IN VIVO MEASUREMENTS OF UTERINE CAVITIES IN 795 WOMEN OF FERTILE AGE

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ABSTRACT

The uterine sound length, the functional length of the cervix including the zone of internal cervical os and the fundus transversal were determined in 795 fertile women in vivo using a measuring device, the Cavimeter. The functional cavity length was calculated by subtracting the functional length of the cervix from the uterine sound length.

With growing parity, the uterine length and width increase, but with advance in age, the uterine cavity changes are not so distinct.

The wide ranges found by the investigation demonstrate the individuality of the uterine cavity and the desire to measure it prior to fitting an IUD. The use of adapted IUDs according to the size of the uterine cavity leads to a remarkable reduction of side effects, particularly expulsion, bleeding and cramps caused mainly by dimensional incompatibility. Therefore prefit uterine cavity measurement can lead to better efficacy of IUDs, increased rates of acceptance and higher continuation rates.

INTRODUCTION

In spite of its increasing use (1) as one of the most important reversible method for the regulation of human fertility, intrauterine contraception is permanently hampered by relatively high rates of unwanted side effects, even after introduction of the smaller, copper-bearing IUD.

Since 1969 some investigators have reported the possible connections between these unwanted side effects and the dimensional incompatibility between the inserted IUDs and the individual uterine cavities of different shapes and sizes (2,3). They demonstrated the frequency of IUD-associated bleeding and pain was probably related to the disparity between the size of the uterine cavity and the inserted IUD.

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Wheeler and co-workers (4) evaluated certain mechanical properties of an IUD, e.g. size, thickness, surface area, volume, transversal and longitudinal compression, which could predict expulsion, pregnancy, bleeding and pain.

Hasson and co-workers (5) recorded significantly higher rates of pregnancy, expulsion or removal for medical reasons, when the length of the IUD was two or more centimeters longer or shorter than the length of the endometrial cavity. Wang (6) found that expulsion was more likely to occur, when the fundus transversal diameter was too short or too long beyond the normal range, thus requiring that the endometrial cavity should be measured with a proper uterine metrology device.

Several studies (7,8) proved that IUDs, e.g. Lippes Loops, decrease their failure rates with the increase of size and surface area. On the other hand, the proportion of unwanted side effects increases with enlargement of the size of the IUD.

Copper is being considered as an additional factor for decreasing the pregnancy rates because of its spermatotoxic/blastocystotoxic effects. However, Zipper and co-workers (9) demonstrated the efficacy of copper wire of 32 cm in length and a surface area of 200 mm^2 wound only around a narrow polyethylene thread. During a period of 348 women-months, the pregnancy rate was 3.4% per year of use. Hence, the use of copper allows the plastic carrier to be reduced to smaller sizes with lower irritation potential and a reduction of side effects without loss of safety. This was confirmed experimentally in Rhesus monkeys (10) and in a pilot study, in the course of which 1709 uterine cavities of fertile women were fitted with a Multiload 250 standard, 7 Cu 200 and T Cu 200 IUDs. The transversal arms of the latter were shortened according to the measurements gained by the Cavimeter. This measuring device was invented to determine the uterine sound lengths and the various transversals of the uterine cavity (11).

The reduced rates of side effects in the group with the adapted TCu 200 IUDs led us to determine the longitudinal distances and the fundus transversal of the uterine cavity in 795 cases of fertile women in vivo.

METHODS

Figures 1 and 2 demonstrate, how different lengths of the cervico-uterine axis, the length of the fundus transversal and the connection between the cavital parts of the utero-tubal junctions were determined by means of the Cavimeter (Figures 3 - 5). The values of the different axial lengths were to be rounded off, because exact determination of decimal points was not possible as in the case of fundus transversal. The procedure was carried out on day 4 to 7 of the menstrual cycle in most cases, at least 5 weeks post-abortion and 6 or more weeks after delivery.

The Cavimeter was tested earlier by means of sonography, proving the correct distances between the tips of the wings by sonographically visible thread. Measurements also coincided with those of premenstrual endometrial cavities (Figure 6).

