Diagnostic accuracy of MR sialography in sialolithiasis and salivary ductal stenosis

Noha Mohamed AbdelMaboud Ibrahim *, Amr el Badry

Lecturer of Radiodiagnosis, Department of Radiology, Faculty of Medicine, Tanta University, Egypt

Received 13 September 2012; accepted 12 October 2012
Available online 7 November 2012

Keywords
Salivary glands; Salivary glands MR; Salivary glands radiography; Salivary glands Ultrasound

Abstract  Objectives: The purpose of this study is to determine the diagnostic accuracy of MR sialography in the examination of patients with salivary duct disease.

Patients and methods: Twenty-eight patients (twenty males and eight females, average age, 47 years), with symptoms related to the salivary glands, underwent both conventional sialography and MR sialography. The latter was performed using heavily T2-weighted, two dimensional, fast spin-echo techniques and a neck coil. Contiguous 3-mm axial images with frequency-selective fat suppression were acquired through the symptomatic gland. The MR sialography findings were compared with the final diagnoses determined by conventional sialography, and with surgery in the case of those who underwent surgical intervention. Ultrasound examination was performed using 7.5 MHz transducer. Conventional sialography was performed with the use of 0.012–0.021 inch sialographic catheter and an injection of 0.3–1.5 ml Ultravist 300 mg/ml.

Results: Final diagnosis included sialolithiasis in eleven cases, sialolithiasis and stenosis in four cases, stenosis without lithiasis in ten cases and normal salivary glands in three cases. (The normal cases were excluded from the study).

Conclusion: It is concluded that MR sialography with a heavily T2-weighted sequence is highly successful in the noninvasive visualization of the ductal system of major salivary glands in cases that could not be examined by conventional sialogram. It is useful for diagnosing sialolithiasis...
1. Introduction

Digital sialography has conventionally been considered the gold standard for depiction of ductal disease of the salivary gland. Digital sialography can accurately depict the ductal anatomy and pathology up to 4th order branching (1). Disadvantages of conventional sialography include radiation exposure, the need to cannulate the ductal orifice, and pain during contrast injection. Duct cannulation requires an experienced operator, especially in patients with calculus close to the ductal orifice and papillary stenosis. Potential complication of conventional sialography includes duct trauma, rupture of the ductal system, displacement of calculus, infection, and adverse reactions to contrast material (2).

MR sialography is a promising noninvasive tool for imaging of the ductal system of major salivary gland (3). This technique produces sialographic images similar to those of conventional sialography without the use of contrast media or radiation (1). The underlying principles are exactly the same as those used in the recently developed techniques of fluid imaging using very heavily T2-weighted pulse sequences such as MR urography and MR Cholangiopancreatography (4). MR sialography is fast and demonstrates the entire ductal system which is similar to conventional sialography. It has been performed using different sequences such as modified rapid acquisition with relaxation enhancement (RARE) (5), fast spin-echo (6), constructive interference in steady state (CISS) (4), and half-fourier acquisition single-shot turbo spin-echo (HASTE) (7) pulse sequence for evaluation of benign salivary gland diseases. The purpose of our study was to establish the diagnostic accuracy of MR sialography, compared with the gold standard of conventional sialography in a large group of patients with suspected salivary duct disease.

2. Patients and methods

2.1. Patients

This study was conducted according to the guidelines of the Ethics Committee of Tanta University and approved by our Institutional Review Board; all patients gave us written informed consent to be imaged in our study.

A prospective study of twenty-eight patients (twenty men and eight women; average age 47 years), were included in our study. The presenting symptoms were recurrent: painful salivary gland swelling in 6 patients, swelling in the floor of the mouth in 4 patients, pain and swelling during mastication in 7 patients, recurrent submandibular or parotid swelling in 5 patients and swelling of the salivary gland related to eating in 6 patients. All patients underwent conventional sialography, ultrasound & MR sialography.

