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ORIGINAL ARTICLE

Pneumobilia at Magnetic Resonance Cholangiography: Diagnostic Pitfalls and Solutions

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ABSTRACT

Objective: *To assess the diagnostic problem created by pneumobilia at magnetic resonance cholangiography performed in the supine position, and to investigate whether performing the examination in the decubitus position obviates the problem.*

Patients and Methods: *Twelve patients with a history of recurrent pyogenic cholangitis and ultrasound diagnosis of pneumobilia were studied by means of heavily T2-weighted magnetic resonance cholangiography, with the patients lying in the supine and decubitus positions.*

Results: *With magnetic resonance cholangiography performed in the supine position, signal void foci or segments were noted in the common duct in 8 of 12 patients with pneumobilia. There were 2 mimics of ductal calculi and 6 mimics of ductal strictures. Disappearance of the signal void or shifting of the signal void to non-dependent parts of the common duct were apparent with magnetic resonance cholangiography in the decubitus position.*

Conclusion: *Pneumobilia can mimic common duct calculus or stricture at magnetic resonance cholangiography performed in the supine position. Decubitus magnetic resonance cholangiography aids in differentiating pneumobilia from these mimics.*

Key Words: *Cholangitis, Common bile duct, Magnetic resonance imaging*

INTRODUCTION

Magnetic resonance (MR) cholangiography is a well-established non-invasive imaging modality for the diagnosis of biliary tract disease. The principle is to image the fluid within the biliary system with a long T2 relaxation time. The signal intensity of the surrounding tissue with a shorter T2 is rendered low by employing a heavily T2-weighted sequence and with fat saturation prepulses. A stricture is apparent as a signal void segment in the bile duct with proximal duct dilatation. Stones are represented by intraluminal signal void foci. MR cholangiography has been shown to be accurate for diagnosing biliary tract obstruction and choledocholithiasis.[1-7] False negative diagnoses of obstruction and calculi,[5-10] and false positive diagnoses of stones due to ampullary tumour[7] have been described. It has also been suggested that blood and proteinaceous fluid that shortens the T2 relaxation time of bile would mimic stones on MR cholangiography.[11] Pneumobilia is also a recognised cause of false positive diagnosis of choledocholithiasis.[12] The diagnostic problem of pneumobilia arises from the fact that air is signal void due to scarcity of protons. Further reduction in signal may also result from the magnetic susceptibility effect.[13] The signal void segments or signal void foci created in the biliary tree by air bubbles could simulate stricture or calculi.

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This study aimed to assess the diagnostic problems that can be created by pneumobilia at MR cholangiography performed in the supine position. The use of the decubitus position as a solution to the diagnostic problem was also studied.

PATIENTS AND METHODS

Twelve patients (3 males and 9 females; mean age, 73 years [range, 62 to 85 years]) with pneumobilia at US were evaluated by MR cholangiography on the same day. These patients had a known history of recurrent pyogenic cholangitis, but no active biliary complaints at the time of follow-up US. Sonographic diagnosis of pneumobilia was made when echogenic foci were observed in the distribution of the extrahepatic or intrahepatic bile ducts.[14] Endoscopic sphincterotomy had been performed 3 to 6 months previously for 9 patients, and 1 to 3 years previously for 3 patients. No stricture was demonstrated in the common ducts of these patients at endoscopic retrograde cholangiopancreatography performed 3 to 6 months previously.

MRI was performed with a 1.5T imager (Gyroscan ACSNT, Philips Medical Systems, Best, the Netherlands) using a body coil. MR cholangiography consisted of a non-breath-hold, fat-suppressed, respiratory-triggered turbo spin-echo sequence. Fat suppression was performed using a spectrally selective inversion pulse, with autoshimming. Twenty five oblique coronal source images with a 3 mm section thickness (-0.7 mm gap) were acquired, giving a 57.5 mm coverage. The imaging parameters were: repetition time of 2,200 ms, echo time of 330 ms, 256 x 192 matrix, 37.5 cm field of view, 6 excitations (supine examination), 4 excitations (decubitus examination), and a turbo factor of 54. Superior and inferior saturation bands were prescribed above and below the region of interest.

