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Adnexal torsion: a predictive score for pre-operative diagnosis

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BACKGROUND: Adnexal torsion (AT) is difficult to diagnose and requires immediate surgery. The aim of this study was to develop a simple score for assisting in the pre-operative diagnosis of AT in women with acute pelvic pain.

METHODS: Using data from a retrospective cohort of 142 patients with acute pelvic pain, we developed a score based on multiple logistic regression after a jackknife procedure. We validated the score in a prospective cohort of 35 women with acute pelvic pain.

RESULTS: Five criteria were independently associated with AT confirmed by surgery: unilateral lumbar or abdominal pain [adjusted odds ratio (aOR), 4.1; 95% confidence interval (95% CI), 1.2–14.0]; pain duration <8 h at first presentation (aOR, 8.0; 95% CI, 1.7–37.5), vomiting (aOR, 7.9; 95% CI, 2.3–27.0), absence of leucorrhoea and metrorrhagia (aOR, 12.6; 95% CI, 2.3–67.6) and ovarian cyst larger than 5 cm by ultrasonography (aOR, 10.6; 95% CI, 2.9–38.8). The torsion score was based on these five criteria. Low-risk and high-risk groups were derived from values of the score [probability of AT, 3.7% (95% CI, 0–7.8) and 69% (95% CI, 53–84), respectively]. Application of these criteria to the prospective cohort confirmed the diagnostic accuracy of the score [probability of AT, 0% (95% CI, 0–16) and 75% (95% CI, 26–100) in the low-risk and high-risk groups, respectively].

CONCLUSIONS: This easy-to-calculate score may prove useful for diagnosing AT in patients with acute pelvic pain seen at general or gynaecology emergency departments.

Key words: adnexal torsion / diagnostic model / jackknife procedure / ovarian cyst

Introduction

Acute pelvic pain is the leading reason for emergency visits to gynaecology departments (Kontoravdis *et al.*, 1996). Among common causes of acute pelvic pain, adnexal torsion (AT) is difficult to diagnose and requires immediate surgery. The early diagnosis of AT allows the prevention of adnexal loss, which decreases fertility (Bayer and Wiskind, 1994). Failure to establish the diagnosis early may lead to thrombophlebitis and peritonitis, which in turn may cause death (Nichols and Julian, 1985). Conversely, laparoscopy may be performed unnecessarily in an effort to avoid missing an AT (Georgy and Viechnicki, 1974).

The symptoms and physical findings in patients with AT are non-specific (Huchon and Fauconnier, 2010). Ultrasonography alone is unreliable and Doppler has a limited role (Nichols and Julian, 1985; Pena *et al.*, 2000). The only reliable investigation for diagnosing AT is laparoscopy (Bar-On *et al.*, 2010). The absence of non-invasive investigations for diagnosing AT probably results in underdiagnosis of this acute event (Georgy and Viechnicki, 1974).

These facts prompted us to develop a simple tool for diagnosing AT in women with acute pelvic pain. The aim of this study was to develop and validate a predictive score for the diagnosis of AT in patients seen for acute pelvic pain, based on the medical history, physical findings and simple investigations.

Materials and Methods

Study population

Consecutive patients who presented to our hospital for acute pelvic pain, including those who had a positive pregnancy test and who subsequently required surgery were included, except those who underwent curettage for spontaneous abortion and those whose diagnosis was established pre-operatively (e.g. cardiac activity in ectopic pregnancy). The score was developed in a retrospective cohort of consecutive patients who presented between 1 January 2000 and 30 June 2004. For the validation study, we prospectively included consecutive patients who presented between 1 September 2004 and 31 December 2005.

Table I Diagnostic performance characteristics of selected criteria in the univariate analysis.

Variable	Patients with the criterion (*n*)	Se (%)	Sp (%)	Lr+	Lr−	*P*-value
Ovarian cyst history	34	37.5	80.0	1.89	0.78	0.04
Sudden onset of pain	72	75.8	46.8	1.42	0.52	0.03
Use of an opioid analgesic	18	28.1	91.8	3.43	0.78	0.003
Ovarian stimulation	9	15.6	96.4	4.30	0.88	0.01
Vomiting	39	56.3	80.9	2.95	0.54	<0.0001
Pain duration <8 h	31	37.9	81.1	2.01	0.77	0.03
Absence of leucorrhoea and metrorrhagia	80	93.8	54.5	2.06	0.11	<0.0001
Spontaneous unilateral abdominal or lumbar pain	71	78.1	57	1.82	0.38	0.0005
Absence of pain during uterine mobilization	54	65.6	70	2.19	0.49	0.0003
Unilateral abdominal tenderness to palpation	87	86.7	40.2	1.45	0.33	0.006
Adnexal mass by physical examination	24	34.4	88.2	2.91	0.74	0.003
CRP ≤ 20 mg/l	54	89.5	50.0	1.79	0.21	0.002
Cyst on ultrasonogram	81	93.8	53.6	2.02	0.12	<0.0001
Cyst ≥ 5 cm on ultrasonogram	50	78.1	77.3	3.44	0.28	<0.0001
Little or no fluid in the Douglas pouch	105	93.8	31.8	1.38	0.20	0.004

