

Ectopic Pregnancy: Vascularity Index as a Novel Diagnostic Criterion

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INTRODUCTION

Since the medical management of EP was introduced by Dr. Steven Ory at CAOG (and published in 1986 in the American Journal of Obstetrics and Gynecology), diagnostic criteria have been established to predict its successful medical treatment, which includes its sonographic dimensions (< 4.0 cm EP), its associated low hCG level (< 5000 mIU/ml), and whether there was no embryonic cardiac motion. With the advanced sonographic techniques that have become available, there is yet another feature warranting its inclusion in the diagnostic criteria that we currently use when embarking on the medical treatment with MTX of a known ectopically implanted tubal pregnancy. Specifically, it is the Vascularity Index (VI), which indicates the color density of associated vasculature at the ectopic implantation site. Since tubal rupture is a finite possibility with a tubal EP that is medically treated, there may be significant consequences should rupture occur, and this may be potentially avoidable with the use of diagnostic 3D TVS PDA, as this investigation reports.

VASCULARITY INDEX (VI) – WHAT IT IS

VI is the number of color flow-containing voxels divided by the total number of voxels within the EP volume - region of interest (ROI), expressed as a value (i.e. a percentage).

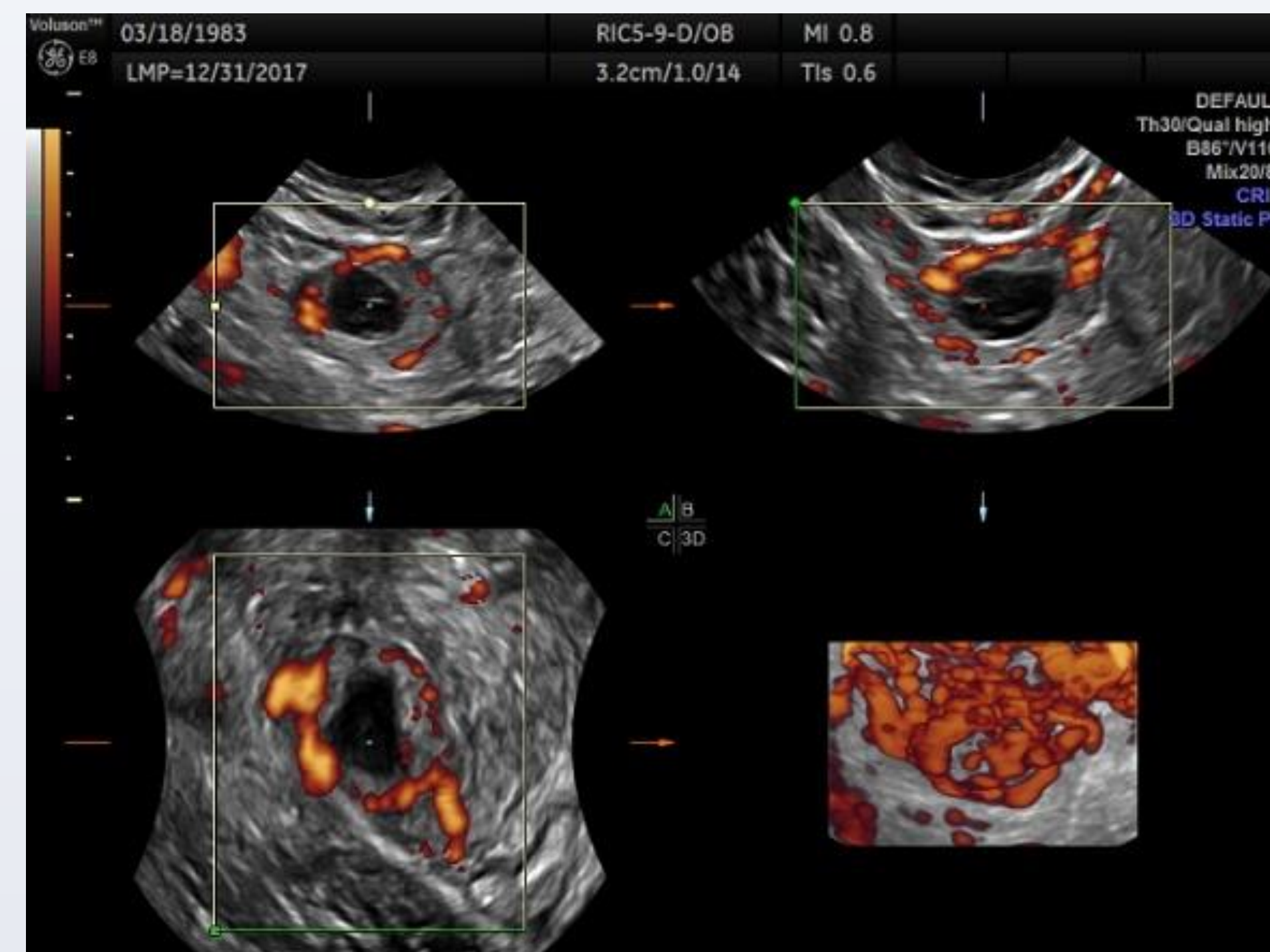
VASCULARITY INDEX – HOW IT IS CALCULATED

