COLON 3D MORPHOMETRY FROM CT RECONSTRUCTION APPLIED TO LAPAROSCOPIC COLON SURGERY

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AIM: To analyze changes on the colon`s anatomy and its placement, in regard to position, gender, age and body mass index, and to describe it using three-dimensional reconstructions from CT images.

METHOD: Three human cadavers were used, and real conditions of colon laparoscopic surgery were reproduced, with pneumoperitoneum, and postural decubitus. 130 patients were selected with an abdominal CT without any pathology. A three-dimensional reconstruction of CT images was performed and defined anatomic points were located. Measurements of established morphometric variables were made.

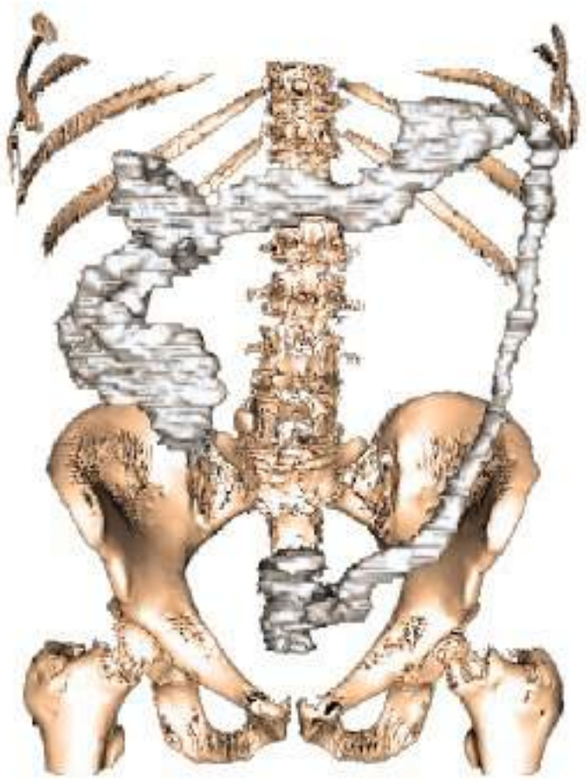

Figure 1. Colon surface tridimensional reconstruction.

