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实时三维超声造影对输卵管伞端通畅性及功能的评价效果*

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摘要 目的:探讨实时三维超声造影对输卵管伞端通畅性及功能的评价效果。**方法:**选取我院 2019 年 6 月到 2021 年 6 月收治的 120 例因不孕症自愿接受 RT 3D-HyCoSy 检查的患者作为研究对象,对所有患者分别应用静态三维与实时三维超声造影,并以腹腔镜下美兰通染液检查作为金标准,记录与分析相关指标。**结果:**120 例患者共 240 条输卵管,美兰通染液检查诊断发现输卵管通畅 58 条,阻塞/粘连 182 条,实时三维超声造影检查发现通畅 51 条,阻塞/粘连 189 条,静态三维通畅 44 条,阻塞/粘连 196 条,实时三维超声造影与静态三维联合通畅 56 条,阻塞/粘连 184 条。实时三维超声造影与静态三维联合诊断组、实时三维超声造影组这两组的准确度、特异度、灵敏度、阳性预测值、阴性预测值均高于静态三维组($P<0.001$);120 名患者通过临床综合诊断发现,35 例一侧输卵管阻塞患者,64 例双侧输卵管阻塞患者,21 例双侧输卵管通畅患者,不同输卵管通畅性三组患者推注压力、VAS 评分、造影剂注入量、造影剂反流量对比差异显著($P<0.05$)、通畅与阻塞患者造影剂通过输卵管间质部时间及造影剂通过输卵管伞端时间对比差异显著($P<0.05$)。**结论:**对于不孕症患者应用 RT 3D-HyCoSy,经检查输卵管伞端粘连和通畅性,进而诊断输卵管通畅性,为不孕症的诊断与治疗提供一定的参考意见。此外,应用实时三维超声造影与静态三维超声能提升输卵管伞端通畅性诊断率,值得临床应用推广。

关键词:三维超声造影;输卵管伞端通畅性;输卵管阻塞;实时三维超声造影;静态三维

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Evaluation of the Patency and Function of Fimbria end of Fallopian Tube by Three-dimensional Contrast-enhanced Ultrasound*

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ABSTRACT Objective: To evaluate the patency and function of the fimbria end of fallopian tube by three-dimensional contrast-enhanced ultrasound. **Methods:** A total of 120 patients admitted to our hospital from June 2019 to June 2021 who voluntarily underwent RT 3D-hycosy examination due to infertility were selected as the research objects. All patients were respectively applied static three-dimensional and real-time three-dimensional contrast-enhanced ultrasound, and the examination of Meilantone solution under laparoscopy was taken as the gold standard to record and analyze the relevant indicators. **Results:** There were 240 fallopian tubes in 120 patients, 58 tubes were unobstructed, 182 tubes were obstructed / adhered, and 63 tubes were unobstructed, 177 tubes were obstructed / adhered by real-time three-dimensional contrast-enhanced ultrasound, Static 3D patency 44, obstruction/adhesion 196, real-time 3D ceUS and static 3D combined patency 66, obstruction/adhesion 184; The accuracy, specificity and positive predictive value of the combined diagnosis of real-time 3D ceUS and static 3D were significantly higher than those of real-time 3D ceUS and static 3D, while the sensitivity and positive predictive value were lower than those of real-time 3D ceUS and static 3D. There were 35 cases of unilateral fallopian tube obstruction, 64 cases of bilateral fallopian tube obstruction and 21 cases of bilateral fallopian tube patency. There were significant differences in injection pressure, VAS score, contrast agent injection volume, time of contrast agent passing through the interstitium of the fallopian tube and time of contrast agent passing through the umbrella end of the fallopian tube contrast agent reflux among the three groups with different fallopian tube patency ($P<0.05$). **Conclusion:** The RT-3D-HYCOSY was applied to infertility

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patients. By examining the adhesion and patency of the tubal umbrella, the patency of the fallopian tube was diagnosed, so as to provide reference for the diagnosis and treatment of infertility. In addition, the application of real-time three-dimensional contrast-enhanced ultrasound and static three-dimensional ultrasound can improve the diagnostic rate of tubal parasol patency, which can be clinical application and promotion.