The first MR cholangiography was performed with the patient in the supine position. The second MR cholangiography was performed immediately after repositioning the patient in the left decubitus position. After reviewing the supine and left decubitus MR cholangiography, right decubitus MR cholangiography was selectively performed if there was still uncertainty about the nature of signal void in the common duct. The nominal scan time for supine MR cholangiography was 6.3 minutes. For decubitus MR cholangiography, the time was 4.3 minutes. The source oblique coronal image data set was also processed using a standard maximum intensity projection (MIP) algorithm to create a radial display of 12 projections at 15° intervals rotating about the cephalocaudal axis. Targeted-volume reconstruction was also performed for selected patients. Both the coronal oblique source images and the MIP images were reviewed and analysed.

Signal void foci or segments in the common duct were specifically noted. Visualisation of the left intrahepatic ducts at supine MR cholangiography versus left decubitus MR cholangiography was assessed by means of a 5-point scoring system, based on the following parameters

- the length of main branches visualised
- the distinctness of ducts as assessed by calibre and continuity
- the number of branches visualised.

A score between +2 and -2 was given as follows — left decubitus MR cholangiography distinctly better (score +2), slightly better (score +1), equal (score 0), slightly worse (-1), or distinctly worse (-2) than supine MR cholangiography, on each of the above items. When the total score on all 3 items was ≥3, visualisation of the left intrahepatic ducts at decubitus MR cholangiography was considered unequivocally superior to supine MR cholangiography.

RESULTS

The distribution pattern of gas at US, and of signal void in the common duct at MR cholangiography is summarised in Table 1. For 4 patients who had small amounts of gas at US, no signal void segments or foci were seen at supine MR cholangiography. Eight patients had

Table 1. Comparison of distribution of gas at ultrasound and signal void at magnetic resonance cholangiography.

Patient	Gas distribution at ultrasound	Distribution of signal void at magnetic resonance cholangiography		
		Supine	Left decubitus	Right decubitus
1	CD L R	Nil*	Nil	Nil
2	CD L R	Proximal CD	Proximal CD	Distal CD
3	CD L R	Distal CD	Mid	Distal CD
4	CD L R	Whole CD	Nil	Not performed
5	CD L R	Mid-CD	Nil	Not performed
6	CD L R	Mid- and distal CD	Nil	Not performed
7	CD L	Nil	Nil	Not performed
8	CD L	Proximal CD	Proximal CD	Distal CD
9	CD L	Mid-CD	Mid-CD	Proximal CD
10	CD L	Distal CD	Proximal CD	Not performed
11	CD R	Nil	Nil	Not performed
12	CD R	Nil	Nil	Not performed

Abbreviations: CD = common duct; L = left hepatic duct; R = right hepatic duct.
* No signal void.

