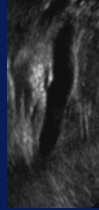


The Extrahepatic Bile Duct

Mindy M. Horrow, MD, FACR

Director of Body Imaging
Albert Einstein Medical Center
Associate Professor of Radiology
Thomas Jefferson University School of Medicine



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Questions

- Does the extrahepatic bile duct dilate with advancing age?
- Does the extrahepatic bile duct dilate after cholecystectomy?
- Is there more to sonography of the bile duct than size alone?

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Age and the Size of the Extrahepatic Bile Duct

- 1983 (Kaude): 350 patients: small, gradual increase in duct size
 - 2.8 mm mean size at 20 years
 - 4.1 mm \geq 71 years
 - 35% cohort < 30 years, 5% > 71 years
- 1984 (Wu): 256 patients:
 - Ages 10 – 70 years
 - Duct varied from 1 – 10 mm, age dependent

Inclusion of pediatric patients forces regression analysis to show effect of age.

Kaude, Eur J Radiol, 1983;3:115-117
Wu, et al. J Clin Ultrasound 1984;12:473-478

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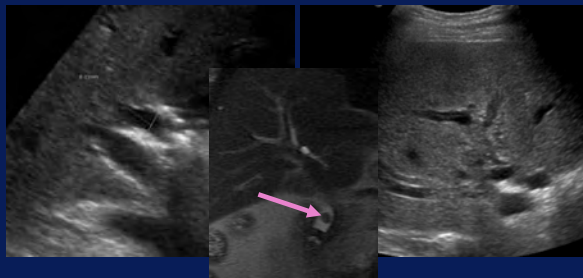
Age and the Size of the Extrahepatic Bile Duct

- “A simple rule of thumb is to consider as normal a 4 mm mean duct diameter at age 40, a 5 mm mean duct diameter at age 50, a 6 mm mean duct diameter at age 60, and so on.”

Laing in Rumack, et al. Diagnostic Ultrasound, 1998: 207

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Patient #1: 83 year old woman with 8.1 mm duct, without cause on sonography



Choledocholithiasis on MRCP

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Re-Evaluation of Duct Size and Age

- 2000: 1018 patients > 60 years.
 - Mean CBD in 60s (3.6 – 3.7 mm) and above 85 years (85-96) mean CBD 3.6 – 4.3 mm.
 - Although duct did increase mildly with age, 98% of all ducts were < 7mm.

Perret, et al. JUM. 2000;19:727-730

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Re-Evaluation of Duct Size and Age

- 2001: 258 asymptomatic patients. Linear regression of average of 3 extrahepatic duct measurements against age tested hypothesis of a slope of 1.0 mm per decade.
 - Age range 20 – 92 years with 1/10 < 35 and 1/10 > 77.
 - Mean proximal, mid, distal AP measurements: 2.9, 3.5, 3.5 mm
- No association found with age.



Horrow et al. Radiology 2001;221:411-414

Re-Evaluation of Duct Size and Age

- 2003: 251 asymptomatic patients.
 - Mean CBD < 50 years $3.1 \pm .82$ and mean CBD > 50 years 4.2 ± 1.15 mm.
 - Duct gradually dilates 0.4 mm/decade.
 - Recommend 8.5 mm as upper limit of normal in elderly patients.



Bachar. JUM 2003;22:879-882

Conclusion

- “ The normal caliber of the common hepatic/bile duct in patients without history of biliary disease has been quoted as up to 6 mm by most studies. There is controversy about whether there is a normal widening of the duct with increasing age. Similarly, the literature is inconclusive with regard to an association between cholecystectomy and a large caliber common bile duct. Although diameters of up to 10 mm have been recorded in an asymptomatic normal population, the great majority of the diameters lie under 7mm. Therefore, a ductal diameter of 7 mm or greater should prompt further investigations, such as correlation with serum levels of cholestatic liver parameters.”



Khallil and Wilson in Rumaek, et al. Diagnostic Ultrasound. 2005; 172

Questions

- Does the extrahepatic bile duct dilate after cholecystectomy?