2.2. MR sialography

Examinations were performed on a 1.5 Tesla MR Unit (General Electric Medical Systems), using a neck coil. No specific preparation for the patients, only they were asked to breathe quietly with no vigorous swallowing or coughing. Sialogogues were not administered because the pooling of saliva could obscure signal from the submandibular duct, which is situated close to the floor of the mouth, and could also cause motion artifacts from swallowing. A slice displaying the sagittal anatomy of the mandibular bone, including the tempromandibular joint was chosen as the scout image. The planes were obtained in a transverse plane parallel to the hard palate and in a sagittal oblique plane parallel to the Wharton duct in cases of submandibular gland examination, and parallel to the stensen duct in cases of parotid gland examination. Axial oblique scans were obtained from the level of the tempromandibular joint down to the angle of the mandible and from the level of the midmandibular ramus down to the hyoid cartilage for submandibular gland examination. Axial oblique and sagittal oblique FRFSE (fast recovery fast spin-echo) T2-weighted imaging was done with TR:3460, TE:131, FA:90, FOV:23×17, matrix 320×224, echotime:20 s, slice thickness 3 mm, the MR sialogram was done with SSFSE (single-shot fast spin-echo), axial oblique and sagittal oblique views with TR:6000, TE:1000, FOV: 22×22, matrix 256×224, echotime 36 s, slice thickness 3 mm.

MR sialography is considered normal if the following criteria were fulfilled:

1) Absence of calculi. 2) Absence of ductal dilatation. 3) Absence of high signal intensity areas within the glandular parenchyma. 4) Absence of ductal displacement. 5) Absence of ranulas, diverticular out pouching or tumors (8).

2.3. Conventional sialography

Conventional sialography was performed by using standard fluoroscopic equipment; conventional radiographs were obtained in antero-posterior and lateral-oblique projections to detect grossly radiopaque stones. To best visualize the intraoral opening of either the Stensen or Wharton duct, all patients received a secretogogue (fresh lemon). The sialographic equipment included a 0.012–0.021 inch sialographic cannula, a polyethylene connecting tube, a 5-ml syringe, and a low–osmolarity water-soluble contrast agent. Once the ductal opening was identified, the cannula was advanced gently to avoid perforation, and 0.3–1.5 ml of Ultravist 300 mg I/ml were injected slowly by using manual pressure. The injection was always performed under fluoroscopic control to achieve optimum ductal filling, and spot radiographs were obtained in antero-posterior and lateral-oblique projections.
Gray-scale US in the salivary glands was performed on all patients by using a linear–probe 7.5 MHz transducer (Siemens Sonoline Siena). The gland and its duct were examined on both sides in longitudinal and transverse planes. Small echogenic lesions with acoustic shadow were regarded as indicative of intraductal stone. US was performed at the same time as conventional sialography, and the findings from both examinations were reported together.

2.5. Image interpretation

The radiographs were analyzed for the presence of duct dilatation, and any duct abnormality. In patients with calculus disease, the number and location of stones and their visibility on the control radiographs were recorded. In patients with strictures, the site of stricture was classified as being intraglandular or extra-glandular and in the latter case, subdivided into proximal, mid, or distal duct, corresponding to the division of the extra glandular duct into equal thirds. For descriptive purposes, the portion of the main duct, close to the glandular parenchyma, was labeled as the proximal end of the duct and the portion of the main duct close to the papilla as the distal end of the duct.

The MR sialography was analyzed for the presence of duct dilatation and any duct lesion. The maximum extra glandular duct diameter was measured. Stones were diagnosed when imaging showed well-defined, rounded, low-signal-intensity lesions surrounded by high-signal-intensity saliva. The number of stones, their location and their maximum size were recorded. Stricture was defined as a tapered segment of signal loss involving the duct and associated with proximal duct dilatation. The site of obstruction and the degree of proximal duct dilatation were assessed and recorded in a similar fashion to that of conventional sialography.

3. Results

This study was performed on twenty-eight patients, twenty males and eight females, average age (47 years).

