Clinical and radiological value of whole-body magnetic resonance imaging in health screening of top executives

Poster No.: C-0696
Congress: ECR 2014
Type: Scientific Exhibit
Authors: D. L. Tarnoki¹, A. D. Tarnoki¹, A. Richter¹, K. Karlinger², V. Bérczi², D. Pickuth¹; ¹Saarbrücken/DE, ²Budapest/HU
Keywords: eHealth, Computer applications, Professional issues, MR, MR-Diffusion/Perfusion, MR-Angiography, Screening, Outcomes analysis, Localisation, Occupational / Environmental hazards, Neoplasia, Multidisciplinary cancer care
DOI: 10.1594/ecr2014/C-0696

Any information contained in this pdf file is automatically generated from digital material submitted to EPOS by third parties in the form of scientific presentations. References to any names, marks, products, or services of third parties or hypertext links to third-party sites or information are provided solely as a convenience to you and do not in any way constitute or imply ECR’s endorsement, sponsorship or recommendation of the third party, information, product or service. ECR is not responsible for the content of these pages and does not make any representations regarding the content or accuracy of material in this file.

As per copyright regulations, any unauthorised use of the material or parts thereof as well as commercial reproduction or multiple distribution by any traditional or electronically based reproduction/publication method ist strictly prohibited.

You agree to defend, indemnify, and hold ECR harmless from and against any and all claims, damages, costs, and expenses, including attorneys' fees, arising from or related to your use of these pages.

Please note: Links to movies, ppt slideshows and any other multimedia files are not available in the pdf version of presentations.

www.myESR.org
Aims and objectives

Whole-body magnetic resonance imaging (WB-MRI) has become increasingly popular in population-based research in the recent decade to provide a high resolution image of the human body from head to toe. High soft tissue spatial resolution, multiplanarity, lack of ionising radiation, low incidence of nephrotoxicity caused by contrast agents, as well as high sensitivity and specificity for vascular and malignant diseases (1, 2) make MRI a perfect technique for screening. Due to financial reasons and limited availability, WB-MRI enables an early diagnosis mainly in defined groups of subjects who do not yet show symptoms in an attempt to reduce morbidity and mortality. The most common diseases in elderly population include; atherosclerosis and malignant tumours which are responsible for major portion of death, and cardiovascular diseases which are still the major leaders of morbidity and mortality in the developed countries (3). WB-MRI is capable of detecting a wide range of malignant diseases; such as bronchial carcinoma, hepatic malignancies, renal carcinoma, colonic cancer, lymphoma, and also rare malignancies such as bone or soft tissue tumours (4).

Our aim was to retrospectively analyze the frequencies of potentially relevant incidental findings throughout the body, especially in view of those that require further medical evaluation.
Methods and materials

We carried out a retrospective analysis of top executive subjects (mainly managers, lawyers, accountants, chief executive officers, company directors) with extreme health consciousness who underwent whole-body MRI and MRA at the Institute of Diagnostic and Interventional Radiology, Caritas Klinikum Saarbrücken St. Theresia, Germany between March 2012 and September 2013. Subjects were referred to WB-MRI scan by a family doctor, their company or were self referrals. The top executives completed a comprehensive questionnaire including their current symptoms, previous clinical findings, operations, and risk factors. MR studies were acquired on a Discovery MR750w 3 Tesla wide bore device (General Electric Healthcare, GE, Milwaukee, USA; 70 cm wide bore magnet) using T1 weighted (fast Spin Echo technique with a slice thickness of 5 mm), short tau inversion recovery (STIR), and diffusion weighted imaging (DWI) sequences according to a standardized protocol (Figs. 1-4). Depending upon the height of the patient, 6 or 7 slabs were acquired in a slab-by-slab-technique with no continuous table movement. T1 and STIR acquisitions are well established in the literature, STIR imaging allows the better identification of water containing (potentially malignant) lesions due to the suppression of surrounding fat tissue. The WB-MRI protocol was identical for all participants and included a plain WB-MRI and detailed examination of head, neck, chest, abdomen, pelvis, spine and extremities. A rolling platform with extended field of view allowed whole-body examinations with a table range of more than 200 cm, several dozen simultaneous receiver channels, and multiple plugs for attaching several RF coils concurrently enabling the individual to be covered with coils from "head to toe". The high number of coils allowed for parallel imaging which speeded up the data acquisition.