Post Cholecystectomy Bile Duct

- **Cadavers**
 - Measured midway between cystic duct insertion and ampulla of Vater
 - 527 normal and 128 pathologic cases
 - 9 cases with cholecystectomy had average duct diameter of 20.9mm



Puestow et al. Annals of Surgery 1935;101: 599

Post Cholecystectomy Bile Duct

- 67 patients: pre and post cholecystectomy sonograms
- 84% (56) had post-op CHD < 4mm
- 3 had post-op CHD of 5mm
- 7 had post-op CHD ranging between 6 and 10mm
 - 3 with patulous ducts on intra-operative cholangiogram
 - 2 with normal operative cholangiogram
 - 1 no operative cholangiogram
 - 1 with history of spontaneous passage of retained stone prior to repeat US

Dilated pre-operative duct may return to normal
No association between CBD exploration and postoperative dilatation



Graham, Cooperberg et al. Radiology 1980;135:137-139

Post Cholecystectomy Bile Duct

- 1981: Prospective study of 40 asymptomatic patients with pre-operative biliary sonography and 6 month follow up. 38/40 showed no dilatation (3-5 mm), one duct ↑ slightly and one duct ↓ slightly.
- 1989: Prospective study of 24 patients with elective cholecystectomy with pre-operative measurements and then a 1 mos., 12 mos. and 5 years.
 - Mean CHD increased from 3.95 mm before surgery to 4.48mm at 5 years.
 - Significant dilatation only in 2/21.

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Mueller et al. AJR 1981;136:355-358
Hunt et al. Gastroenterology 1989;97:1485-1488

Post Cholecystectomy Bile Duct

- 1995: Prospective study of 234 patients with pre-operative biliary sonography and re-imaging after surgery between 1 week and 6 years later, mean 393 days.
 - Mean diameter pre: 5.4 ± 0.7 , post: 6.0 ± 1.4 . $p < .001$
 - 84% were normal pre operative and 71% were normal post operative.
 - Most patients DID NOT have “significant compensatory dilatation of the duct after cholecystectomy”.

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Feng et al. AJR 1995;165:859-861

Post Cholecystectomy Bile Duct

- 1999: Prospective study of 59 patients with CHD measured prior to surgery and then at 3 mos., 6 mos., 1 yr., 5 yrs. Measurement of error ± 1 mm.
 - Mean CHD pre surgery 3.43 ± 0.82 mm. At 3 mos. 3.78 (0.87), 6 mos. 3.76 (1.16), 1 yr. 3.95 (1.06), 5 yr. 3.96 (1.11).
 - “The difference between preoperative duct diameter and diameter at six months, one year and five years was statistically significant using a paired t test, although this difference disappeared when the margin of error of 1 mm was considered. The clinical relevance of such a minor increase is also dubious.”
 - Recommendation: Increases greater than 6mm with normal pre-op duct should justify further evaluation.

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Majeed et al. Gut 1999;45:741-743

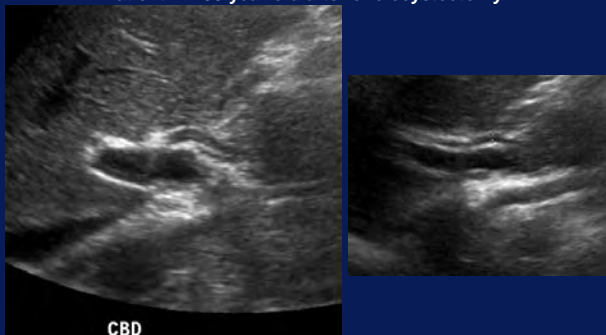
Post Cholecystectomy Bile Duct

- 2002: EUS study of size of papilla of Vater and periampullary pancreatic part of CBD. Both measurements increased immediately after surgery, normalizing at 6 months.

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Skalicky et al. Eur J Gastroent 2002;14:399-404

Patient #2: 33 year old after cholecystectomy



Normal sized duct, low cystic duct insertion

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Conclusion

- Minor duct dilatation may occur after cholecystectomy. More significant dilatation, if seen, occurs in older patients. Thus, one cannot assume that a dilated duct in a cholecystectomy patient is the result of surgery.
- Symptomatic patients, regardless of duct size, deserve some type of cholangiography (CT, MR, EUS).

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Wilkinson. Gut. 1999;45:637-638

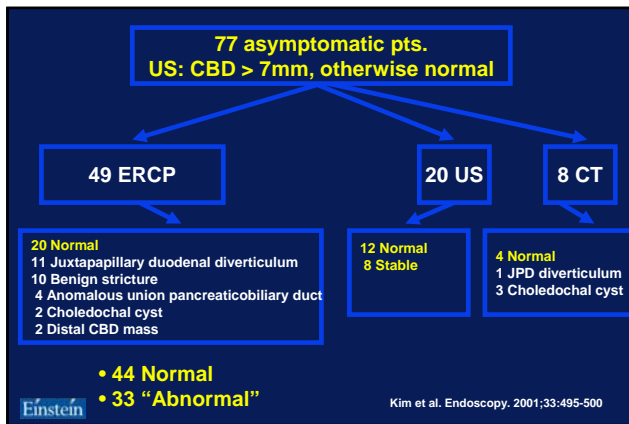
Questions

- Is there more to sonography of the bile duct than size alone?

