger T, Kreitner KF, Krummenauer F, Simiantonaki N, Trouet S, Thelen M. Local staging of rectal carcinoma and assessment of the circumferential resection margin with high-resolution MRI using an integrated parallel acquisition technique. *Journal of magnetic resonance imaging : JMRI*. 2005;22(1):101-8.
94. Okizuka H, Sugimura K, Ishida T. Preoperative local staging of rectal carcinoma with MR imaging and a rectal balloon. *Journal of magnetic resonance imaging : JMRI*. 1993;3(2):329-35.
95. Okizuka H, Sugimura K, Yoshizako T, Kaji Y, Wada A. Rectal carcinoma: prospective comparison of conventional and gadopentetate dimeglumine enhanced fat-suppressed MR imaging. *Journal of magnetic resonance imaging : JMRI*. 1996;6(3):465-71.
96. Park MJ, Kim SH, Lee SJ, Jang KM, Rhim H. Locally advanced rectal cancer: added value of diffusion-weighted MR imaging for predicting tumor clearance of the mesorectal fascia after neoadjuvant chemotherapy and radiation therapy. *Radiology*. 2011;260(3):771-80.
97. Pegios W, Vogl J, Mack MG, Hünerbein M, Hintze H, Balzer JO, Lobeck H, Wust P, Schlag P, Felix R. MRI diagnosis and staging of rectal carcinoma. *Abdominal imaging*. 1996;21(3):211-8.
98. Peschard F, Cuenod CA, Benoist S, Julié C, Beauchet A, Siauve N, Taieb-Kasbi F, Penna C, Nordlinger B. Accuracy of magnetic resonance imaging in rectal cancer depends on location of the tumor. *Diseases of the colon and rectum*. 2005;48(8):1603-9.
99. Piippo U, Pääkkö E, Mäkinen M, Mäkelä J. Local staging of rectal cancer using the black lumen magnetic resonance imaging technique. *Scandinavian journal of surgery : SJS : official organ for the Finnish Surgical Society and the Scandinavian Surgical Society*. 2008;97(3):237-42.
100. Pomerri F, Pucciarelli S, Maretto I, Zandonà M, Del Bianco P, Amadio L, Ruge M, Nitti D, Muzzio PC. Prospective assessment of imaging after preoperative chemoradiotherapy for rectal cancer. *Surgery*. 2011;149(1):56-64.
101. Poon FW, McDonald A, Anderson JH, Duthie F, Rodger C, McCurrach G, McKee RF, Horgan PG, Foulis AK, Chong D, Finlay IG. Accuracy of thin section magnetic resonance using phased-array pelvic coil in predicting the T-staging of rectal cancer. *European journal of radiology*. 2005;53(2):256-62.
102. Rafaelsen SR, Sørensen T, Jakobsen A, Bisgaard C, Lindebjerg J. Transrectal ultrasonography and magnetic resonance imaging in the staging of rectal cancer. Effect of experience. *Scandinavian journal of gastroenterology*. 2008;43(4):440-6.
103. Rao SX, Zeng MS, Xu JM, Qin XY, Chen CZ, Li RC, Hou YY. Assessment of T staging and mesorectal fascia status using high-resolution MRI in rectal cancer with rectal distention. *World journal of gastroenterology*. 2007;13(30):4141-6.
104. Sani F, Foresti M, Parmiggiani A, D'Andrea V, Manenti A, Amorotti C, Scotti R, Gallo E, Torricelli P. 3-T MRI with phased-array surface coil in the local staging of rectal cancer. *La Radiologia medica*. 2011;116(3):375-88.
105. Schnall MD, Furth EE, Rosato EF, Kressel HY. Rectal tumor stage: correlation of endorectal MR imaging and pathologic findings. *Radiology*. 1994;190(3):709-14.
106. Song I, Kim SH, Lee SJ, Choi JY, Kim MJ, Rhim H. Value of diffusion-weighted imaging in the detection of viable tumour after neoadjuvant chemoradiation therapy in patients with locally advanced rectal cancer: comparison with T2 weighted and PET/CT imaging. *The British journal of radiology*. 2012;85(1013):577-86.

107. Starck M, Bohe M, Fork FT, Lindström C, Sjöberg S. Endoluminal ultrasound and low-field magnetic resonance imaging are superior to clinical examination in the preoperative staging of rectal cancer. *The European journal of surgery = Acta chirurgica*. 1995;161(11):841-5.
108. Strassburg J, Lewin A, Ludwig K, Kilian L, Linke J, Loy V, Knuth P, Püttcher O, Ruehl U, Stöckmann F, Hackenthal M, Hopfenmüller W, Huppertz A. Optimised surgery (so-called TME surgery) and high-resolution MRI in the planning of treatment of rectal carcinoma. *Langenbeck's archives of surgery / Deutsche Gesellschaft für Chirurgie*. 2007;392(2):179-88.
109. Sun YS, Li XT, Zhang XY, Tang L, Cui Y, Zhang XP. [Preoperative staging of rectal carcinoma with high-resolution MRI: correlation with histopathologic findings]. *Zhonghua wai ke za zhi [Chinese journal of surgery]*. 2012;50(3):207-10.