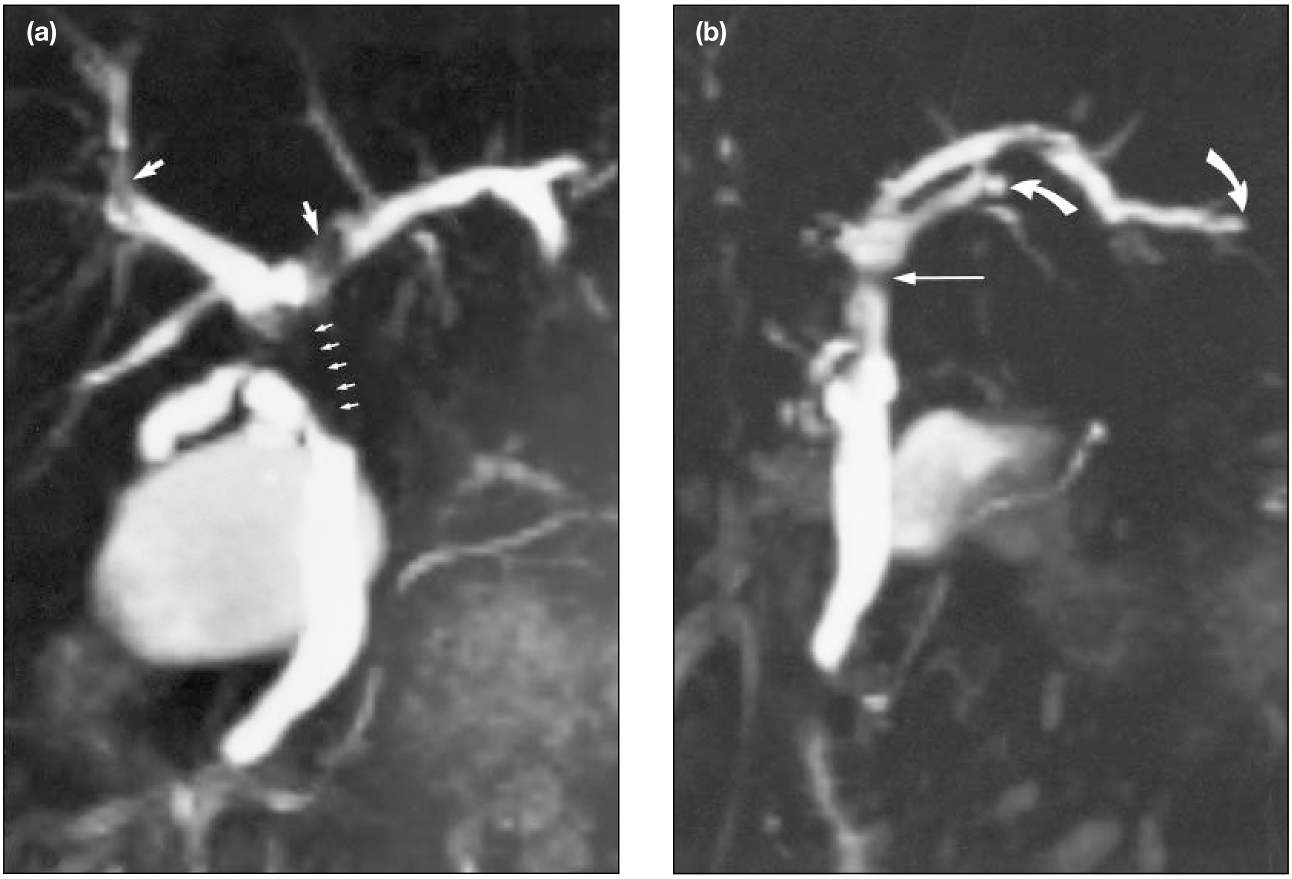

Figure 1. Maximal intensity projection of (a) supine and (b) left decubitus magnetic resonance cholangiography of a 62-year-old woman. (a) Signal void segment mimicking stricture is apparent in the common hepatic duct (small arrows). The distal common duct is dilated, fluid-filled, and clearly visualised. Signal void foci due to gas are also evident in the right and left hepatic ducts (large arrows); (b) the signal void segment is now fluid-filled and signal-rich, with a much smaller signal void focus remaining (straight arrow). Signal void focus in the left hepatic duct is no longer seen. Abrupt intrahepatic duct termination is also shown (curved arrows).

signal void segments or foci in different portions of the common duct at MR cholangiography. There were 6 mimics of stricture (Figures 1 and 2) and 2 mimics of stones (Figure 3). No roundish air bubble-like signal void focus was found in the common duct. For 4 patients with proximal or mid-common duct signal void segments, the distal portions could be seen as fluid-filled dilated ducts (Figure 1).

At left decubitus MR cholangiography, changes in the location or configuration of the signal void in the common duct were noted in 8 patients. In 3 patients, signal void was no longer seen in the common duct (Figure 3), excluding stricture or stone. For 1 patient, the signal void segment shifted to a different part of the common duct (Figure 2), with exclusion of stricture and small ductal calculi.

In the remaining 4 patients, a signal void portion was still noted in the common duct at left decubitus MR cholangiography, although for 2, the signal void was much smaller (Figure 1), and for 1, there was change in location of the signal void. Additional right decubitus MR cholangiography was employed for these 4 patients, which confirmed the inconstant and gaseous nature of the signal void by detecting its shift away from the dependent position on the decubitus MR cholangiogram.