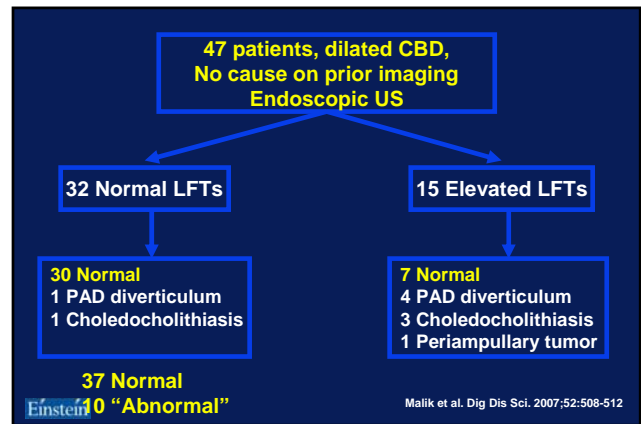
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What is the significance of common duct dilatation in asymptomatic patients?

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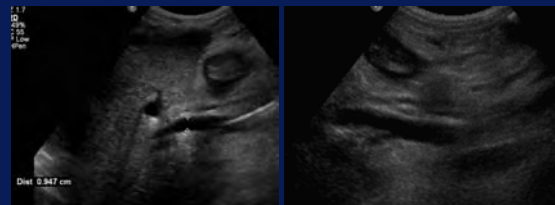
Other Size Related Issues

- Extra hepatic bile duct can change size rapidly within hours and days because of elastic recoil
- Chronically obstructing lesions may effect elastic tone, resulting in a "floppy" duct which is prone to easy distensibility
- Transverse measurements slightly larger than AP
- Opium addiction causes dilatation of the CBD, increasing with length of the addiction

Mueller, et al. AJR. 1982;142:467-472
Wachsberg, et al. AJR. 1998;170:669-674
Farahmand, et al. Korean J Radiol. 2007;8:212-215

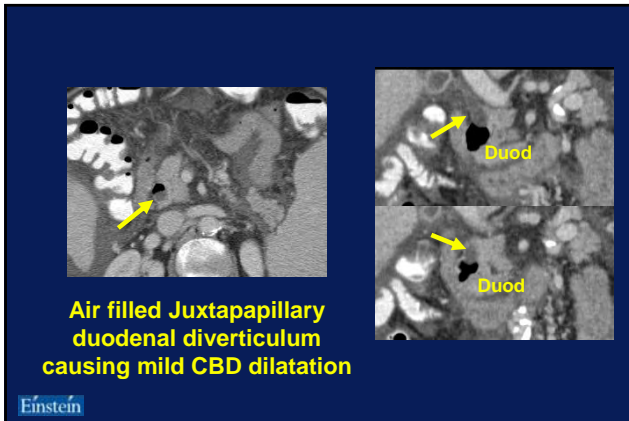
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Patient #3: 42 year old male with cirrhosis



Mildly dilated extrahepatic bile duct
without identifiable cause on ultrasound

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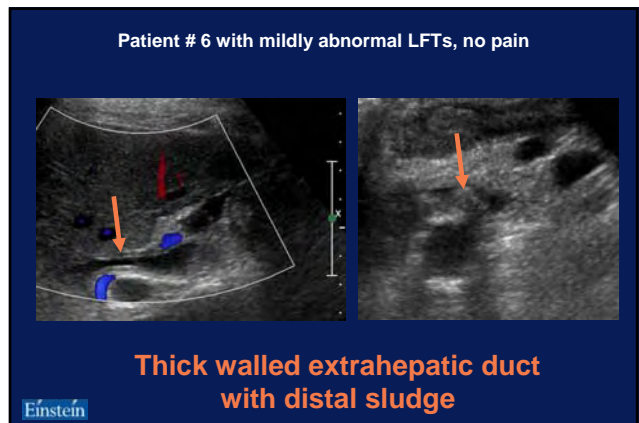
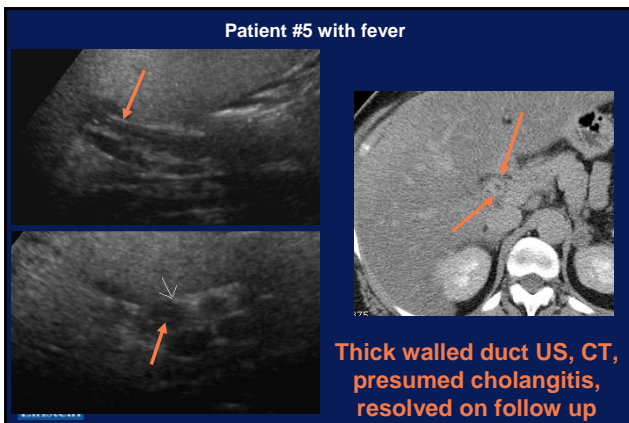
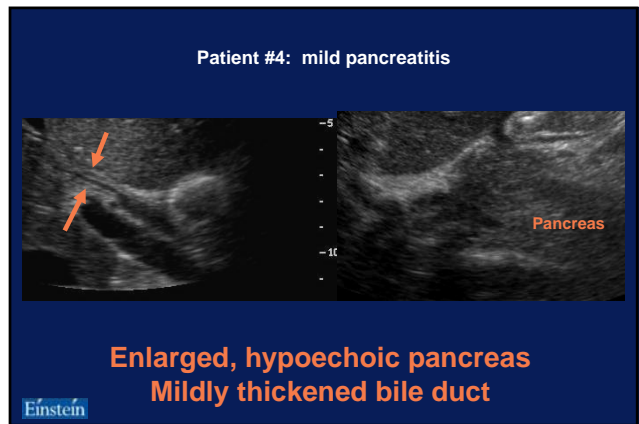
Conclusion