Step 1 - 3D U/S VOLUME ACQUISITION of the EP with PDA

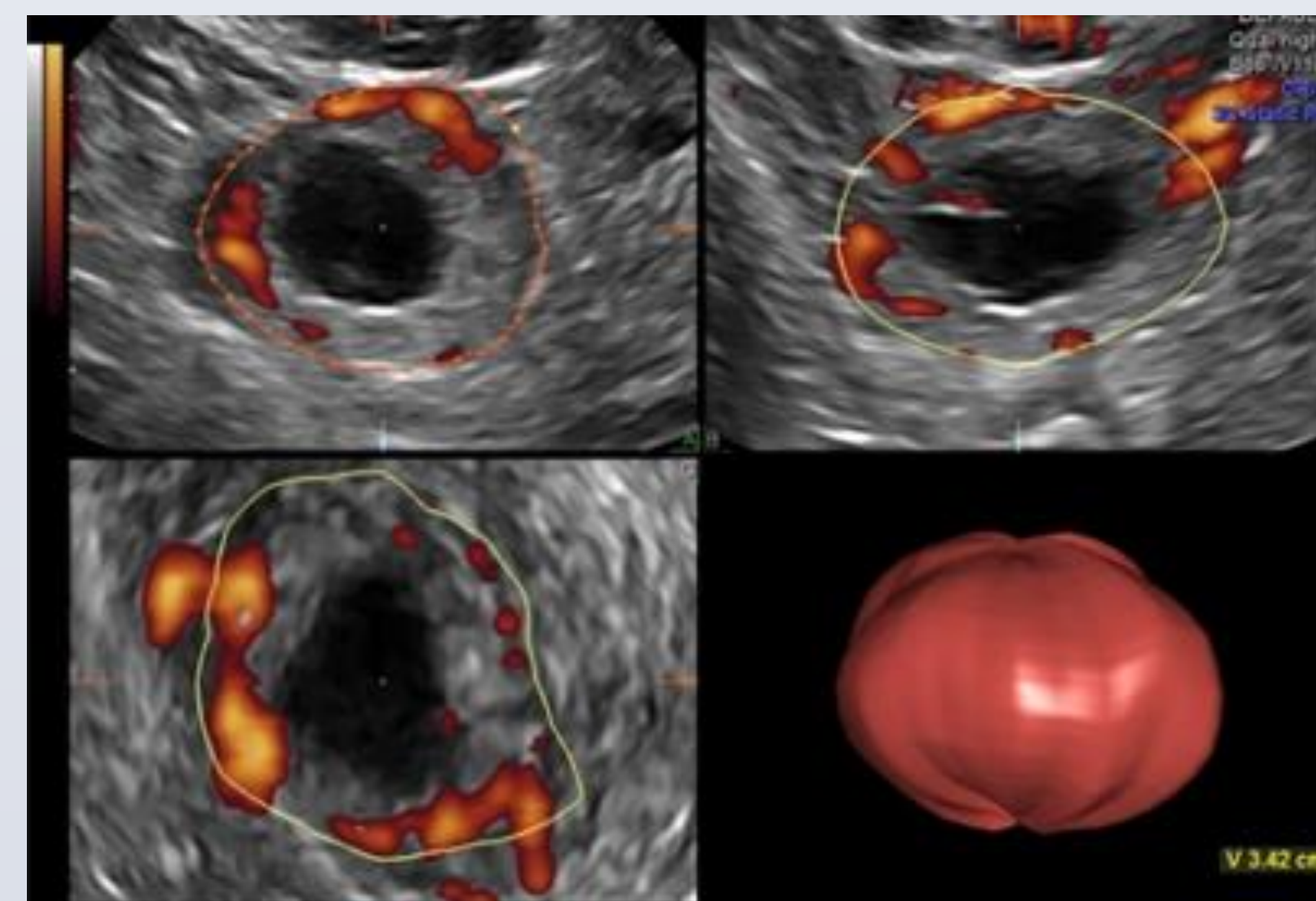
Step 2 - Obtain the volume of the EP using Virtual Organ Computer-aided Analysis (VOCAL)