110. Suppiah A, Hunter IA, Cowley J, Garimella V, Cast J, Hartley JE, Monson JR. Magnetic resonance imaging accuracy in assessing tumour down-staging following chemoradiation in rectal cancer. *Colorectal disease : the official journal of the Association of Coloproctology of Great Britain and Ireland*. 2009;11(3):249-53.
111. Tamakawa M, Kawaai Y, Shirase R, Satoh T, Akiba H, Hyodoh H, Hareyama M, Furuhashi T, Hirata K, Hasegawa T. Gadolinium-enhanced dynamic magnetic resonance imaging with endorectal coil for local staging of rectal cancer. *Japanese journal of radiology*. 2010;28(4):290-8.
112. Tatli S, Morteale KJ, Breen EL, Bleday R, Silverman SG. Local staging of rectal cancer using combined pelvic phased-array and endorectal coil MRI. *Journal of magnetic resonance imaging : JMRI*. 2006;23(4):534-40.
113. Taylor A, Slater A, Mapstone N, Taylor S, Halligan S. Staging rectal cancer: MRI compared to MDCT. *Abdominal imaging*. 2007;32(3):323-7.
114. Taylor FG, Quirke P, Heald RJ, Moran B, Blomqvist L, Swift I, St Rose S, Sebag-Montefiore DJ, Tekkis P, Brown G, MERCURY study group. One millimetre is the safe cut-off for magnetic resonance imaging prediction of surgical margin status in rectal cancer. *The British journal of surgery*. 2011;98(6):872-9.
115. Thaler W, Watzka S, Martin F, La Guardia G, Psenner K, Bonatti G, Fichtel G, Egarter-Vigl E, Marzoli GP. Preoperative staging of rectal cancer by endoluminal ultrasound vs. magnetic resonance imaging. Preliminary results of a prospective, comparative study. *Diseases of the colon and rectum*. 1994;37(12):1189-93.
116. Torkzad MR, Lindholm J, Martling A, Cedermark B, Glimelius B, Blomqvist L. MRI after preoperative radiotherapy for rectal cancer; correlation with histopathology and the role of volumetry. *European radiology*. 2007;17(6):1566-73.
117. Tytherleigh MG, Ng VV, Pittathankal AA, Wilson MJ, Farouk R. Preoperative staging of rectal cancer by magnetic resonance imaging remains an imprecise tool. *ANZ journal of surgery*. 2008;78(3):194-8.
118. Videhult P, Smedh K, Lundin P, Kraaz W. Magnetic resonance imaging for preoperative staging of rectal cancer in clinical practice: high accuracy in predicting circumferential margin with clinical benefit. *Colorectal disease : the official journal of the Association of Coloproctology of Great Britain and Ireland*. 2007;9(5):412-9.
119. Vliegen RF, Beets GL, Lammering G, Dresen RC, Rutten HJ, Kessels AG, Oei TK, de Bruïne AP, van Engelshoven JM, Beets-Tan RG. Mesorectal fascia invasion after neoadjuvant

- chemotherapy and radiation therapy for locally advanced rectal cancer: accuracy of MR imaging for prediction. *Radiology*. 2008;246(2):454-62.
120. Vliegen RF, Beets GL, von Meyenfeldt MF, Kessels AG, Lemaire EE, van Engelshoven JM, Beets-Tan RG. Rectal cancer: MR imaging in local staging--is gadolinium-based contrast material helpful?. *Radiology*. 2005;234(1):179-88.
121. Vogl TJ, Pegios W, Mack MG, Hünnerbein M, Hintze R, Adler A, Lobbeck H, Hammerstingl R, Wust P, Schlag P, Felix R. Accuracy of staging rectal tumors with contrast-enhanced transrectal MR imaging. *AJR. American journal of roentgenology*. 1997;168(6):1427-34.
122. Wong EM, Leung JL, Cheng CS, Lee JC, Li MK, Chung CC. Effect of endorectal coils on staging of rectal cancers by magnetic resonance imaging. *Hong Kong medical journal = Xianggang yi xue za zhi / Hong Kong Academy of Medicine*. 2010;16(6):421-6.
123. Xu JM, Zhong YS, Zeng MS, Rao SX, Niu WX, Wei Y, Ren L, Qin XY. [Evaluation of the preoperative staging of rectal cancer by magnetic resonance imaging]. *Zhonghua wei chang wai ke za zhi = Chinese journal of gastrointestinal surgery*. 2008;11(2):132-5.
124. Yimei J, Ren Z, Lu X, Huan Z. A comparison between the reference values of MRI and EUS and their usefulness to surgeons in rectal cancer. *European review for medical and pharmacological sciences*. 2012;16(15):2069-77.
125. Zhan S, Wang X, Huang X, Zhu H. Magnetic resonance imaging in restaging rectal cancer after neoadjuvant chemoradiotherapy. *Journal of B.U.ON. : official journal of the Balkan Union of Oncology*. 2015;20(1):62-7.
126. Zhang XM, Zhang HL, Yu D, Dai Y, Bi D, Prince MR, Li C. 3-T MRI of rectal carcinoma: preoperative diagnosis, staging, and planning of sphincter-sparing surgery. *AJR. American journal of roentgenology*. 2008;190(5):1271-8.