- Asymptomatic patients (clinically and by laboratory values) with incidental bile duct dilatation rarely have a significant underlying abnormality and are unlikely to require further evaluation.

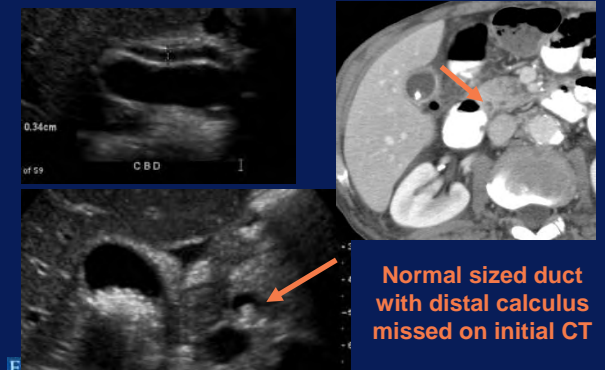
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When is there a biliary abnormality without dilatation?

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Patient #7 with pain



0.34cm
of 59
C B D

Normal sized duct with distal calculus missed on initial CT

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When is there a biliary abnormality without dilatation?

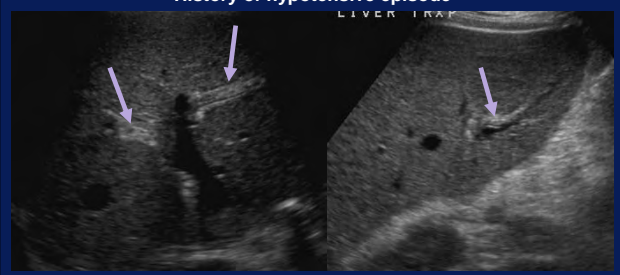
1. Wall thickening: bacterial cholangitis, AIDS cholangitis, pancreatitis
2. Choledocholithiasis and/or sludge

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When is it difficult to diagnose biliary dilatation on ultrasound?

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**Patient #8 with liver transplant and fever
History of hypotensive episode**

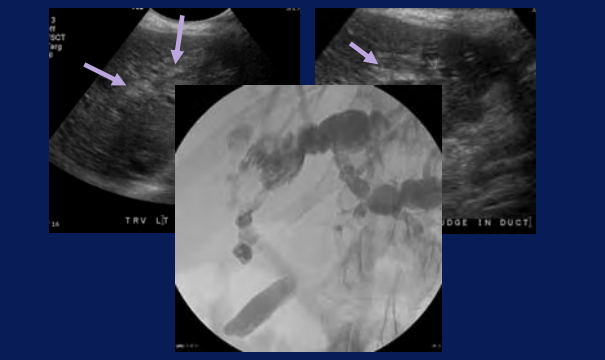


LIVER TRANSPLANT

Slightly dilated ducts filled with sludge. Ischemia affects bile ducts which receive blood supply from hepatic artery.

