Perilesional enhancement of liver hemangiomas in magnetic resonance studies

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Purpose

Hemangiomas are the most common benign tumors in the liver with a reported prevalence of 0.4 to 20% according to several studies (1). It is well established that hemangiomas are multiple in more than 50% of cases and have a female predilection, reported as approximately 5:1, typically being discovered between the fourth and fifth decades of life (2,3). Being deprived of malignant potential and often asymptomatic, they are primarily detected incidentally during abdominal imaging work-up, but must be distinguished from more menacing abnormalities, including malignant lesions. The widespread use of cross-sectional imaging has allowed not only an increased detection rate but a better characterization of its distinctive three enhancement patterns which are widely accepted as diagnostic (4,5):

- Type 1 immediate and complete homogeneous enhancement on arterial-dominant phase representing a flash-filling hemangioma;
- Type 2 early peripheral nodular enhancement with centripetal filling in the late phases;
- Type 3 early peripheral nodular enhancement with centripetal progression with persistent non-enhancing central area in the late phase.

It has been also shown that perilesional parenchymal enhancement on arterial phase images, previously thought to be associated with a malignant lesion, has been found in benign liver masses, in particular hemangiomas with an incidence in the order of 19-25% of cases (4,6). The physiopathological mechanism of temporal peritumoral enhancement is still not completely clarified yet.

Our purpose was to evaluate the occurrence rate of temporal peritumoral enhancement associated with hepatic hemangiomas and to determine if there are specific features from which a hemodynamic explanation may be formulated.
Methods and Materials

- Patients

In this retrospective study, a computerized search of the database was performed using the keywords "hemangioma" and "angioma" for consecutive patients between January 2008 and February 2012 who had abdominal MR examination.

Eight patients (n=8) were excluded because they had:

- history of previous chemotherapy or prior liver resection or hepatic intervention (n=2)
- portal vein thrombus (n=3)
- atypical enhancement pattern with no histologic evidence (n=3)

Two radiologists with 8 and 1 year of experience in gastrointestinal MR images reviewed in consensus 223 patients with 515 liver hemangiomas, which met the study entry criteria as described subsequently. The patients consisted of 119 women and 104 men, aged 24-89 years (55.4±13.54 years).

Institutional review board approval was obtained for this study and the necessity for informed consent was waived due to its retrospective nature.

- MR Technique and Image Analysis

All patients underwent MR examinations including precontrast T1- and T2-weighted images and postgadolinium dynamic images (gadoterate meglumine, Dotarem; Guerbet, Paris, France), performed using the Signa 1.5T system (GE Healthcare Medical Systems,) with a phased-array coil.

Diagnosis of hemangioma was established by:

- moderately high T2 signal intensity; moderately low signal intensity on T1-weighted images;
- discontinuous ring of peripheral nodules (figure 1) or uniform enhancement on immediate post-Gadolinium images (figure 2);
- centripetal progression or uniform enhancement in the late phases.
**Fig. 1**: Hemangioma. (a) Axial T2wi SSFSE with Fat Suppression and pre (b) and postcontrast axial T1wi 3D-GRE with fat suppression in the arterial dominant phase. (c) Images show two well-de#ned lobular lesions, one of which demonstrate moderately high signal on T2-weighted image (Lenh type 3**, arrow) and characteristic peripheral nodular enhancement with centripetal progression on 3D GRE image whereas more uniform enhancement on 3D GRE image is apparent in the other hemangioma (Lenh type 2, arrowhead). Perilesional enhancement is depicted* in c). ** see table 1

**References**: radiology, Hospital do Espirito Santo - Evora - Évora/PT
Fig. 2: Flash-filling hemangioma. (a) Transverse T2wi SSFSE with Fat Suppression with pre (b) and postcontrast axial T1wi 3D-GRE with fat suppression in the arterial dominant (c) and portal phases (d). Images depict a millimetric flash-filling hemangioma (circle) with temporal perilesional enhancement seen in arterial phase (c), on the subcapsular region of segment II.

References: radiology, Hospital do Espirito Santo - Evora - Évora/PT

Perilesional (PL) enhancement was diagnosed when images showed circumferential or wedge-shaped or homogeneous enhancement in the liver parenchyma adjacent to the hemangioma in the arterial phase of dynamic MR and returned to be iso or less hyperintense in the portal phase.

Speed of lesion enhancement (table 1) and distance from the capsule were correlated with the presence of PL enhancement. Hemangioma`s location was assigned as follows:

- Locat$_A$ - capsular or supcapsular regions (#10mm from hepatic capsule)
- Locat$_B$ - more than 10mm from hepatic capsule.
Table 1: Speed of intratumoral contrast material enhancement was determined with early nonequilibrium phase images and was categorized as rapid (Lenh type 1 with intratumoral enhancement with approximately 100% of extent at arterial phase), intermediate (Lenh type 2: 60-99% of lesion extent), or slow (Lenh type 3:

References: radiology, Hospital do Espirito Santo - Evora - Évora/PT

We also correlated the presence of temporal peritumoral enhancement with the size of hemangiomas (greatest dimension on T2-weighted images). Each hemangioma was categorized as ultra small (#10mm), small (11-20mm) medium (21-40mm) or large (>40 mm).

The two readers also assessed the lesion location according to the hepatic segment numbering system of Couinaud and the presence of early opacification of portal branches during the HAP.