The final diagnosis in all twenty-eight salivary glands was sialolithiasis in eleven glands, combined sialolithiasis and stenosis in four glands, duct stenosis without lithiasis in ten, and three patients showed normal salivary glands and were excluded from the study. (Table 1).

By conventional sialography, we diagnosed sialolithiasis in 9 of 11 cases as filling defects seen in salivary ducts (one in the parotid, eight in submandibular duct), one submandibular duct had a narrow orifice and was difficult to be cannulated, in another case, the stone was radiolucent so it was missed by conventional sialography. However from the 4 combined cases of stones and stenosis we diagnosed three cases and in one case the stone was at the orifice of the duct which resulted in difficult cannulation. Regarding the number of stones, eight cases showed multiple stones and four cases showed single stone (from the whole number of sialolithiasis and combined cases). Ductal stenosis was diagnosed by conventional sialography in nine of ten cases, in one case the stenosis was near the orifice of the duct and so it was difficult to be cannulated, from the four cases of the combined stones and stenosis, three cases were diagnosed. Also conventional sialography allows better visualization of the secondary and tertiary ducts. Table 2 shows the cases of sialolithiasis diagnosed by conventional sialography.

US diagnosed 9 of 11 cases of sialolithiasis, one case in the parotid gland, eight cases in the submandibular gland, the size of the stones <3 mm. in four cases, 3–9 mm. in three cases, and >9 mm. in two cases, the other two cases the stones were <3 mm. as proved by MR sialogram with no acoustic shadow and could not be seen by US. Table 3 shows the cases of sialolithiasis diagnosed by US.

Regarding duct stenosis, US diagnosed only four cases as it could only trace the duct of straight course but not of kinked or tortuous course, and the caliber could not be accurately measured. The four cases of combined stones and stenosis were also diagnosed by US.

MR sialography could diagnose 10 of 11 cases of sialolithiasis, one case in the parotid, and nine in submandibular gland. The calculi were intraductal in five submandibular, one parotid, and intraparenchymal in four glands single stone in four cases and multiple stones in six cases. Discrepancies regarding the exact location of a calculus as assessed at MR sialography and conventional sialography were noted in two cases. In these cases, active filling of the ductal system with contrast material during conventional sialography resulted in the displacement of an anteriorly placed ductal stone into a more posterior position. Table 4 shows the cases of sialolithiasis as diagnosed by MR sialogram.

MR sialography could diagnose seven cases of ductal stenosis out of ten. Stenosis was localized at the level of the primary branching ducts in one gland.

The degree of ductal dilatation seen at MR sialography and caused by stenosis was the same as that seen at conventional sialography. No discrepancies, regarding the exact location of a stenotic area as assessed at MR sialography and conventional sialography were noted.

Table 5 shows a comparative study between MR sialogram, US & Conventional sialography Fig. 1–3.

4. Discussion

Conventional sialography is widely used for diagnosing ductal abnormalities of the main salivary glands providing cannula-
tion of the duct and a good radiographic technique observed, high spatial resolution images of the extra and intraglandular duct systems can be obtained. Images may be obtained in more than one plane, and the response to sialogogues can be used to assess duct function. (9).

However, Weber (10) stated that the cannulation of the duct cannot always be achieved even in the absence of duct abnormality. Also the orifices of the submandibular ducts are difficult to identify as the ducts are normally of narrow caliber, and if the stone is present at the duct orifice, cannulation may be impossible. In this study, one submandibular duct was difficult to be cannulated and is proved to be normal by the MR sialography. One case, had a stone at the orifice which also resulted in difficult cannulation, in another case the stone was radiolucent and was also missed by conventional sialography. There were discrepancies regarding the exact location of stone as was assessed by MR sialogram and conventional sia-

Table 3 Number & % of cases of sialolithiasis without associated stenosis diagnosed by US.

