CASE REPORT

Identification of the primary tumour with the help of diffusion-weighted MRI in a patient with autosomal dominant polycystic kidney disease and metastatic renal cell carcinoma

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ABSTRACT. We report the case of a 47-year-old patient with autosomal dominant polycystic kidney disease, who became symptomatic owing to a painful metastasis of a renal cell carcinoma. Abdominal sonography, multiphase CT and MRI were performed in order to localise and resect the primary tumour, but its identification was severely hampered owing to multiple renal cysts. In addition to standard MRI protocol, a spin-echo, single-shot echo planar diffusion-weighted imaging sequence was performed. The mean apparent diffusion coefficient (ADC) of renal cysts was $2.66 \pm 0.12 \times 10^{-3} \text{ mm}^2 \text{ s}^{-1}$, $1.76 \pm 0.19 \times 10^{-3} \text{ mm}^2 \text{ s}^{-1}$ of renal parenchyma in and $1.26 \pm 0.18 \times 10^{-3} \text{ mm}^2 \text{ s}^{-1}$ of a suspicious soft-tissue mass at the midsection of the right kidney, indicating an area of higher cellularity. This value was significant lower than the ADC obtained for renal parenchyma ($p < 0.0001$). Right-sided nephrectomy was performed and the pathological diagnosis of the suspicious lesion was clear cell renal carcinoma.

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With the increasing use of cross-sectional imaging, the majority of renal cell carcinomas (RCCs) are being diagnosed incidentally [1, 2]. In patients with autosomal-dominant polycystic kidney disease (ADPKD), most of the renal parenchyma is replaced by cysts, which vary widely in size and appearance and may exhibit complex features [3, 4]. The association of RCCs and ADPKD is controversial, although higher incidences of bilateral, multicentric and sarcomatoid RCCs have been described [3–6]. In such cases, detection of RCCs can be delayed, whereas early diagnosis is crucial for the patient prognosis [7].

Diffusion-weighted imaging (DWI) is a non-invasive MRI method to supply information of water proton mobility, which is reduced in the restricted environment of dense cellular malignant lesions [8]. Until now, limited clinical experience exist for the application of DWI to renal lesions, but lower apparent diffusion coefficients (ADCs) have been reported in RCCs than in renal parenchyma [9–11].

To the best of our knowledge, we report of the first case of a patient with ADPKD and metastatic RCC, in which DWI was of great benefit in identifying the primary tumour site.

Case report

A 47-year-old male presented with a 5 month history of right shoulder pain and loss of strength in the right

Figure 1. Arterial contrast-enhanced CT displays multiple bilateral renal cysts of varying size, configuration and localisation (two representative cysts are marked with asterisks). At the midsection of the right kidney appears to be a $3.6 \times 2.7 \text{ cm}$ region of nodular tissue thickening (arrowheads). Misleadingly intralesional cysts can also be identified (arrows) and contrast-enhancement is equivalent to that of adjacent renal parenchyma.

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arm. Clinical examination revealed a palpable bulk dorsal of the right spina scapulae while shoulder mobility was reduced. MRI showed an osteodestructive soft-tissue mass of the right lateral scapula. Histological workup of an open biopsy revealed the tumour to correspond to a metastasis of RCC.

In order to reveal the primary tumour site abdominal ultrasonography was performed, but because the patient had ADPKD, identification of the affected kidney was not possible owing to multiple bilateral cysts. Therefore, multi-phase contrast-enhanced CT (HiSpeed, General Electric, Milwaukee, WI) was performed. 120 ml of contrast media (Imeron 300, Bracco Altana Pharma, Konstanz, Germany) was administered from an antecubital venous approach with the use of a power-injector (MEDRAD Vistron CT, Indianola, IA) and a flow of 3.5 ml s^{-1} . Scans were acquired pre-contrast as well as in the arterial, nephrographic and pyelographic phases. Multiple bilateral simple, complicated and partially calcified renal cysts were found. There was a

$3.6 \times 2.7 \text{ cm}$ region suspicious of an apparent nodular mass in the midsection of the right kidney. Also displayed were intralesional cysts and densities equally to adjacent renal parenchyma in all phases (Figure 1).

The case was discussed at our interdisciplinary tumour board meeting; bilateral nephrectomy was suggested if the primary tumour could not be identified. In an ultimate attempt to clarify the case, MRI (Siemens Symphony, 1.5 Tesla, Erlangen, Germany) was performed. Sequences used were unenhanced axial and coronal T_1 weighted (T_1W) gradient-echo, T_2 weighted (T_2W) turbo-spin-echo, as well as gadolinium-DTPA (Magnevist, Schering, Berlin, Germany) enhanced fat-saturated dynamic T_1W images. In addition to standard MRI, but before any contrast media injection, DWI was performed in the coronal plane using a spin-echo, single-shot echo planar imaging (EPI) sequence with the following parameters: repetition time (TR)/time to echo (TE)/number of excitations (NEX)=10 200 ms/108 ms/ 2;

Figure 2. (a) On corresponding transverse T_2 weighted MRI, the solid part of the lesion displays almost homogeneous low-signal intensities (arrowheads), which are similar to that of adjacent renal parenchyma. Intralésional cysts (arrows) reveal similar high-signal intensities compared with other renal cysts (two representative cysts are marked with asterisks). (b) On corresponding transverse T_1 weighted MRI the nodular lesion also appears isointense to adjacent parenchyma (arrowheads). Renal cysts display mixed signal intensities (two representative cysts are marked with asterisks). (c) On coronal gadolinium-enhanced T_1 weighted MRI (nephrographic phase) the lesion (arrowheads) also reveals similar contrast enhancement as adjacent parenchyma.