For 9 of the 10 patients with gas in the left ducts at US, the left ducts were unequivocally better visualised (Figures 3) with left decubitus MR cholangiography than with supine MR cholangiography (mean total improvement score 4.6 [range, 3 to 6]). In no patient was left intrahepatic duct visualisation worse with left decubitus MR cholangiography than with supine MR cholangiography with respect to length, distinctness, or number of left ductal branches visualised. In 6 patients, abrupt tapering of left intrahepatic ducts could be shown because visualisation of more peripheral left ductal branches was achieved with left decubitus MR cholangiography (Figure 1).

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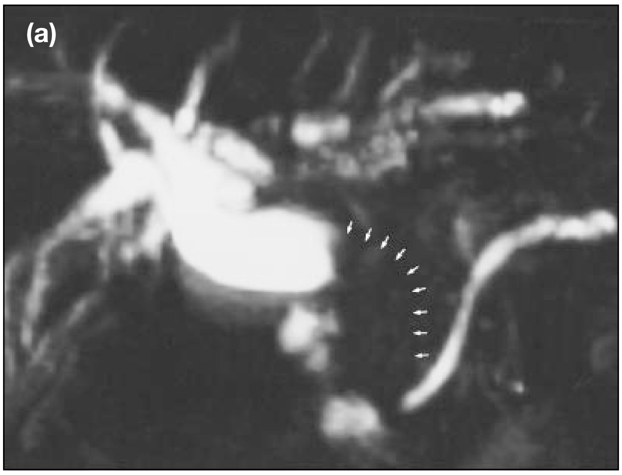

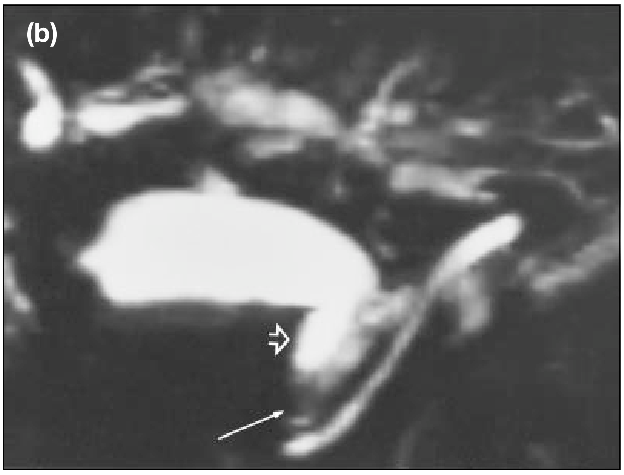

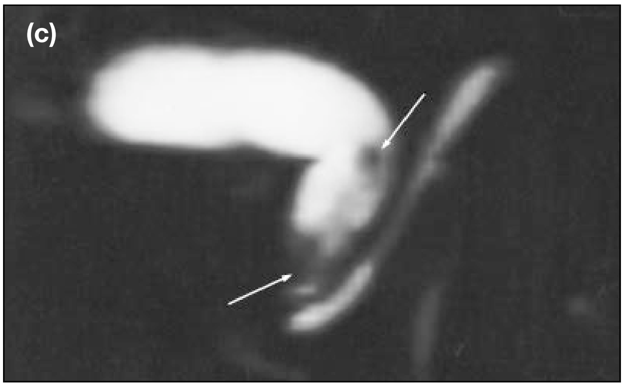

Figure 2. Maximal intensity projection of (a) supine, (b) left decubitus, and (c) targeted-volume reconstruction of left decubitus magnetic resonance cholangiography of a 73-year-old man. (a) A long segment of the distal common duct is not visualised. The expected course of the distal common duct is indicated by arrows; (b) the distal portion of the common duct is now fluid-filled and well delineated (short arrow), with small intraluminal signal void foci (long arrow) consistent with stones; (c) signal void foci representing calculi are more clearly demonstrated (long arrows).

DISCUSSION

The most common cause of pneumobilia is communication between the bile duct and the gastrointestinal tract. Gas in the bile duct is most often seen in post-operative patients, especially after sphincterotomy and choledochoenterostomy.[15,16] Pneumobilia may also be seen in patients without previous surgery as in incompetent sphincter of Oddi, erosion of a gallstone into the bile duct, peptic ulcer erosion into the common bile duct, choledochoduodenal fistula, and emphysematous cholecystitis.[15-18]

In Asia, recurrent pyogenic cholangitis is a recognised cause of biliary complaints.[13-22] Pneumobilia has been reported in 52% of patients with recurrent pyogenic cholangitis.[22] Therefore, differentiation of pneumobilia from biliary pathology at MR cholangiography is of particular importance in this region.