Se, sensitivity; Sp, Specificity; Lr+, positive likelihood ratio; Lr−, negative likelihood ratio.

The study was approved by the institutional review board of the French College of Obstetricians and Gynaecologists under the number CEROG-2008-063.

Variables of interest

Data were collected by reviewing the medical records. A standardized form was used to collect data of the prospective cohort. The type, location, severity and duration of pain were recorded, as well as abdominal tenderness, leucorrhoea or vaginal bleeding at speculum examination, and adnexal masses and cervical motion tenderness at digital examination. When data were missing, the relevant symptoms were considered absent.

In our department, ultrasonography is performed and recorded routinely in patients with acute pelvic pain. During the study, three ultrasound machines were used: a Voluson 530 MT fitted with a 7.5-MHz S-EW5/7K convex transvaginal probe (Kretztechnik AG), a Logic 700 fitted with a 5.6-MHz 618E convex transvaginal probe (GE Medical System) and a Logic 500 fitted with a 4.8-MHz E721 convex transvaginal probe (GE Medical System). All ultrasound scans were done by a gynaecology department resident, using a standardized procedure. For the study, all sonograms were reviewed by one of us (C.H.). The presence of fluid in the Douglas pouch was defined as fluid visible behind the uterus on the mid-sagittal image. The amount of intraperitoneal fluid was assessed semi-quantitatively, based on whether the upper edge of the effusion was no higher than the uterine isthmus, at the level of the uterine body or above the uterine fundus. When an adnexal cyst was identified, its size was recorded; in the case of a multilocular cyst, the overall cyst diameter was recorded.

The reference standard for the diagnosis of AT was the surgical diagnosis.

Statistical analysis

Patients with and without AT were compared using Pearson's χ^2 test for qualitative variables and Student's *t*-test for quantitative variables. Ordinal and continuous variables that yielded *P*-values of <0.05 in the univariate analysis were dichotomized based on the area under the receiver-operating characteristic (ROC) curve (ROC-AUC) and used in a predictive model (Tsuruta and Bax, 2006). For each variable that was significantly associated with AT, we computed sensitivity (Se), specificity (Sp), the positive likelihood ratio (Lr+) and the negative likelihood ratio (Lr−).

Multiple logistic regression analysis was then used to select the best model for diagnosing AT. Variables yielding *P*-values smaller than 0.05 in the univariate analysis were entered into the logistic regression model. A forward stepwise procedure was used to obtain the best combination of variables independently associated with AT at a *P* threshold <0.05 (Harrell *et al.*, 1996). The stability of the predictive model was tested using the jackknife method (Efron and Gong, 1983).

The torsion score was based on items significant in the multivariate logistic regression analysis and found to be stable using the jackknife procedure. The number of torsion score points contributed by each score item was obtained by rounding up the β coefficient of the logistic regression to generate a simple scale. The ROC-AUC of the torsion score was then compared with the ROC-AUC of the logistic regression to check that the two values were not significantly different from each other. The probability of AT ($P = 1/[1 + \exp(-(\alpha - \beta^{*}\text{score}))]$), Se and Sp were calculated for each torsion score value in the derivation cohort. Risk groups of AT were then constructed, in order to maximize classification rates, by considering that the probability of AT should be <5% in the low-risk group and >70% in the high-risk group.

For each patient in the validation cohort, the torsion score was calculated and correlated with the final diagnosis. Analyses were carried out using Stata® version 11.0 (Stata Corp., College Station, TX, USA).

Results

We included 142 patients in the retrospective derivation cohort, among 332 patients admitted for acute pelvic pain during this period and 35 patients in the validation cohort. The AT rate was not significantly different between the two cohorts (22.5 and 17.1%, respectively; $P = 0.49$), and the main characteristics were comparable (data not shown).