To determine the distance between the utero-tubal junctions, the Cavimeter was cautiously pushed deeper after measuring the fundus transversal, until the investigator felt a resistance. The result was the shortest thread-dependent connection between the cavital parts of the utero-tubal junctions (Figure 2a,5b).

Determination of the utero-tubal junctions was necessary to demonstrate the incorrect, too long measurement of the fundus transversal, particularly in case of the uterus arcuatus or subseptus. Those malformed uteri were detected by the tip of the tube of the Cavimeter I or the tips of the Cavimeter II, the latter can be used like an uterine probe (Figure 3). In case of an arcuate or subseptate uterus, the difference of the connection between the utero-tubal junctions and the fundus transversal was +5 mm to +15 mm determined with the thread using Cavimeter I.

The values found were transferred on a fact sheet (Figure 7).

Approximately 2-3 ml Mepivacaine 3%, local anesthetic solution, was administered by the Jet method particularly in nulliparous women prior to the measurements.

RESULTS

The frequencies and the distributions of the total length, the functional length of the cervix including the zone of the internal cervical os and the functional length of the uterine cavity are shown in Figure 8a-c. By definition, the functional length of the uterine cavity generally is shorter than the length of the endometrial cavity.

Frequency and distribution of the fundus transversal are demonstrated in Figure 8d.

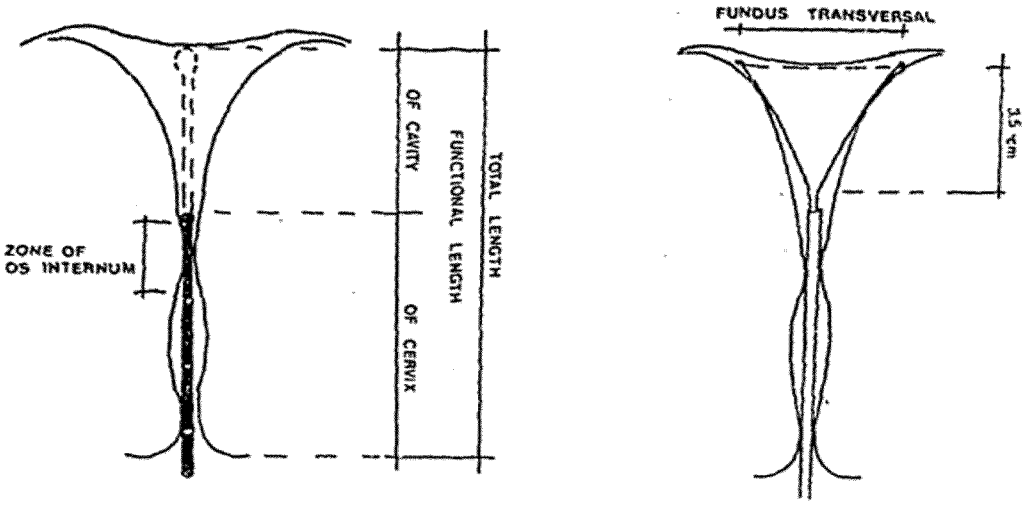


Figure 1. Longitudinal and transversal measurement.

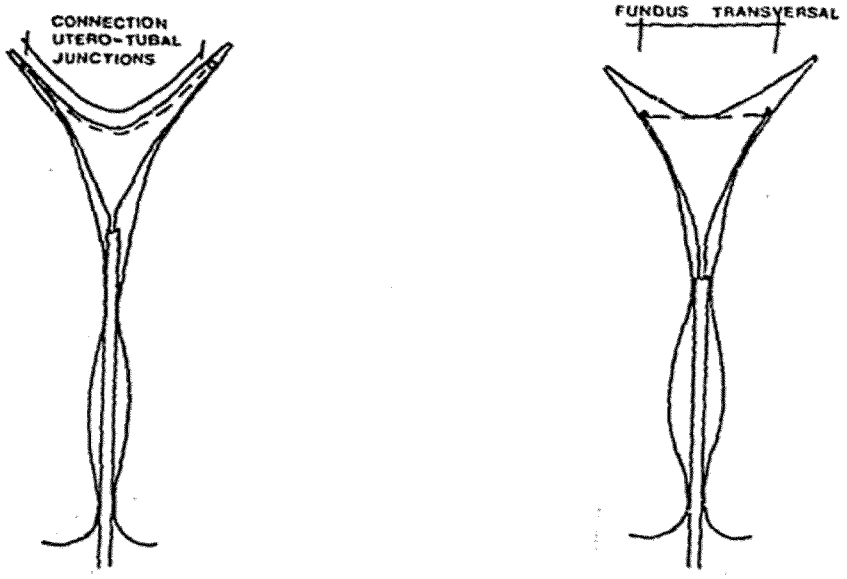


Figure 2.