Qualitative and quantitative data were subjected to statistical analysis (Chi-squared test or Fischer's exact test) and a P value of less than 0.05 was considered to indicate a statistically significant difference.
Results

Qualitative analysis showed 80 (15.53%) hemangiomas with PL enhancement at the same time as no perilesional signal changes and enhancement difference was observed in the remaining 435. The incidence of PL enhancement was significantly higher (P < 0.05) in tumors with rapid enhancement (49 of 80 hemangiomas [61.25%] than in those with $L_{enh}$ type 2 or $L_{enh}$ type 2 - see table 2.

<table>
<thead>
<tr>
<th>Extent of lesion enhancement</th>
<th>Hgs with PL enhancement</th>
<th>Hemangiomas without PL enhancement</th>
</tr>
</thead>
<tbody>
<tr>
<td>$L_{enh}$ type 1 (see table 1)</td>
<td>49 **</td>
<td>20</td>
</tr>
<tr>
<td>$L_{enh}$ type 2</td>
<td>17</td>
<td>19</td>
</tr>
<tr>
<td>$L_{enh}$ type 3</td>
<td>14</td>
<td>396</td>
</tr>
<tr>
<td>Total (n)</td>
<td>80</td>
<td>435</td>
</tr>
</tbody>
</table>

Table 2: Correlation between PL enhancement and speed of lesion enhancement ** P

References: radiology, Hospital do Espírito Santo - Évora - Évora/PT

The majority of lesions with transient hepatic signal differences were subcapsular in location (p<0.05) - fig.2 - as summarized in table 3. Only 17.5% (14 of 80) of the hemangiomas with PL enhancement were positioned more than 10mm from the hepatic surface (mean distance 16.7±6.08mm) and in 6 of these a vascular branch originating from liver capsule was identified (see figure 3). However there was no significant difference between prevalence of parenchymal enhancement and early visualization of portal/vein branches.

<table>
<thead>
<tr>
<th>Liver Capsule distance</th>
<th>Hemangiomas with PL enhancement (n=80)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Subcapsular location</td>
<td>66 (82.5%)</td>
</tr>
<tr>
<td>(located ≤10mm from the hepatic surface)</td>
<td></td>
</tr>
<tr>
<td>Deep location</td>
<td>14 (17.5%)</td>
</tr>
<tr>
<td>(distance of &gt;10mm from the liver capsule)</td>
<td></td>
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</table>

Table 3: Summarizes the location observed in hemangiomas with PL enhancement

References: radiology, Hospital do Espírito Santo - Évora - Évora/PT
**Fig. 3:** Hemangioma in a deep location. Consecutive images. Postcontrast axial T1wi 3D-GRE with fat suppression in the arterial dominant (a) phase. A wedge shaped parenchymal enhancement is depicted with early visualization of a portal branch as well as a capsule-based vessel (arrow).

**References:** radiology, Hospital do Espirito Santo - Evora - Évora/PT

The hemangiomas ranged in size from 2 to 130mm (mean 18.25±18.49mm). Mean sizes of the hemangiomas with and without peritumoral enhancement were 12.09±7.41mm and 19.37±19.60 mm, respectively.

Although temporal hepatic signal differences were usually seen in ultra small and small hemangiomas, there was no statistically significant relationship between lesion size and occurrence rate of the transient enhancement although hemangionas with $L_{\text{enh}}$ type 1 (rapid) were significantly smaller than those with intermediate or slow enhancement.
Conclusion

Transient perilesional enhancement, traditionally considered a feature of malignant tumors, has been increasingly reported in association with benign lesions, namely hemangiomas. At our institution, MR imaging is routinely performed for evaluation of hepatic lesions allowing the investigation of this event. We detected peritumoral enhancement on the arterial-dominant phase in 15.53% of hemangiomas which was slightly lower than that of the MRI study by Jeong et al (32 of 167 [19%]), (7,8).

The majority of hemangiomas with PL enhancement were small flash-filling lesions located adjacent to the capsule. Possible explanations reported in the literature for this association include characteristics of the internal architecture or the existence of arterio-venous shunting linked to their hyperdynamic status. Yamashita et al (5,9) suggested that the enhancement pattern might correlate with the collective size of its constituent vascular spaces and assumed that rapidly enhancing hemangiomas have smaller vascular spaces and large interstitium. As a result, it might be reasonable to presume that a large amount of inflow and outflow in the smaller intravascular spaces is more likely to cause shunting between branches of hepatic artery and the portal vein, (10,11).

In our study an alternative explanation can be formulated. The association between the appearance of the temporal peritumoral enhancement and subcapsular location of hemangiomas was statistically significant which combined with the occasional visualization of a vascular branch in the enhanced area rising from liver capsule may reflect recruitment of capsular based vessels. It is possible that small capsular arteries directly communicate with peripheral intrahepatic arteries and capsular veins may as well penetrate the hepatic surface and drain into a peripheral portal branch.

There are several limitations in our study that deserve mention, namely, the lack of pathologic and angiographic correlation with MR findings, since the diagnosis was only established by the characteristic imaging features and would not be ethical to carry out an invasive procedure for a known benign condition.

A significant percentage of patients indeed presented transient perfusion abnormalities associated with hepatic hemangiomas. Familiarity with these temporal signal changes on multisection dynamic MR images is important to avoid diagnostic errors.

Furthermore it is through an understanding of these hemangioma features that hypotheses and additional studies concerning microvascular phenomena may arise.
References