Step 3 - Calculation of VI using HISTOGRAM

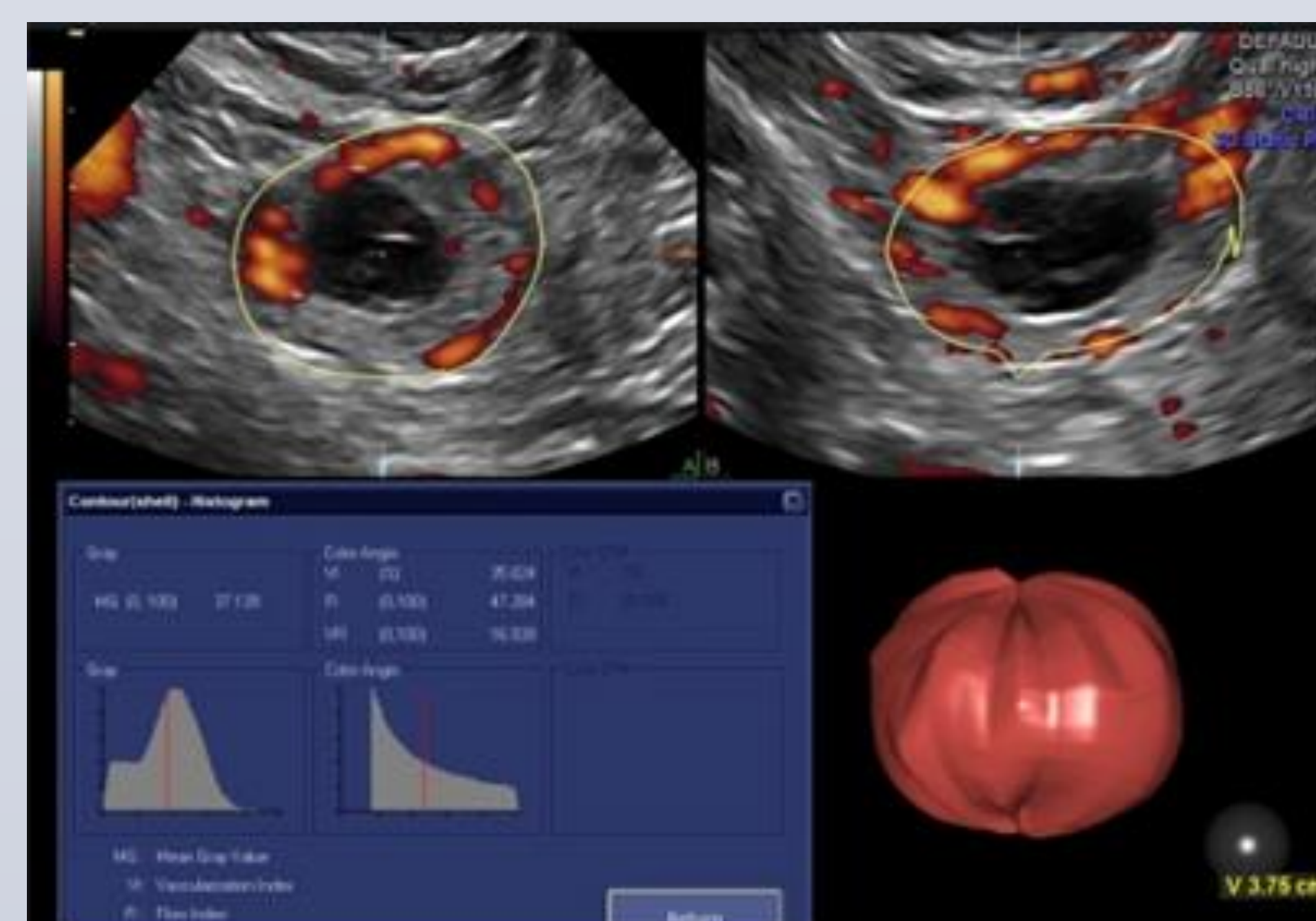
ACQUISITION OF VASCULAR INDEX (VI)