<table>
<thead>
<tr>
<th>Number of patients</th>
<th>Gland affected</th>
<th>Diameter of stones</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Parotid</td>
<td>Submandibular</td>
</tr>
<tr>
<td>11</td>
<td>1</td>
<td>8</td>
</tr>
<tr>
<td>%</td>
<td>9</td>
<td>72.7</td>
</tr>
</tbody>
</table>

Table 4 The cases of sialolithiasis diagnosed by MR sialogram.

<table>
<thead>
<tr>
<th>Number of patients</th>
<th>The gland affected</th>
<th>Site</th>
<th>Number of stones</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Parotid</td>
<td>Submandibular</td>
<td>Intraductal</td>
</tr>
<tr>
<td>11</td>
<td>1</td>
<td>9</td>
<td>6</td>
</tr>
<tr>
<td>%</td>
<td>9</td>
<td>81.8</td>
<td>54.5</td>
</tr>
</tbody>
</table>

Table 5 Comparative study between MR sialogram, US & Conventional sialography.

<table>
<thead>
<tr>
<th></th>
<th>Sialolithiasis</th>
<th>Stenosis</th>
<th>Combined</th>
</tr>
</thead>
<tbody>
<tr>
<td>MR sialography</td>
<td>10</td>
<td>7</td>
<td>4</td>
</tr>
<tr>
<td>US</td>
<td>9</td>
<td>4</td>
<td>4</td>
</tr>
<tr>
<td>Conventional sialography</td>
<td>9</td>
<td>9</td>
<td>3</td>
</tr>
<tr>
<td>Number of patients</td>
<td>11</td>
<td>10</td>
<td>4</td>
</tr>
</tbody>
</table>

Fig. 1 (a) Ultrasound of the left submandibular gland shows hyperechoic stone within the dilated duct. (b), (c) MR sialogram of the same case shows signal void stone within the dilated duct of the left submandibular gland (sagittal oblique view). MRI of the same case, (d) sagittal view T2 weighted image shows the dilated duct of the left submandibular gland and signal void stone in its proximal end. (e) Axial T2 weighted image shows the signal void stone; (f) Axial view shows the dilated duct.
In this case the filling of the duct with contrast during conventional sialography resulted in the displacement of anteriorly placed stones to a more posterior position. One of the eleven cases of sialolithiasis could not be diagnosed by MR sialogram as the stone was of 3 mm. diameter and was misinterpreted as short stenosis. Conventional sialography enabled a better visualization of the secondary and tertiary ducts however MR sialogram clearly demonstrated the main ducts and primary branching ducts but failed to demonstrate secondary and tertiary branches owing to limited spatial resolution as opposed to digital subtraction sialogram.

Capacciop (11) reported that US is of high accuracy in detecting stones and duct dilatation but is less accurate in the differentiation of multiple intraparenchymal duct stones from a large single stone. In this study, US is accurate in detecting the majority of cases of stones. However, in two cases, ultrasound could not detect stones that were <3 mm. in diameter as proved by MR sialogram. US could not detect stones <3 mm. as it does not produce posterior acoustic shadow, also US could not diagnose all cases of duct stenosis and the exact site of stenosis as US could only trace the ducts of straight course but not of kinked or tortuous course, also US could detect abnormality but not accurately as it could not measure the inner to inner caliber and could not detect accurately the duct lumen.

MR sialogram has been performed using modified RARE (5) fast spin-echo (6), and half-fourier acquisition single short
diagnosing sialolithiasis and ductal stenosis. However, normal stenosis but it is invasive and some ducts are difficult to cannulate.


5. Summary and conclusion

Conventional sialogram is accurate for the detection of calculi stenosis but it is invasive and some ducts are difficult to cannulate.

US is non-invasive but cannot detect the site and length of duct stenosis. MR sialography with a heavily T2-weighted sequence is highly successful in the noninvasive visualization of the ductal system of major salivary glands in cases that could not be examined by conventional sialogram. It is useful for diagnosing sialolithiasis and ductal stenosis. However, normal MR sialographic findings do not allow the exclusion of small calculi. Thus, in patients with strong clinical suspicion of calculi and normal MR sialographic findings, conventional sialography should still be performed.

References