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Patient #9 with liver transplant, fever and abnormal LFTs



Moderately dilated, sludge filled ducts

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Hepatic Artery Thrombosis with collaterals




9% Map 5
1200 Hz
Cyc. Med V
-85.5cm/s
-20.0km/h
0.54
INTRA HEP
Low RI, slightly delayed upstroke

Hepatic Artery Thrombosis with collaterals

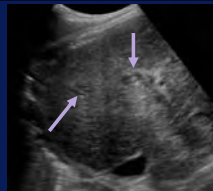
Horrow et al. AJR 2007;189:346-351
Dydynski et al. AJR 2008;191:546-549

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Patient #10: with jaundice



1.3 cm CHD with sludge



Sludge in right duct, isolated dilated ducts





Poor filling, beaded appearance

Primary Sclerosing Cholangitis

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Patient # 11, pancreatic carcinoma with biliary stent

Pneumobilia makes assessment of duct dilatation difficult

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When is it difficult to diagnose biliary dilatation on ultrasound?

When the dilated ducts are not filled with simple bile:

1. Pneumobilia: biliary enteric fistula, cholangitis
2. Sludge: ischemia of biliary tree, PSC, cholangitis, cystic fibrosis
3. Hemobilia: trauma, iatrogenic manipulation of biliary tree
4. Tumor: cholangiocarcinoma, metastases

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Bibliography

- Bachar GN et al. Effect of aging on the adult extrahepatic bile duct. *J Ultrasound Med* 2003; 22: 879-882
- Dydynski PB et al. Collateral transformation of the hepatic artery after liver transplantation. *AJR* 2008; 191:546-549
- Farahmand H, et al. Chronic extrahepatic bile duct dilatation: sonographic screening in the patients with opioid addiction. *Korean J Radiol.* 2007; 8: 212-215
- Feng B, Song Q. Does the common bile duct dilate after cholecystectomy? Sonographic evaluation in 234 patients. *AJR* 1995;165:859-861

Einstein

Bibliography

- Graham MF, et al. The size of the normal common hepatic duct following cholecystectomy: An ultrasonographic study. *Radiology* 1980; 135: 137-139
- Horrow MM, et al. Is age associated with size of adult extrahepatic bile duct: Sonographic study. *Radiology* 2001;221-411-414
- Horrow MM, et al. Sonographic diagnosis and outcome of hepatic artery thrombosis after orthotopic liver transplantation in adults. *AJR* 2007;189:346-351
- Hunt DR, Scott AJ. Changes in bile duct diameter after cholecystectomy: a 5-year prospective study. *Gastroenterology* 1989;97:1485-1488

Einstein

Bibliography

- Kaude JV. The width of the common bile duct in relation to age and stone disease: an ultrasonographic study. *Eur J Radiol* 1983;3: 115-117
- Khalili K, Wilson SR. The biliary tree and gallbladder. In: Rumack C, Wilson S, Charboneau JW, eds. *Diagnostic Ultrasound 3rd Edition*. St Louis, Mo: Elsevier Mosby, 2005; 173
- Kim JE, et al. The clinical significance of common bile-duct dilatation in patients without biliary symptoms or causative lesions on ultrasonography. *Endoscopy* 2001; 33: 495-500

Einstein

Bibliography

- Laing FC. The gallbladder and bile ducts. In: Rumack C, Wilson S, Carboneau JW, eds. Diagnostic ultrasound 2nd edition. St Louis, MO: Mosby, 1998; 207
- Majeed AW, et al. The preoperatively normal bile duct does not dilate after cholecystectomy: results of a five year study. Gut 1999;45:741-743
- Malik S, et al. EUS yield in evaluating biliary dilatation in patients with normal serum liver enzymes. Dig Dis Sci. 2007;52:508-512
- Mueller PR, et al. Postcholecystectomy bile duct dilatation: Myth or reality? AJR 1981;136:355-358

Einstein

Bibliography

- Mueller PR, et al. Observations on the distensibility of the common bile duct. Radiology 1982;142:467-472
- Perret RS, et al. Common bile duct measurements in an elderly population. J Ultrasound Med 2000;19:727-730
- Puestow CB, Morrison RB. The relationship of cholecystitis and cholecystectomy to dilatation of the choledochus. Annals of Surgery 1935;101:599-602
- Skalicky M, et al. Effect of cholecystectomy for gallstones on the surface of the papilla of Vater and the diameter of the common bile duct. Eur J Gastroenterol Hepatol 2002;14:399-404

Einstein

Bibliography

- Wachsberg RH, et al. Sonographic versus endoscopic retrograde cholangiographic measurements of the bile duct revisited: Importance of the transverse diameter. AJR 1998;170:669-674
- Wilkinson ML. Are dilating bile ducts a cause for concern? Gut 1999;45:637-638
- Wu CC, et al. Effect of aging on common bile duct diameter: a real-time ultrasonographic study. J Clin Ultrasound 1984;12:473-478

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