Table II Factors associated with AT in the multiple logistic regression model.

	aOR	95% CI
Leucorrhoea and metrorrhagia		
No	12.6	2.3–67.6
Yes	1	
Cyst >5 cm on ultrasonogram		
No	1	
Yes	10.6	2.9–38.8
Pain duration		
≥8 h	1	
<8 h	8	1.7–37.5
Vomiting		
No	1	
Yes	7.9	2.3–27.0
Spontaneous unilateral abdominal or lumbar pain		
No	1	
Yes	4.1	1.2–14.0

aOR, adjusted odds ratio; 95% CI, 95% confidence interval.

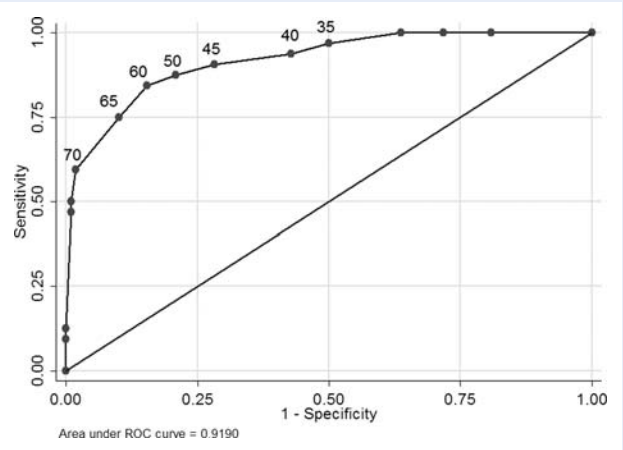

Figure 1 ROC curve of the torsion score.

Derivation cohort

The diagnostic performance characteristics of the variables associated with AT in the univariate analysis are shown in Table I. AT was not significantly associated with pain intensity, peritoneal signs, obstetric history, contraception or history of tubal ligation. Ovarian cyst visualization by ultrasonography was more common in the AT group, and the optimal cyst diameter for discriminating between the two groups was 5 cm.

By multiple logistic regression analysis, five variables independently predicted the diagnosis of AT: absence of leucorrhoea and metrorrhagia, ovarian cyst larger than 5 cm, unilateral abdominal or lumbar pain, pain lasting <8 h and vomiting. Adjusted odds ratios (aORs) are reported in Table II. The ROC-AUC was 0.92 [95% confidence interval (95% CI), 0.86–0.97]. The jackknife procedure showed that the logistic model was stable.

Table III Number of torsion score points contributed by each factor and clinical prediction rule.

Variable	Score points	Predicted risk (95% CI), %
Absence of leucorrhoea and metrorrhagia	25	
Cyst >5 cm on ultrasonogram	25	
Pain duration <8 h	20	
Vomiting	20	
Spontaneous unilateral abdominal or lumbar pain	15	
Total torsion score		
0–40		3.7% (0–7.8)
45–60		20% (4–36)
>60		69% (53–84)

95% CI, 95% confidence interval.

The torsion score was given by the following equation: Score = Absence of leucorrhoea and metrorrhagia * 25 + Ovarian cyst larger than 5 cm * 25 + Pain lasting less than 8 h * 20 + Vomiting * 20 + Abdominal or lumbar pain * 15. The probability of AT can be estimated using an appropriate logistic transformation as $P = 1/[1 + \exp(0.098 * \text{score} - 6.42)]$. The score ROC curve is shown in Fig. 1 with the torsion score values.

The rounded coefficients constituting the score are given in Table III. Loss of fit due to coefficient rounding was negligible (ROC-AUC, 0.92; 95% CI, 0.87–0.97) and the ROC-AUC of the score was not significantly different from the ROC-AUC of the initial logistic regression model ($P = 0.48$).

The low-risk group comprised patients with torsion scores ≤40, whose probability of AT was 3.7% (95% CI, 0–7.8), and the high-risk group comprised patients with torsion scores >60, whose probability of AT was 69% (95% CI, 53–84) (Table III).

Validation cohort

The diagnostic performance characteristics and the probability of AT in each probability-level group are reported in Table IV. With a cut-off of 40, the sensitivity was 100% (95% CI, 61–100) and the negative likelihood ratio was zero. A cut-off of 60 produced high specificity (97%, 95% CI, 90–100) and positive likelihood ratios (>16) values, indicating that patients with acute pelvic pain and at least three or four of the five independent criteria had a high probability of AT.

Discussion

We used a retrospective cohort to develop a simple score for predicting AT. Five criteria were associated with AT: absence of leucorrhoea and metrorrhagia, ovarian cyst larger than 5 cm seen on the ultrasonogram, unilateral lumbar or abdominal pain, pain lasting <8 h and

Table IV Diagnostic values of the torsion score in the validation cohort (n = 35).