MR angiography (using 3D technique) was performed by the administration of 0.45 ml/kg body weight gadolinium contrast agent (0.5 mmol/ml gadoterate meglumine, Dotarem, Guerbet, Roissy, France), and was automatically injected at a flow rate of 1.2 ml/s in the first and 0.6 ml/s in the second phase (Fig. 5). The patient was placed in the supine position, and the phases were acquired using respiratory gating.

Findings and anatomical variants were documented in a standardized reading protocol. Picture archiving and communication system (AGFA IMPAX and KIS-RIS ORBIS, AGFA Healthcare, Mortsel, Belgium) were used for image storing. In order to ensure the best possible quality and to minimize the inter-reader variability, three readers reported the whole set of images: first-line reading was performed by a resident in radiology (2-4 years' experience), followed by two senior radiologists including the head of the department. The three readers evaluated the studies independently of each other. Then the results were discussed in consensus, finally, opinion, diagnoses/differential diagnoses and recommendation were evaluated together. Statistical analysis was performed by Microsoft Excel.
Fig. 1: Whole-body MRI set-up of coils (head, chest, abdomen and extremity coils) in a wide bore magnet device.

© Department of Diagnostic and Interventional Radiology, Caritasklinikum Saarbrücken St. Theresia, Academic Teaching Hospital of Saarland University - Saarbrücken/DE
**Fig. 2:** Whole-body MRI acquired on a dedicated whole-body MRI system and matrix coils in asymptomatic, smoker male 46-year-old patient, coronal T1 image.

© Department of Diagnostic and Interventional Radiology, Caritasklinikum Saarbrücken St. Theresia, Academic Teaching Hospital of Saarland University - Saarbrücken/DE
Fig. 3: Whole-body MRI acquired on a dedicated whole-body MRI system and matrix coils in asymptomatic, smoker male 46-year-old patient, coronal STIR image.

© Department of Diagnostic and Interventional Radiology, Caritasklinikum Saarbrücken St. Theresia, Academic Teaching Hospital of Saarland University - Saarbrücken/DE
**Fig. 4:** Whole-body MRI acquired on a dedicated whole-body MRI system and matrix coils in asymptomatic, smoker male 46-year-old patient, coronal DWI image.

© Department of Diagnostic and Interventional Radiology, Caritasklinikum Saarbrücken St. Theresia, Academic Teaching Hospital of Saarland University - Saarbrücken/DE
Fig. 5: Whole-body MRA acquired on a dedicated whole-body MRI system and matrix coils with a single injection of contrast agent in an asymptomatic male 52-year-old patient, coronal reconstruction, pasted image.

© Department of Diagnostic and Interventional Radiology, CaritasKlinikum Saarbrücken St. Theresia, Academic Teaching Hospital of Saarland University - Saarbrücken/DE
Results

Subject characteristics

Twenty-two top executives (82% men, age 47±9 years, mean±standard deviation) who underwent whole-body MRI and MRA imaging between March 2012 and September 2013 were included in the study. The WB-MR scans were analyzed retrospectively. The mean body mass index of the subjects was 25.2 kg/m². 65% of the subjects were completely asymptomatic. 45% of the subjects had a history of allergy. Eightyfive percent of the subjects were never smokers, 10% reported a previous smoking history and 5% was active smoker. Subjects reported never, occasional, and regular sport activity in 5%, 10% and 85%, respectively. Four-fifth of the subjects had current symptoms, previous symptoms/surgeries which are summarized in Table 1.