field of view (FOV), 180–250 mm; matrix, 256×256 pixels; section thickness, 5 mm; interslice gap, 1 mm; 30 section levels. The b -values were 0, 500 and 1000 s mm^{-2} . T_2W images showed multiple bilateral medullary and cortical hyperintense cystic lesions. The suspicious lesion of the midsection of the right kidney was isointense to adjacent renal parenchyma harbouring two intralésional cysts (Figure 2a). On unenhanced T_1W renal cystic lesions displayed mixed signal intensities, reflecting simple and complicated cysts. Again, the suspicious lesion was isointense to adjacent renal parenchyma (Figure 2b). On dynamic contrast-enhanced T_1W images, contrast-media enhancement and wash-out patterns of the lesion were almost identical compared with adjacent renal parenchyma (Figure 2c). Intralésional signal intensities were 362 ± 9 for the arterial phase, 368 ± 7 for the nephrographic phase and 325 ± 17 for the pyelographic phase. In adjacent renal parenchyma, signal intensities were 322 ± 19 for the arterial phase, 350 ± 14 for the nephrographic phase and 321 ± 11 for the pyelographic phase, thus the corresponding signal intensities were of no significant difference. In conclusion, the reliable identification of the primary tumour localisation by morphological imaging was not possible.

ADC maps were calculated from DWI on a voxel-by-voxel basis with an implemented algorithm. ADC values in renal cysts were $2.66 \pm 0.12 \times 10^{-3} \text{ mm}^2 \text{ s}^{-1}$, with the lowest values being $2.27 \pm 0.09 \times 10^{-3} \text{ mm}^2 \text{ s}^{-1}$. Areas of renal parenchyma displayed ADC values of $1.76 \pm 0.19 \times 10^{-3} \text{ mm}^2 \text{ s}^{-1}$, which were significantly lower than ADCs of renal cysts ($p < 0.0001$). In the suspicious lesion, ADC values of $1.26 \pm 0.18 \times 10^{-3} \text{ mm}^2 \text{ s}^{-1}$ were found. These values were the lowest values measured in both kidneys and significantly lower than in adjacent renal parenchyma ($p < 0.0001$; Figure 3). No other area of such low ADCs was detected, although intralésional cystic areas displayed ADC values of $2.54 \pm 0.10 \times 10^{-3} \text{ mm}^2 \text{ s}^{-1}$, which were by means of DWI indistinguishable from the other renal cysts. Hence, the suspicious lesion was assumed to represent the primary tumour site. Nephrectomy of the right kidney was performed and histological analysis of the lesion revealed a moderate differentiated clear cell RCC Grade II (Figure 4). Owing to nephrectomy taking place outside of our hospital, it was not possible to acquire a macroscopic image of the right kidney. The histopathological report showed no evidence of other malign foci in the right kidney apart from the suspicious lesion shown in DWI; however, it is important to note that an additional contralateral tumour can not be fully excluded as the left kidney was preserved.

Discussion

Surgical excision is the mainstay in the management of RCCs. Even when RCCs cannot be cured by means of surgery, resection of the primary tumour appears to be an integral part of systematic therapy for metastatic RCCs [12]. Nevertheless, identification of the original tumour site in patients with ADPKD is hampered owing to multiple cysts and the fact that RCCs may arise from cystic renal masses [13].

Figure 3. Coronal apparent diffusion coefficient (ADC) map of diffusion-weighted single-shot echo planar MR sequence corresponding to Figure 2c. The suspicious nodular lesion (arrowheads) shows significantly lower ADC values ($p < 0.0001$) than adjacent renal parenchyma (white asterisk). Cysts reveal a significantly higher ADC value (two representative cysts are marked with asterisks) than the lesion or renal parenchyma ($p < 0.0001$).

Water proton mobility is unrestricted in cystic lesions but reduced in dense cellular lesions like solid tumours [14]. Therefore, the application of DWI in patients with ADPKD as a tool to identify lesions with higher cellular density appears especially appealing.

In our patient the mean ADC value of renal parenchyma was $1.76 \pm 0.19 \times 10^{-3} \text{ mm}^2 \text{ s}^{-1}$. Although very different ADC values have been reported for normal renal parenchyma in healthy volunteers ranging from $1.63 \times 10^{-3} \text{ mm}^2 \text{ s}^{-1}$ [15] to $5.76 \times 10^{-3} \text{ mm}^2 \text{ s}^{-1}$ [16], such differences are primarily owing to the selected b -value ranges and hamper comparison. Nevertheless, the mean ADC value of renal parenchyma was significantly lower than even the lowest value for cystic lesions ($2.27 \pm 0.09 \times 10^{-3} \text{ mm}^2 \text{ s}^{-1}$), which allowed all cystic lesions to be identified as being benign. Standard abdominal CT and MRI techniques failed to clearly depict the primary tumour site. An apparent nodular mass was noted, but contrast-media enhancement and

Figure 4. Histopathology of lesion biopsy shows a clear-cell renal tumour with distinct borders and small nuclei.

wash-out behaviour were equivalent to adjacent renal parenchyma on multiphase CT as well as on dynamic contrast-enhanced MRI. In addition, intralesional cysts further obscured tumour identification. In contrast, this region displayed a significantly lower mean ADC value compared with adjacent renal parenchyma, indicating restricted diffusion owing to higher tissue cellularity as it has been reported for most malignant tumours [14]. In addition, these results were in good agreement with previous observations although clinical experience is still preliminary [9–11].

Conclusion

DWI of the kidney can provide helpful additional information to differentiate RCCs from renal parenchyma as well as from complex renal cysts, which is valuable in patients with ADPKD.

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