Pneumobilia, as shown at US in these patients, frequently demonstrates a classical distribution pattern, with gas in the common, left, and right ducts.[16] The left duct was frequently gas-filled, a finding attributable to the non-dependent anterior position of the left duct with the patient supine. The presence of a large amount of gas within the biliary system, resulting in a more peripheral distribution, may also be a contributory factor.[14]

Pneumobilia did not noticeably affect the supine MR cholangiography image for every patient. One-third of these patients with sonographic pneumobilia in the common duct had no abnormal signal void in the common duct at supine MR cholangiography in the presence of demonstrable dilated intra- and extra-hepatic biliary tree. In this aspect, MR cholangiography is better than US, in which the dilated status of biliary tree often could not be assessed objectively due to the obscuring effect of gas,[14] and we postulate that, in these patients, it may be due firstly to the small amount of gas present, and secondly to the mobility of gas bubbles within the duration of the MR acquisition. In the supine position, if only a small number of gas bubbles are present, they are likely to collect on the anterior non-dependent portion of a dilated duct.

On coronal sectioning of the common duct, the fluid-filled dependent part of the duct will appear to be normal. Mobility of gas bubbles in the common bile duct is a well-observed phenomenon.[18] Such mobility during MR

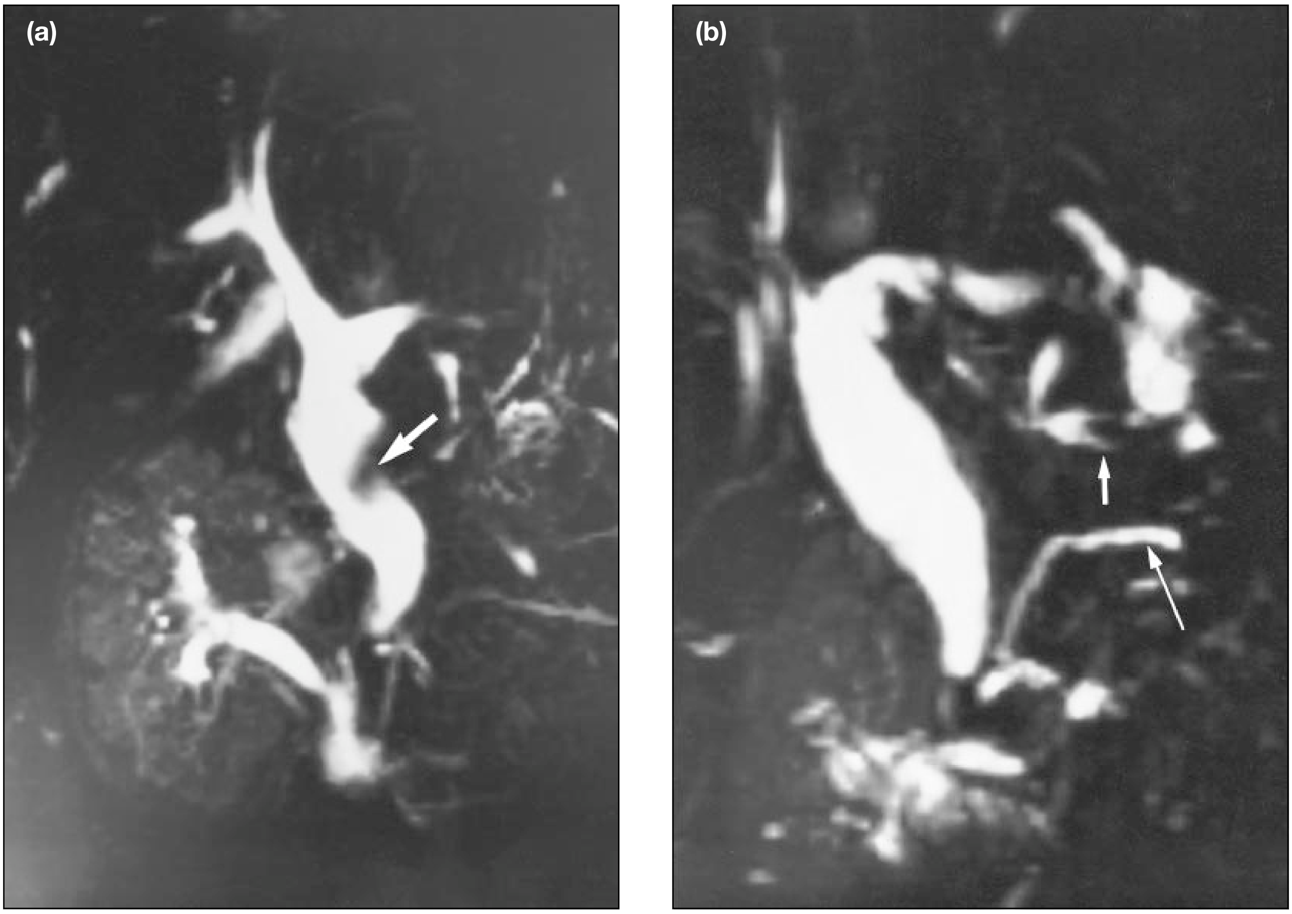

Figure 3. Maximal intensity projection of (a) supine and (b) left decubitus magnetic resonance cholangiography of a 78-year-old woman. (a) A discrete single signal void focus (arrow) is seen in the lumen of the mid-common duct. This is suggestive of calculus or mass; (b) signal void focus is no longer seen. The left intrahepatic ducts are better delineated. Abrupt tapering of the peripheral portion of the left intrahepatic ducts with an arrowhead configuration is also well demonstrated (short arrow). The pancreatic duct is also better delineated (long arrow).

acquisition could result in temporal averaging of signal loss, rendering their effect undetectable. It is probably through the same mechanism of temporal averaging that gas in the left intra-hepatic duct results in less distinct visualisation of ductal branches, rather than discrete air bubble-like signal void focus.