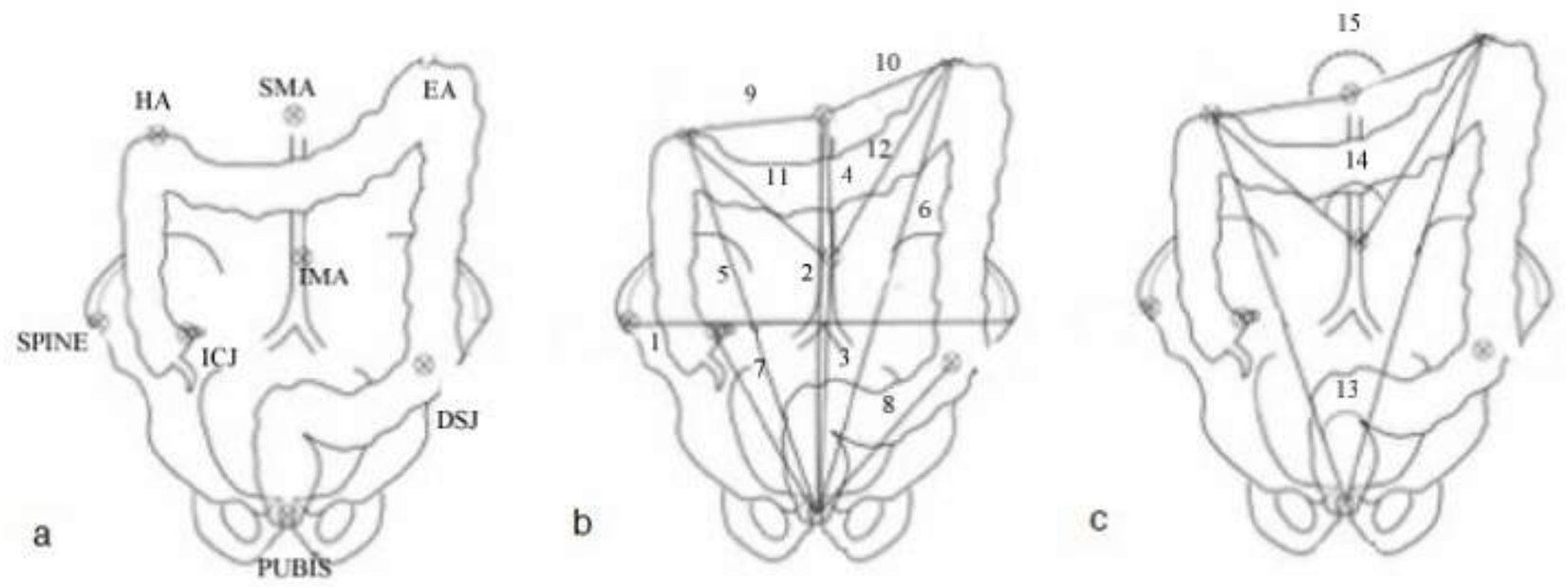

Figure 2. Study variables proposed as benchmarks and as lenght and angle measures.
a: Proposed benchmarks. b: Proposed lenght measures: Lenght SPINE - SPINE (1). Lenght PUBIS - SMA (2). Lenght PUBIS – IMA (3). Lenght SMA – IMA (4). Lenght PUBIS – HA (5). Lenght PUBIS – EA (6). Lenght PUBIS – ICJ (7). Lenght PUBIS - DSJ (8). Lenght SMA – HA (9). Lenght SMA – EA (10). Lenght IMA – HA (11). Lenght IMA – EA (12). c: Proposed angle measures: Angle HA – PUBIS – EA (13). Angle HA – SMA – EA (14). Angle HA – IMA – EA (15).

RESULTS: ***Cadaver`s Radiologic Study*** – Of the 450 measurements performed, 202 were modified between 5% and 9,99%, and 112 were modified above 10%, in the different series that changed the conditions. The greatest differences were observed between the pubis and both mesenteric arteries, and between them and the colon`s angles. ***Patient`s Radiologic Study*** – An important anatomic variability was observed. Significant differences appeared on measurements after patients were grouped by gender, age and body mass index.

Figure 3. Cadaver`s Radiologic Study – Colon surface tridimensional reconstruction in the three human cadavers.

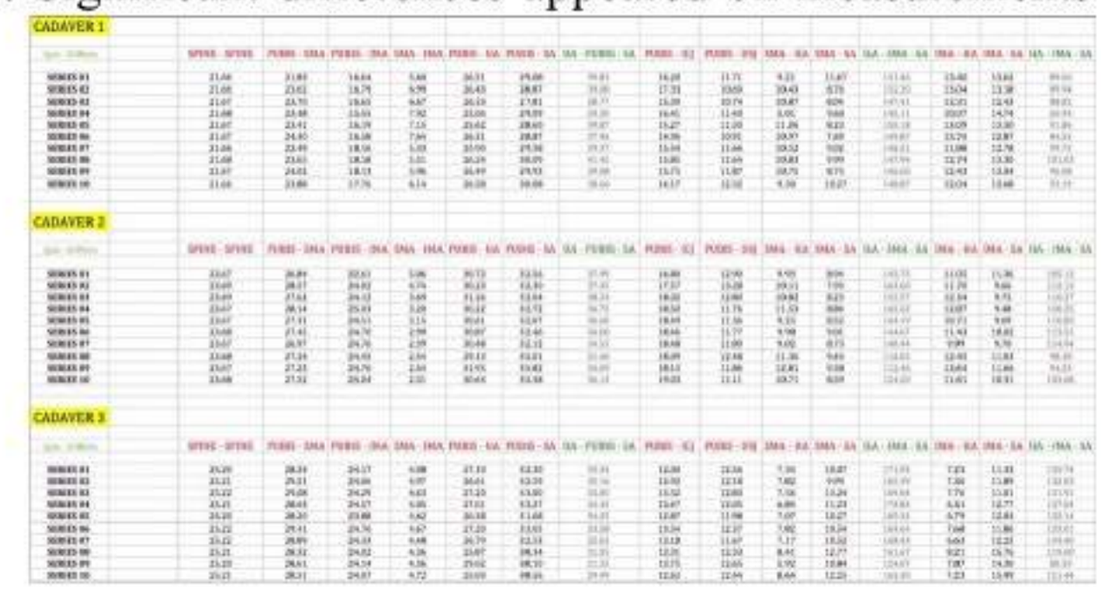

Figure 4. Cadaver`s Radiologic Study – Measurements.

	MEN MEAN ± SD RANGE (IR)	WOMEN MEAN ± SD RANGE (IR)	test	p
AGE	63,40 ± 15,43	65,54 ± 17,72	-0,635*	0,526
BMI	28,53 (5,71)	24,09 (8,56)	-0,759**	0,448

	MEN MEAN ± SD RANGE (IR)	WOMEN MEAN ± SD RANGE (IR)	test	p
SPINE - SPINE	21,07 ± 2,32	21,48 ± 2,27	-0,869*	0,386
PUBIS - SMA	23,71 ± 2,66	24,36 ± 1,75	-1,766*	0,80
PUBIS - IMA	16,62 ± 2,24	17,98 ± 1,70	-3,904*	<0,001
SMA - IMA	7,14 ± 1,07	6,32 ± 1,22	3,688*	<0,001
PUBIS - HA	24,25 ± 4,09	22,75 ± 3,38	2,161*	0,33
PUBIS - EA	29,70 ± 3,63	27,76 ± 3,35	2,88*	0,005
HA - PUBIS - EA	38,79 ± 7,71	36,50 ± 5,69	1,844*	0,67
PUBIS - ICJ	14,63 ± 3,56	12,75 ± 3,45	2,948*	0,004
PUBIS - DSJ	14,76 ± 1,83	14,13 ± 2,01	1,247*	0,215
SMA - HA	9,38 ± 2,51	9,28 ± 1,85	0,286*	0,776
SMA - EA	10,92 (2,99)	7,06 (2,75)	-4,851**	<0,001
HA - SMA - EA	79,12 (24,25)	83,64 (29,70)	-0,497**	0,619
IMA - HA	11,28 ± 3,00	9,69 ± 2,42	5,385*	0,001
IMA - EA	14,54 ± 2,54	11,38 ± 2,92	6,285*	<0,001
HA - IMA - EA	105,21 (22,95)	106,28 (39,74)	-3,598**	<0,001