Step 1 - EP 3D US volume acquisition with PDA



Step 2 - Obtain the EP volume using Virtual Organ Computer-aided Analysis (VOCAL)



Step 3 – Use HISTOGRAM to obtain the VI

RESULTS

Case#	Maximum Diameter (cm)	Human Chorionic Gonadotropin (mIU)	Cardiac Motion (Y/N)	Vascularity Index (ratio)	Outcome
1	1.76	442	N	2.5	
2	3.8	58	N	3.9	
3	2.9	471	N	6.8	
4	1.9	1,500	N	1.2	
5	3.8	13,296	Y	13.6	
6	1.1	3,146	N	27.1	Subsequent MTX failure (rupture)
7	2.5	281	N	5.6	
8	3.7	5,664	N	10.7	Ruptured
9	2.6	1,271	N	2.2	
10	3	1,418	N	6	
11	2.9	8	N	1.9	
12	2.2	170	N	4.7	
13	1.5	581	N	3.3	
14	3.2	158	N	5	
15	5	2,610	N	2.8	Subsequent MTX failure (rupture)
16	2.9	910	N	2.5	
17	3.1	286	N	5.6	
18	6.3	3,289	N	4.1	Subsequent MTX failure (rupture)
19	4.3	865	N	1.2	
20	1.4	196	N	6.2	
21	2.9	6,270	N	13.5	
22	2.4	306	N	10.6	
23	2.5	470	N	8	
24	2.7	627	N	2.9	
25	4.8	75	N	10.7	
26	8.1	2,097	N	0.8	Ruptured
27	2.2	5,767	N	3.2	
28	4.5	1,500	N	17.1	Ruptured
29	3.3	363	Y	4.6	
30	1.6	5,522	N	46.4	MTX Failure (rising hCG)
31	2.5	400	N	4.2	
32	5.8	30,942	N	5.5	
33	2.2	38,000	N	3.9	
34	3.7	5,664	Y	11.8	Ruptured
35	2.5	9,469	Y	23.4	
36	1.8	460	N	1.5	Subsequent MTX failure (rupture)
37	2.1	5,392	N	22.7	Subsequent MTX failure (rupture)
38	3.2	15,891	N	3.9	
39	4.4	11,265	Y	9	
40	6.1	295	N	5	
41	6.9	492	N	3.6	
42	2.4	76	N	3.4	
43	3.7	38,000	N	10.8	
44	2.6	2,066	N	15.5	Ruptured
45	3.2	31,477	N	13.6	
46	1.8	475	N	10.6	
47	2.1	702	N	12.4	
48	4.5	897	N	4.6	Ruptured
49	3.6	1,461	N	13.2	Ruptured
50	3.2	3,458	N	4.5	
51	6.9	65	N	1.5	Ruptured
52	3	654	N	3.9	Ruptured
53	2.5	1,709	N	12.5	Subsequent MTX failure (rupture)
54	8	948	N	6.9	Ruptured
55	4.8	44	N	11.7	Ruptured
56	3.6	32,705	N	12.4	Ruptured
57	3.3	825	N	21.9	Subsequent MTX failure (rupture)
58	1.8	425	N	9.7	Ruptured
59	2.8	799	N	6.1	
60	2.3	2,515	N	9.7	Subsequent MTX failure (rupture)
61	4.3	1,615	Y	13.9	
62	2.7	18,033	N	21.2	
63	3.9	853	N	4.8	Ruptured
64	5.7	3,200	N	10.3	Ruptured

Biomarkers highlighted if exceeded risk levels:

Maximum Diameter > 4 cm

Human chorionic gonadotropin > 5,000 mIU

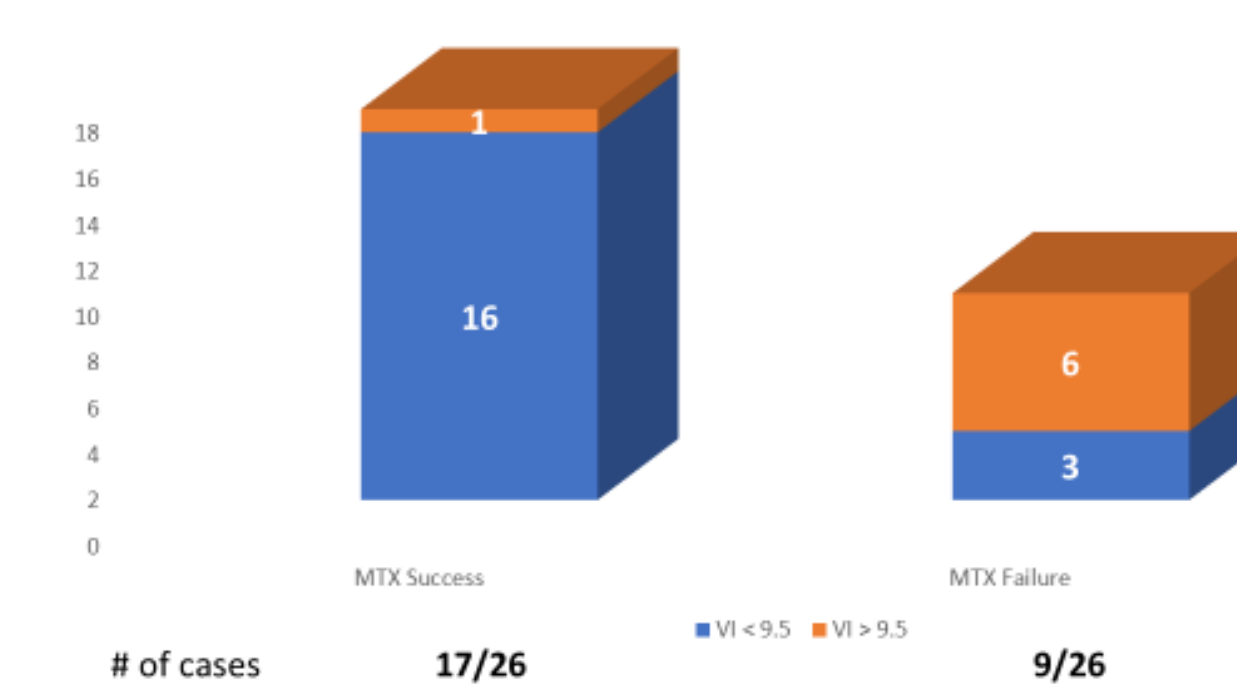
Cardiac Motion present Y

Vascularity Index > 9.5

Indicates cases in which VI identified tubal rupture, when no other Biomarker did (16% of cases)

MTX Treatment of Ectopic Pregnancy

Vascularity Index (VI) Identified (pre-treatment)



CONCLUSION

We describe a series of consecutive cases of ectopic pregnancy presenting to our Emergency Department, with 3D TVS PDA performed prior to surgical or medical treatment. Eight cases of tubal rupture occurred subsequent to IM methotrexate, and one additional case of MTX-failure (non-descent of hCG). Since mortality is known to occur from EP resulting from tubal rupture, the authors wish to describe this advanced sonographic feature to illustrate its potential clinical value. Such significantly increased vascularity, described by a highly elevated Vascularity Index (> 9.5), which identifies the vasculature that surrounds the tube at the ectopic implantation site, was seen in 41% of our data set of 64 cases of ectopic pregnancy. This vasculature surrounding the fallopian tube is often referred to as a "ring of fire", and the VI is its numerical representation. Since we now have the capability of possibly predicting such serious morbidity from tubal rupture after medical therapy for this is given, we wish to show some examples of this, in order that the gynecologic community (and their patients treated) can benefit from this information.

REFERENCES

- Alcazar JL, Kudla MJ: Three dimensional vascular indices calculated using conventional power doppler and high-definition flow imaging. J Ultrasound Med 2010;29:761-66
- haley E, Yarom I, Bustan M, Weiner E, Ben-Shlomo I: Transvaginal sonography as the ultimate diagnostic tool for the management of ectopic pregnancy: experience with 840 cases. Fertil Steril 1998;69(1):62-5.
- ACOG Practice Bulletin No. 191, Feb, 2018, Tubal ectopic pregnancy.

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