Risk group	Score value	Sensitivity	95% CI	Specificity	95% CI	Probability of AT	95% CI
Low-risk	≤40	69%* (20/29)	52–86	100%* (6/6)	61–100	0% (0/20)	0–16
High-risk	>60	50% (3/6)	19–81	97% (28/29)	90–100	75% (3/4)	26–100

*Calculated with absence of AT as the correct outcome; 95% CI, 95% confidence interval.

vomiting. This torsion score performed well in a prospective validation cohort of women with acute pelvic pain.

Our study has several limitations. First, we included only patients who underwent surgery. In theory, we might have missed patients who had AT but did not undergo surgery. However, virtually all patients with undiagnosed AT experience severe complications and persistent severe pain due to adnexal necrosis, which eventually lead to surgery. Thus, patients discharged with undiagnosed AT would probably have returned promptly to our emergency room, as our institution serves a very large area. Second, as we used a retrospective design and included all patients who had surgery, the 22% AT rate constitutes an overestimation due to referral bias. However, using an AT prevalence of 10% in patients with acute pelvic pain, the cut-off of 40 will be associated with a 26% AT rate by laparoscopy (positive laparoscopy) thus leading to an aggressive rate of laparoscopy whereas using the cut-off of 60 will lead to a 64% AT rate by laparoscopy, which we consider acceptable. Furthermore, our finding that the torsion score produced similar results in the prospective validation cohort to those obtained in the retrospective derivation cohort argues against substantial overfitting.

Most of the criteria used in our torsion score are well known to be associated with AT. Vomiting was described as a symptom of AT in several studies (Hibbard, 1985; Bouguizane *et al*., 2003). Earlier studies found that the time from pain onset to physician visit was short (Nichols and Julian, 1985; Goldstein, 1989). That absence of leucorrhoea and metrorrhagia was significantly associated with AT in our study probably reflects the occurrence of both symptoms in patients with other diagnoses (Kahn *et al*., 1991; Dodson, 1994).

Ultrasound visualization of an ovarian cyst in a patient with pelvic pain suggests AT (Chiou *et al*., 2007; Linam *et al*., 2007), because torsion usually complicates a prior adnexal abnormality (Chapron *et al*., 1996). Ovarian cyst size may play a key role in the mechanism of AT (Linam *et al*., 2007), and the 5-cm threshold found significant in our study is consistent with the literature (Pena *et al*., 2000; Bouguizane *et al*., 2003). Ovarian masses may reflect either the presence of a cyst causing AT or prolonged ischaemia due to prolonged torsion (Smorgick *et al*., 2008). However, ultrasonography cannot differentiate AT from other cyst complications (Linam *et al*., 2007). Furthermore, the initial ultrasonogram is normal in 9–26% of patients with AT (Huchon and Fauconnier, 2010). Thus, ultrasonography alone is not reliable for diagnosing AT.

At present, no prediction rule is available for detecting AT. Given that no single tool can reliably provide the diagnosis of AT, we sought to determine whether a combination of symptoms, signs and ultrasonography findings was useful. We developed a score based on five such criteria. Our torsion score does not require Doppler examination or other sophisticated investigations as advocated by some authors (Desai *et al*., 1994). It has been estimated that clinicians accurately diagnose AT in 23–66% of cases, but these studies included only patients with AT documented by laparoscopy (Hibbard, 1985; Haskins and Shull, 1986; Bar-On *et al*., 2010). Although our model may improve the diagnosis rate compared with standard clinical evaluation, this study does not provide evidence of such an improvement. The torsion score might prove useful in emergency departments for selecting patients who require immediate referral to the gynaecology department and emergency laparoscopy. Also, the torsion score may avoid useless surgical procedures and may improve referral to gynaecology of women with acute pelvic pain seen at general emergency departments.

Conclusion

We developed a simple diagnostic score based on five reproducible criteria, to assist in the triaging of emergency room patients with acute pelvic pain possibly due to AT. Prospective multicenter studies are needed to evaluate the diagnostic performance of the torsion score compared with standard clinical evaluation, in large numbers of patients. The torsion score might prove useful for evaluating patients with acute pelvic pain seen at general or gynaecology emergency departments. Since no considerable experience in gynaecology or radiology is needed to assess the five score items, the torsion score may be suitable for routine use by any physician or resident as a non-invasive tool for separating patients having low versus high probabilities of AT and for identifying patients who require emergency laparoscopy.

Authors' roles

C.H. processed the database and wrote the manuscript. S.S. managed data collection under the supervision of C.H. and A.F. supervised the writing of the manuscript and provided statistical expertise.

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