When a larger amount of gas is present, both the dependent and non-dependent portions of the common duct would be occupied by air most of the time and the temporal averaging effect would be lost. This would result in a distinct signal void segment or focus in the common duct on MR cholangiography. This occurred in two-thirds of these patients with common duct gas at US, mimicking stones in 2 patients and stricture in 6 patients at supine MR cholangiography. It has been suggested that at MR cholangiography, the portion of common duct distal to the stricture is frequently not visualised.[2] However, the converse is not true, as it has also been shown that bile duct distal to a stricture is fluid-opacified and visualised at MR cholangiography in up to 30% of patients.[3] In the present series of patients with signal void segments in the proximal or mid-common duct at MR cholangiography, the fluid-filled distal parts were indeed visualised. The degree of proximal dilatation at MR cholangiography is also not reliable for the exclusion of stricture, as the proximal ducts may not be markedly dilated during the early stage of obstruction. By simple change of posture during imaging, decubitus MR cholangiography is able to detect the absence of stricture by the replacement of air with bile caused by a gravitational effect at the part of the common duct involved. Addition of left decubitus MR cholangiography frequently clarifies the absence of stricture, but additional right decubitus MR cholangiography may also be required. Differentiation from stones may also be achieved with left decubitus MR cholangiography in which the signal void is no longer seen in the common duct or in the more dependent part of the left duct.

Gas in the biliary tree may mask the portion of bile in which disease is present. Stones may be obscured, and more peripheral ductal branches may not be visualised. Adequate visualisation of the left duct is important in this region because the left duct is more often affected in patients with a history of recurrent pyogenic cholangitis.[19, 20] Additional left decubitus MR cholangiography provided a more complete delineation of the more peripheral ductal branches due to shifting of fluid into the dependent side, with displacement of the gas to the non-dependent side.

CONCLUSION

Pneumobilia at supine MR cholangiography may result in signal voids mimicking a stone or stricture in the common duct. It is also associated with under-delineation of more peripheral ductal branches. Additional decubitus MR cholangiography appears a useful technique to avoid a false diagnosis of stricture or stone. It also provides better delineation of peripheral ductal branches on the dependent side. Routine additional decubitus MR cholangiography is not to be advocated, as this will lead to lengthening of the MRI examination, but it is recommended when a diagnostic problem arises such as pneumobilia or suspected pneumobilia.

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