Table 1

Current symptoms, previous history of diseases/medical findings and operations of subjects who underwent whole-body magnetic resonance imaging (n=22)

<table>
<thead>
<tr>
<th>Symptoms, history of diseases/ findings</th>
<th>n (%) value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Discus protrusion</td>
<td>4 (18)</td>
</tr>
<tr>
<td>Hypertension</td>
<td>3 (14)</td>
</tr>
<tr>
<td>Bone and joint pain</td>
<td>3 (14)</td>
</tr>
<tr>
<td>Heart pain/symptoms*</td>
<td>3 (14)</td>
</tr>
<tr>
<td>Previous pneumonia</td>
<td>2 (9)</td>
</tr>
<tr>
<td>Sleep disorder</td>
<td>2 (9)</td>
</tr>
<tr>
<td>Nasal septum deviation</td>
<td>2 (9)</td>
</tr>
<tr>
<td>Sinusitis</td>
<td>2 (9)</td>
</tr>
<tr>
<td>Tinnitus</td>
<td>2 (9)</td>
</tr>
<tr>
<td>Hypercholesterinaemia</td>
<td>2 (9)</td>
</tr>
<tr>
<td>Ulcerative colitis</td>
<td>1 (5)</td>
</tr>
<tr>
<td>Night sweats</td>
<td>1 (5)</td>
</tr>
<tr>
<td>Thyroid nodules</td>
<td>1 (5)</td>
</tr>
<tr>
<td>Nephrolithias</td>
<td>1 (5)</td>
</tr>
</tbody>
</table>
Uterine myoma 1 (5)
Allergy 1 (5)
Urinary tract inflammation 1 (5)
Prostata hypertrophy 1 (5)
Inguinal hernia 1 (5)
Reduced hearing ability 1 (5)
Idiopathic thrombocytopenia 1 (5)
Bronchitis 1 (5)
Hepatitis B 1 (5)
Rectal haemorrhoids 1 (5)
Retinoschisis 1 (5)
Anal fibroma 1 (5)
Melanoma 1 (5)
Pneumothorax 1 (5)
Vertigo 1 (5)
Chest pain 1 (5)
Anal fissure and abscess 1 (5)
Neurodermatitis 1 (5)

**Operations**
Tonsillectomy 8 (36)
Appendectomy 5 (23)
Nasal septum correction 2 (9)
Orthopedic knee surgery 2 (9)
Nasal polypectomy 2 (9)
Hernia repair 2 (9)
Lipoma resection 1 (5)
Caesarean section 1 (5)
Varicectomy 1 (5)
Struma surgery 1 (5)
Ophthalmologic surgery 1 (5)
Naevus resection 1 (5)
Cryptorchism 1 (5)
Splenectomy 1 (5)
Cholecystectomy 1 (5)
Anal fibroma resection 1 (5)
Melanoma surgery 1 (5)
*including arrhythmia, valve insufficiency

**WB-MRI findings**

A suspicious (pararectal) malignancy was detected in one patient (4.5%) (Fig. 6-8). Two patients (9%) had negative MR reports, whereas incidental findings were described in 20 subjects (91%). The findings, categorized as significant (findings that require further medical evaluation and immediate referral), potentially significant (abnormalities potentially needing further medical evaluation or follow-up), and insignificant (abnormalities without well-defined diagnostic and therapeutic consequences according to existing guidelines and best practice recommendations), are shown in Fig. 9. Hydrocele was the most common incidental finding (50%; 61% of men), followed by a benign bony lesion in 32%. Incidental findings would have needed diagnostic workup at a urologist (77% of all lesions), rheumatologist (68%), internist (59%), otorhinolaryngologist (27%), pulmonologist (27%), surgeon (23%), gynecologist (18%), and dermatologist (5%). Further investigations were recommended in 68% of subjects including eight sonographies (36%, 2/3 abdominal), five chest computed tomographies (CT) (23%), one pelvic CT (5%), two mammographies (9%) and two additional MRIs (9%). In case of the suspicious pararectal malignancy, biopsy was recommended. The patient had an endorectal sonography which confirmed the presence of a highly suspicious mass, probably a lymph node. A rectoscopy/colonoscopy was planned, however the patient moved to another city and the further diagnostic/therapeutic workup is unknown yet.