	≤ 65 YEARS OLD MEAN ± SD RANGE (IR)	> 65 YEARS OLD MEAN ± SD RANGE (IR)	test	p
SPINE - SPINE	20,55 ± 2,21	21,96 ± 2,17	-3,671*	<0,001
PUBIS - SMA	9,10 (2,52)	10,95 (3,10)	-2,375**	0,018
PUBIS - IMA	17,61 ± 1,91	16,81 ± 2,31	2,148*	0,034
SMA - IMA	6,81 ± 1,21	6,70 ± 1,20	0,516*	0,607
PUBIS - HA	23,25 ± 4,20	24,00 ± 3,64	-1,090*	0,278
PUBIS - EA	29,39 ± 3,64	28,41 ± 3,61	1,545*	0,125
HA - PUBIS - EA	36,05 ± 6,12	39,12 ± 7,65	-2,531*	0,013
PUBIS - ICJ	13,59 ± 3,73	13,99 ± 3,45	-0,633*	0,528
PUBIS - DSJ	14,43 ± 1,90	14,70 ± 1,94	-0,807*	0,421
SMA - HA	8,93 ± 2,40	9,61 ± 2,12	-1,768*	0,080
SMA - EA	9,25 ± 2,15	9,25 ± 2,27	0,002*	0,998
HA - SMA - EA	76,19 (25,90)	83,49 (30,45)	-0,761**	0,446
IMA - HA	9,84 ± 3,00	11,16 ± 2,72	-2,632*	0,10
IMA - EA	13,25 ± 3,15	13,15 ± 3,06	0,183*	0,855
HA - IMA - EA	124,43 (30,81)	108,23 (24,91)	-0,400**	0,689

	NORMAL WEIGHT MEAN ± SD RANGE (IR)	OVERWEIGHT MEAN ± SD RANGE (IR)	OBESITY MEDIA ± SD RANGE (IR)	test	p
SPINE - SPINE	20,43 ± 2,28	21,38 ± 1,99	21,75 ± 2,49	3,483*	0,034
PUBIS - SMA	23,74 ± 2,29	23,70 ± 2,50	24,49 ± 2,11	1,618*	0,202
PUBIS - IMA	8,31 (3,34)	8,69 (2,77)	8,80 (2,41)	1,257**	0,535
SMA - IMA	6,35 ± 1,38	6,92 ± 1,15	7,00 ± 1,02	3,402*	0,036
PUBIS - HA	15,15 (4,90)	18,55 (4,53)	15,87 (4,11)	25,161**	<0,001
PUBIS - EA	27,72 ± 3,80	29,25 ± 3,89	29,36 ± 3,03	2,459*	0,090
HA - PUBIS - EA	36,97 ± 5,55	38,24 ± 7,96	38,02 ± 6,99	0,358*	0,700
PUBIS - ICJ	12,03 ± 3,46	14,13 ± 3,37	14,92 ± 3,55	7,096*	0,001
PUBIS - DSJ	8,31 (2,64)	7,79 (2,29)	10,62 (2,55)	15,162**	0,001
SMA - HA	9,02 ± 2,10	9,41 ± 2,34	9,53 ± 2,28	0,535*	0,587
SMA - EA	8,31 ± 1,94	9,62 ± 2,15	9,56 ± 2,35	4,381*	0,015
HA - SMA - EA	75,23 (28,25)	83,49 (25,89)	76,19 (27,19)	0,299**	0,861
IMA - HA	8,85 ± 2,26	10,97 ± 3,03	11,49 ± 2,62	10,195*	<0,001
IMA - EA	11,86 ± 3,07	13,89 ± 3,15	13,50 ± 2,88	4,829*	0,010
HA - IMA - EA	115,94 ± 28,75	96,86 ± 27,71	95,81 ± 17,82	8,422*	<0,001

Figures 5, 6, 7, 8. Patient`s Radiologic Study – Sample distribution and statistics results by gender, age and body mass index. **: Student t test. **: Mann-Whitney U test.*

CONCLUSIONS: The colon can be studied in its anatomical variability and different placement with three-dimensional reconstruction obtained from CT images, and it undergoes changes that can be related to its position, gender, age and body mass index.