Key words: Three dimensional contrast-enhanced ultrasound; The fimbria end of fallopian tube was unobstructed; Tubal obstruction; Real time three-dimensional contrast-enhanced ultrasound; Static 3D

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前言

输卵管阻塞是导致女性不孕的因素之一,将导致30~50%的女性不孕^[1,2],不孕症与盆腔炎发作次数相关,一次是12%,两次是23%,三次增加至54%^[3,4]。在中国,由于计划生育的实施,造成人流等宫腔手术的增多,导致盆腔炎引起的不孕症比例大幅度增加^[5]。盆腔炎会损伤输卵管上皮细胞,引起输卵管伞端粘连、阻塞或积水,破坏输卵管伞端的拾卵功能,造成不孕。由此可见,输卵管伞端阻塞或粘连与不孕症关系密切,诊断不孕症的重要步骤包括对于输卵管伞端通畅性的准确评价。输卵管阻塞包括近段与远段阻塞,阻塞部位不同,治疗方式也不同^[6]。近段阻塞治疗方法可在门诊进行X线下介入疏通术等进行治疗^[7]。而输卵管远段阻塞需住院通过腹腔镜行输卵管伞端造口术等进行治疗,费用极为昂贵^[8]。经阴道实时三维子宫输卵管超声造影(Transvaginal real time three-dimensional hysterosalpingo-contrast sonography, TVS RT 3D-HyCoSy)技术,具有无创、安全快捷、费用低廉、定位准确等优点。因此,本研究选取120例因不孕症自愿接受RT 3D-HyCoSy检查的患者作为研究对象,探讨三维超声造影评价输卵管伞端通畅性及功能的效果,具体报告如下。

1 资料与方法

1.1 一般资料

选取我院2019年6月到2021年6月收治的120例因不孕症自愿接受RT 3D-HyCoSy检查的患者作为研究对象。所有患者年龄为18-35岁,平均 (22.43 ± 2.63) 岁;不孕年限1-8年,平均 (3.53 ± 1.25) 年;其中84例继发性不孕患者,36例原发性不孕患者。

纳入标准:原发性及继发性不孕患者;处于月经干净后3-7d;检查前7d无同房;受检者均被告知实施三维子宫输卵管超声造影检查程序、可能的不良反应及注意事项等;签署造影知情同意书。

排除标准:排除阴道流血;急性生殖系统炎症或慢性生殖系统炎症进行发作患者;急性性传播疾病。

1.2 方法

1.2.1 仪器 采用具有编码造影成像CCI技术的彩色超声诊断仪(GE公司, Voluson E8 EXPERT),配有宽频带腔内微凸三维容积探头,频率5.0-9.0MHz。

1.2.2 试剂 使用湖南康润药业有限公司雪瑞欣(全氟丙烷人血白蛋白注射液)造影剂,在1支雪瑞欣瓶中加入3mL NaCl溶液,振摇瓶身形成混悬液,检查前抽取3.0mL混悬液+17mL

NaCl溶液,配制成20mL造影液。

1.2.3 检查方法 患者于腹腔镜术前1-3d进行RT 3D-HyCoSy检查。术前30min予阿托品0.5mg肌内注射。嘱患者排空膀胱,取截石位,消毒铺巾,暴露并固定子宫颈,插入12号双腔导管,根据宫颈的松弛程度于外腔内注入NaCl溶液1.5~2.0mL。常规经阴道二维超声检查子宫、卵巢大小及与子宫的活动度、双侧附件区情况,然后将阴道探头置于子宫横切面的水平,上下调整探头位置,选取合适的三维成像初始平面,显示双侧宫角及宫旁组织,保持探头不动,启动三维预扫描模式,尽可能将双侧宫角及卵巢包括在扫描图像中。接着切换到3D造影模式,三维容积扫描角度为179°,将图像质量等级调整为Mid 2,并切换到RT 3D-Contrast模式,尽可能加宽感兴趣区域,启动造影模式,嘱助手经导管匀速推注造影液。当造影液在子宫角显影时,即刻启动四维容积动态采集并观察造影剂的流动,显示屏右下角显示存储图像约48秒时,按P2动态存储键。最后切换到3D造影模式,采集静态存储信息并按P1键,接着立即在CCI模式下观察卵巢周边造影剂溢出及盆腔分布情况并存图。继续在二维超声引导下经导管推注15-40mL生理盐水,观察液体在双侧宫角流动方向、输卵管伞端溢出性及盆腔粘连带的分布,结合3D、4D及CCI模式评估输卵管伞端通畅性及盆腔粘连情况。