**WB-MRA findings**

WB-MRA was negative in 16 subjects (73%). Vascular normal variations (e.g. irregular caliber of the vertebral artery, polar renal artery, stronger posterior communicant artery) were reported in five subjects (23%), and a non-significant stenosis was described in one subject (4.5%) (Fig. 10). A further subject had a possible right subclavian stenosis which might be confounded by motion artifact.
Fig. 6: Whole-body MR image of a 52-year-old male patient with history of sleep disorder, night sweats, hypercholesterinaemia and previous smoking. Note the right pararectal 16x14 mm mass (arrows) on the coronal T1 image (hypointense signal)

© Department of Diagnostic and Interventional Radiology, Caritasklinikum Saarbrücken St. Theresia, Academic Teaching Hospital of Saarland University - Saarbrücken/DE
Fig. 7: Whole-body MR image of a 52-year-old male patient with history of sleep disorder, night sweats, hypercholesterinaemia and previous smoking. Note the right pararectal 16x14 mm mass (arrows) on the coronal STIR image (hyperintense signal)

© Department of Diagnostic and Interventional Radiology, CaritasKlinikum Saarbrücken St. Theresia, Academic Teaching Hospital of Saarland University - Saarbrücken/DE
Fig. 8: Whole-body MR image of a 52-year-old male patient with history of sleep disorder, night sweats, hypercholesterinaemia and previous smoking. Note the right pararectal 16x14 mm mass (arrows) on the diffusion weighted (DWI) axial image indicating a restricted diffusion. Inverted DWI image is similar to a PET image.

© Department of Diagnostic and Interventional Radiology, Caritasklinikum Saarbrücken St. Theresia, Academic Teaching Hospital of Saarland University - Saarbrücken/DE
Fig. 9: Prevalence of WB-MRI findings in all patients (%).

© Department of Diagnostic and Interventional Radiology, Caritasklinikum Saarbrücken St. Theresia, Academic Teaching Hospital of Saarland University - Saarbrücken/DE
Fig. 10: Coronal reconstruction of whole-body MRA in a 52-year-old male patient with history of appendectomy and previous smoking. Note the 2 mm long, approximately 40% concentric stenosis of the left common carotid artery 3 cm distal to the aortic arch (arrow). Please note the left vertebral hypoplasia, kinking of the midcervical portion of the right internal carotid artery and the coiling of the distal cervical portion of the left internal cerebral artery.

© Department of Diagnostic and Interventional Radiology, Caritasklinikum Saarbrücken St. Theresia, Academic Teaching Hospital of Saarland University - Saarbrücken/DE
Conclusion

Our data suggest that 3 T wide bore WB-MRI, DWI and MRA of high diagnostic accuracy lead to the detection of clinically relevant diseases and many incidental findings in a cohort of top executives that require further imaging or surveillance in two-third of subjects. We demonstrated a potentially malignant lesion detection rate of 4.5% in our cohort and a high number of incidental findings (91%) requiring further radiological investigations in 68% of individuals. WB-MRA demonstrated normal vascular variations in 23% of subjects and a non-significant left proximal common carotid artery stenosis in 4.5%. It is subject to discussion that the method generates numerous further radiological investigations (68% in our study) due to its high sensitivity. Our research was the first one which involved this highly selected patient group, using a high field 3 T wide bore magnet system with T1, STIR, whole-body DWI and MRA acquisitions.
Personal information

David Laszlo Tarnoki, MD, PhD

Department of Diagnostic and Interventional Radiology, Caritasklinikum Saarbrücken St. Theresia, Academic Teaching Hospital of Saarland University, Saarbrücken, Germany. Rheinstrasse 2, 66113 Saarbrücken, Germany.

Department of Radiology and Oncotherapy, Semmelweis University, Budapest, Hungary, 78/a Ulloi street, Budapest 1082, Hungary.

Tel.: +36303687843. Email: tarnoki4@gmail.com
References