1.3 诊断标准

1.3.1 RT 3D-HyCoSy 诊断标准 (1)输卵管伞端通畅:输卵管全程显影自然,伞段可见造影剂呈片状或喷射状溢出,卵巢周边见造影剂环状包绕,盆腔造影剂弥散均匀(图1-A)。(2)输卵管伞端阻塞:推注造影剂时阻力大,输卵管远段显影明显增粗、扭曲,伞端未见造影剂溢出,卵巢周边未见或见少许造影剂,同侧盆腔未见造影剂弥散(图1-B)^[9,10]。

1.3.2 腹腔镜检查诊断标准 患者进行全麻,行腹腔镜下输卵管通染液检查,置镜后全面探查盆腔情况,观察盆腔有无粘连,再经双腔子宫输卵管造影导管注入5mL美兰液,依据推注压力大小及美兰是否从伞端溢出,检查结果分为:①输卵管伞端通畅:推注无阻力,注入美兰液可见从伞端溢出^[11];②输卵管伞端阻塞:推注美兰时阻力大,美兰返流明显,伞端无美兰溢出(图2)。

1.4 观察指标

1.4.1 输卵管伞端阻塞诊断率比较 观察并记录美兰通染液检查和实时三维超声造影输卵管伞端阻塞诊断率情况。

1.4.2 不同输卵管通畅性患者相关指标 观察并记录双侧输卵管通畅、一侧输卵管阻塞、双侧输卵管阻塞患者三维输卵管造影诊断中推注VAS评分、造影剂注入量以及造影剂返流量

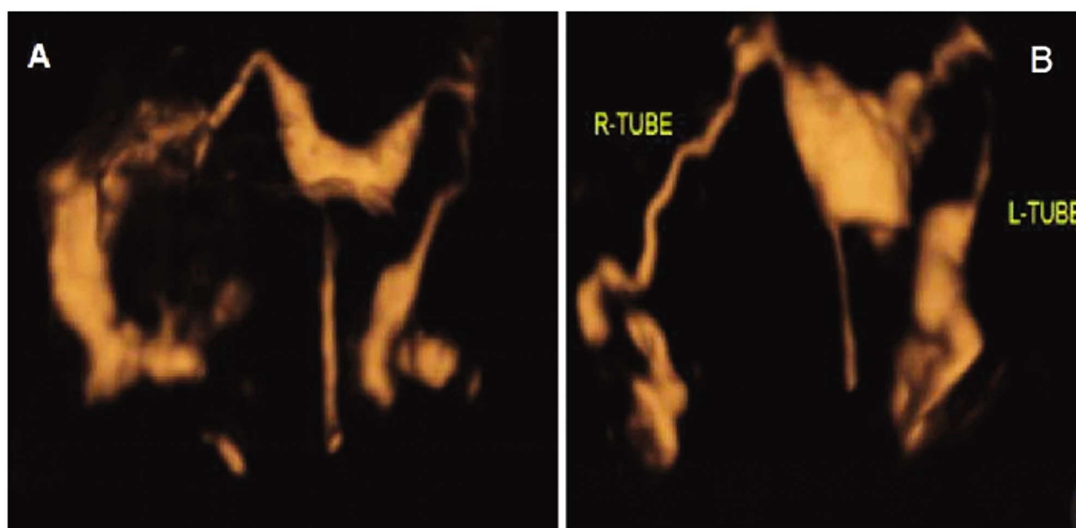


图1 RT 3D-HyCoSy 显示输卵管伞端通畅性

Fig. 1 RT 3D-HyCoSy showing tubal umbrella end patency

A: 双侧输卵管伞端通畅; B: 右侧输卵管伞端造影剂溢出, 左侧伞端阻塞。

A: Bilateral tubal umbrella ends are unobstructed; B: The contrast agent spilled from the right umbrella end of the fallopian tube, and the left umbrella en.

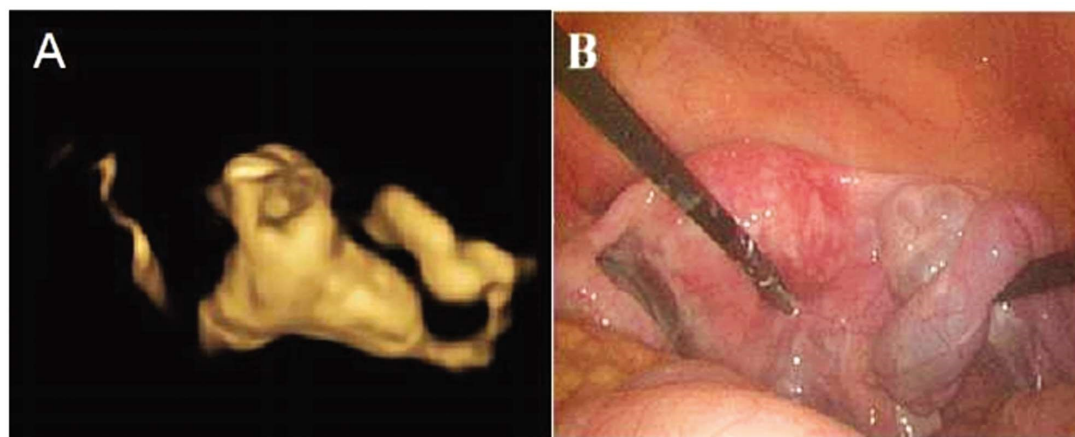


图2 RT 3D-HyCoSy 与腹腔镜分别显示双侧输卵管伞端阻塞

Fig.2 RT 3D-HyCoSy and laparoscopy showed bilateral oviduct umbrella end occlusion and left umbrella end occlusion respectively

A: 双侧输卵管伞端阻塞, 远段显影增粗、扭曲; B: 腹腔镜下见左侧输卵管伞端积液肿胀并闭锁, 扭曲变形, 右侧输卵管伞端增粗与盆壁粘连。

A: Bilateral tubal umbrella end obstruction, distal development thickened and distorted; B: Under laparoscopy, the left tubal umbrella end was swollen with fluid accumulation, atresia and distortion, and the right tubal umbrella end was thickened and adhered to the pelvic w.

情况、通畅与阻塞患者造影剂、通过输卵管间质部时间以及造影剂通过输卵管伞端时间。正常子宫输卵管灌注压范围为: 40.00~60.00kPa, 双侧输卵管通畅时, 灌注压的上限为 46.55kPa; VAS 评分应用视觉模拟评分量表, 对患者推注造影剂过程中的疼痛程度进行评价, 让患者从 0-10 个数字中选取一个代表自身疼痛感, 分数越高代表疼痛越剧烈^[12]。

1.4.3 伞端类型与输卵管通畅性的关系分析 统计并分析伞端正常、异常与疑似异常状况下, 输卵管的通畅性^[13]。

1.4.4 三维超声造影对输卵管伞端通畅性的诊断价值 应用诊断准确度、特异度、敏感度、阳性预测值和阴性预测值的计算来判定实时三维超声造影、静态三维与两者联合的诊断价值。

1.5 统计学方法

采取 SPSS 23.0 进行数据分析, 计数资料以 n/% 表示, 进行 χ^2 检验; 计量资料用 ($\bar{x} \pm s$) 表示, 采用 F 检验; 以 $P < 0.05$ 为差异有统计学意义。

2 结果

2.1 三维超声造影与金标准输卵管伞端阻塞诊断率对比分析

120 例患者共 240 条输卵管, 美兰通染液检查诊断发现输卵管通畅 58 条, 阻塞 / 粘连 182 条, 实时三维超声造影检查发现通畅 51 条, 阻塞 / 粘连 189 条, 静态三维通畅 44, 阻塞 / 粘连 196, 实时三维超声造影与静态三维联合通畅 56, 阻塞 / 粘连 184。如表 1 所示。

2.2 三维超声造影对输卵管伞端通畅性的诊断价值

根据表 2 可知: 三组的准确度、特异度、灵敏度、阳性预测值、阴性预测值差异均有统计学意义 ($P < 0.001$)。进一步采用 Bonferroni 法进行多重比较, 发现实时三维超声造影与静态三维联合诊断组的准确度、特异度、灵敏度、阳性预测值、阴性预测值与实时三维超声造影组差异均无统计学意义 ($P > 0.05$)。而实时三维超声造影与静态三维联合诊断组、实时三维超声造影

组这两组的准确度、特异度、灵敏度、阳性预测值、阴性预测值均高于静态三维组($P<0.001$)。

2.3 不同输卵管通畅性患者相关指标对比分析

120 患者通过临床综合诊断发现,一侧输卵管阻塞患者 35 例,双侧输卵管阻塞患者 64 例,双侧输卵管通畅患者 21 例,不

同输卵管通畅性三组患者 VAS 评分、造影剂注入量、造影剂返流量与阻塞对比差异显著($P<0.05$),如表 3 所示。通畅与阻塞患者造影剂通过输卵管间质部时间及造影剂通过输卵管伞端时间对比差异显著($P<0.05$),如表 4 所示。

表 1 三维超声造影与金标准输卵管伞端阻塞诊断率对比分析(n, %)

Table 1 Comparative analysis of the diagnostic rate of tubal umbrella end obstruction between 3D contrast-enhanced ultrasound and gold standard (n, %)

Check the method		Transvaginal real time		Static 3D		Joint diagnosis		Total
		three-dimensional						
		hysterosalpingo-contrast sonography						
		Blocking/adhesion	unobstructed	Blocking/adhesion	unobstructed	Blocking/adhesion	unobstructed	
Check meilantong dye solution	Blocking/ adhesion	180	2	167	15	179	3	182
	unobstructed	9	49	29	29	5	53	58
Total		189	51	196	44	184	56	240

表 2 三维超声造影对输卵管伞端通畅性的诊断价值

Table 2 Diagnostic value of three-dimensional contrast-enhanced ultrasound in the patency of the tubal umbrella end

Groups	Accuracy Rate	Specific Rate	Sensitivity Rate	Positive predictive value	Negative predictive value
Transvaginal real time three-dimensional hysterosalpingo-contrast sonography	95.42 % (229/240)	84.48 % (49/58)	98.90 % (180/182)	95.24 % (180/189)	96.08 % (49/51)
Static 3D	81.67 % (196/240)	50.00 % (29/58)	91.76 % (167/182)	85.20 % (167/196)	65.91 % (29/44)
Joint diagnosis	96.67 % (232/240)	91.38 % (53/58)	98.35 % (179/182)	97.28 % (179/184)	94.64 % (53/56)
χ^2	41.644	30.642	16.297	22.984	23.530
P	<0.001	<0.001	<0.001	<0.001	<0.001

表 3 不同输卵管通畅性患者相关指标对比分析($\bar{x} \pm s$)

Table 3 Comparative analysis of related indicators in patients with different fallopian tube patency ($\bar{x} \pm s$)

Different patency	n	VAS score (points)	Injecting amount of contrast medium (mL)	Contrast reagent flow rate (mL)
Bilateral fallopian tubes are unobstructed	21	2.43 $\pm$ 0.65	21.48 $\pm$ 2.62	1.21 $\pm$ 0.32
One fallopian tube is obstructed	35	3.21 $\pm$ 0.86	19.42 $\pm$ 2.33	2.36 $\pm$ 0.67
Bilateral fallopian tube obstruction	64	4.72 $\pm$ 1.42	8.52 $\pm$ 6.13	4.82 $\pm$ 1.63
F	-	38.248	89.732	84.576
P	-	<0.001	<0.001	<0.001

表 4 通畅与阻塞患者造影剂通过输卵管间质部时间与伞端时间对比分析($\bar{x} \pm s$)

Table 4 Comparative analysis of time of contrast medium passing through tubal interstitium and umbrella end in patients with patent and obstruction ($\bar{x} \pm s$)

Different patency	n	Time of contrast agent passing through oviduct interstitium	Time of contrast agent passing through oviduct umbrella
Bilateral fallopian tubes are unobstructed	21	10.65 $\pm$ 1.17	21.44 $\pm$ 3.53
One fallopian tube is obstructed	35	18.37 $\pm$ 3.49	31.28 $\pm$ 7.20
Bilateral fallopian tube obstruction	64	25.09 $\pm$ 4.26	52.99 $\pm$ 10.62
F	-	130.796	131.791
P	-	<0.001	<0.001

3 讨论

近年来,随着新型造影剂雪瑞欣、SonoVue 在输卵管通畅性诊断方面的研究和计算机 3D 技术在超声显像方面的应用,使得 TVS 3D-HyCoSy 逐渐用于筛查输卵管的通畅性并获得临床研究者的广泛关注^[14,15]。研究显示,TVS 3D-HyCoSy 与作为金标准的腹腔镜检查具有良好的一致性^[16,17],且是最新发展起来一种评价输卵管通畅性的方法,已获得生殖妇科医生的广泛认可,能用于间接评估输卵管蠕动功能以及筛查不孕症等^[18,20]。目前,超声造影评估输卵管通畅性的标准经常以输卵管全程显影、见造影剂经伞端溢出、输卵管显影的形态、造影剂在盆腔及卵巢周围弥散等情况进行综合评估^[21,22]。在实际操作中,运用静态 3D-HyCoSy 检查,对于输卵管伞端的溢出性观察经常不能实时显示,伞端溢出行为显示不清,是一侧通而不畅或周围粘连,而另一侧很通畅,是否是造影剂向压力小的一侧流动所致?单一指标容易造成假阴性。但静态 3D-HyCoSy 检查,显像清晰,可观察造影剂在盆腔弥散情况及是否均匀,间接评估输卵管通畅性,是 RT 3D-HyCoSy 有益补充。查阅文献,国内外鲜有将 RT 3D-HyCoSy 应用于输卵管伞端通畅性及盆腔粘连方面的研究报道^[23]。因此,本研究将 RT 3D-HyCoSy 联合超声引导下宫腔通液术,形成人工盆腔积液,着重观察输卵管伞端造影剂溢出与输卵管通畅性及盆腔粘连的关系,为了解输卵管伞端通畅性与拾卵功能方面做一些有益尝试和探索,可通过电话追踪统计分析入选病例造影一年内的自然妊娠情况,论证造影结果与输卵管通畅程度、蠕动功能与输卵管伞端粘连情况,评估输卵管伞端拾卵功能,为临床诊治不孕症提供帮助。

本研究结果表明,120 例患者共 240 条输卵管,美兰通染液检查诊断发现输卵管通畅 58 条,阻塞/粘连 182 条,实时三维超声造影检查发现通畅 51 条,阻塞/粘连 189 条,静态三维通畅 44,阻塞/粘连 196,实时三维超声造影与静态三维联合通畅 56,阻塞/粘连 184。由此证明,实时三维超声造影检查与美兰通染液检查结果无明显差异,具有较高诊断准确性。本研究与 Li L^[24] 等研究结果相符, Li L 团队发现:通过 TVS RT-3DHyCoSy 可明确观察到输卵管的走向,对诊断不孕症作用重大。分析其原因为:RT 3D-HyCoSy 明显降低了操作医生与推注造影剂人员配合的难度,减少了预扫描中心平面不能包绕两侧卵巢时,需二次推注造影剂检查的环节,只需采集一个数据库,即可实时观察造影剂进入宫、双侧输卵管内流动且从伞端溢出的方向以及包绕卵巢并弥散至盆腔的顺序和时间,可以更准确的判断输卵管的通畅程度及盆腔粘连的关系,明显提高了对输卵管显影的清晰观察^[25,26];实时三维超声造影与静态三维联合诊断组、实时三维超声造影组这两组的准确度,本研究发现、特异度、灵敏度、阳性预测值、阴性预测值均高于静态三维组($P<0.001$)。而实时三维超声造影与静态三维联合诊断组的准确度、特异度、灵敏度、阳性预测值、阴性预测值与实时三维超声造影组差异均无统计学意义($P>0.05$),实时三维超声造影实时、动态、全面评估输卵管伞端通畅性。静态 3D-HyCoSy 检查,显像清晰,可观察造影剂在盆腔弥散情况及是否均匀,间接评估输卵管通畅性,是 RT 3D-HyCoSy 有益补充。两者联合诊断效能应该优于单一诊断手段。究其原因可能

是纳入病例数不多造成的。但目前并无研究针对实时三维超声造影与静态超声造影联合应用评估诊断准确度与特异度的研究,而本研究创新性的得出此结论,也可能是因为静态的 3D-HyCoSy 需操作医生与推注造影剂者良好配合,才能获得清晰的显影图像有关,导致诊断效能降低。120 例患者通过临床综合诊断发现,一侧输卵管阻塞患者 35 例,双侧输卵管阻塞患者 64 例,双侧输卵管通畅患者 21 例,不同输卵管通畅性三组患者 VAS 评分、造影剂注入量、造影剂返流量对比差异显著、通畅与阻塞患者造影剂通过输卵管间质部时间与造影剂通过输卵管伞端时间对比差异显著。由此证明输卵管通畅性与推注压力、VAS 评分、造影剂注入量、造影剂返流量、造影剂通过输卵管间质部及伞端时间具有明显关系。与 Peart JM 等^[27]报道相一致,即输卵管通畅程度与造影剂推注压力息息相关,且呈反比。这是因为,输卵管部分狭窄或完全闭塞,造影剂流经子宫输卵管的过程不同程度的受阻,注入宫腔的造影剂不能顺利或几乎不能经输卵管间质部、峡部、壶腹部快速流动并从伞端溢入盆腔,造影剂逐渐充盈子宫腔,导致宫腔内压力增高,进而造成推注造影剂阻力大^[28,29]。张君^[30]等研究显示并随访观察:子宫输卵管超声造影伞端溢出时间的快慢与促排卵或自然妊娠率有相关性,即溢出时间越快,输卵管的蠕动功能越好,妊娠成功率越高。与本研究内容有相似之处。但以往研究并无针对 VAS 评分、造影剂注入量、造影剂返流量与输卵管通畅性关系的研究,这也是本研究的创新之处,希望能够为日后输卵管通畅程度的诊断提供参考意见。本项目组成员通过电话追踪入选病例造影内一年(2019 年 6 月-202 年 6 月)45 例的自然妊娠情况发现:2 例双侧输卵管堵塞、5 例单侧输卵管堵塞患者未经任何治疗的情况下自然怀孕,结果表明 RT 3D-HyCoSy 在诊断的同时还有很好的再通与治疗作用。

综上所述,应用 RT 3D-HyCoSy 对不孕症患者进行检查,能够通过对输卵管伞端粘连和通畅性的检查,诊断输卵管通畅性,为不孕症的诊断与治疗提供参考意见。另外,应用实时三维超声造影与静态三维超声能够提升输卵管伞端通畅性诊断率,值得临床应用推广。

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