(Left) Uterus arcuatus or subseptus. Incorrect measurements by pushing the Cavimeter deeper after release of the wings.

(Right) Correct measurement of the fundus transversal.

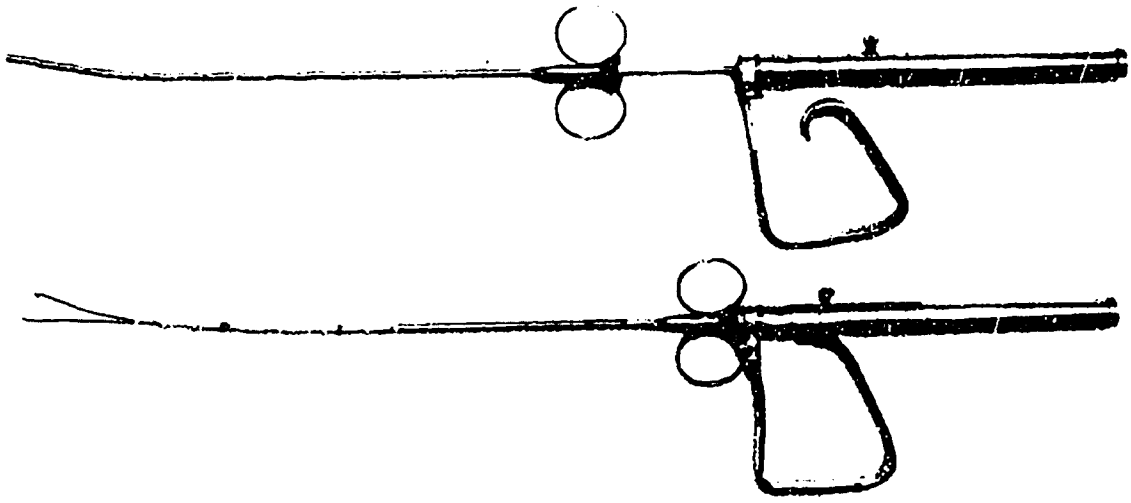


Figure 3.

(Top) Cavimeter in the process of measuring the different lengths of the uterine axis.
(Bottom) Process of transversal measurement after retracting the tube, which is of plastic for this type of Cavimeter.

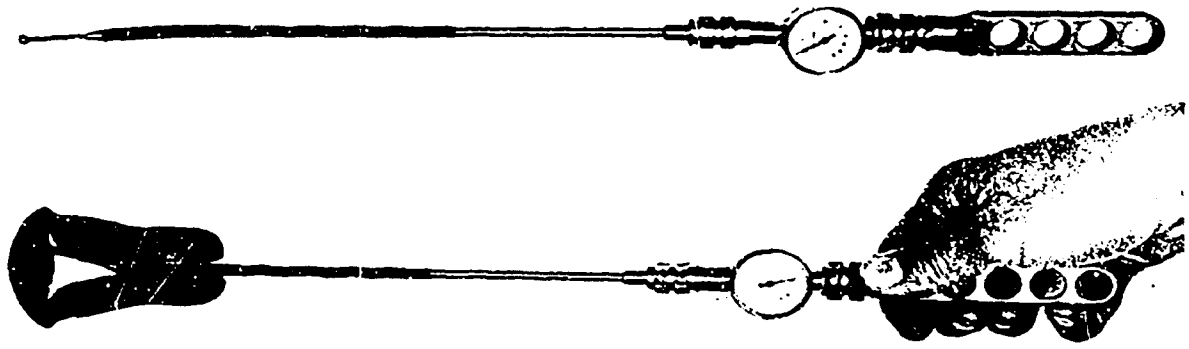
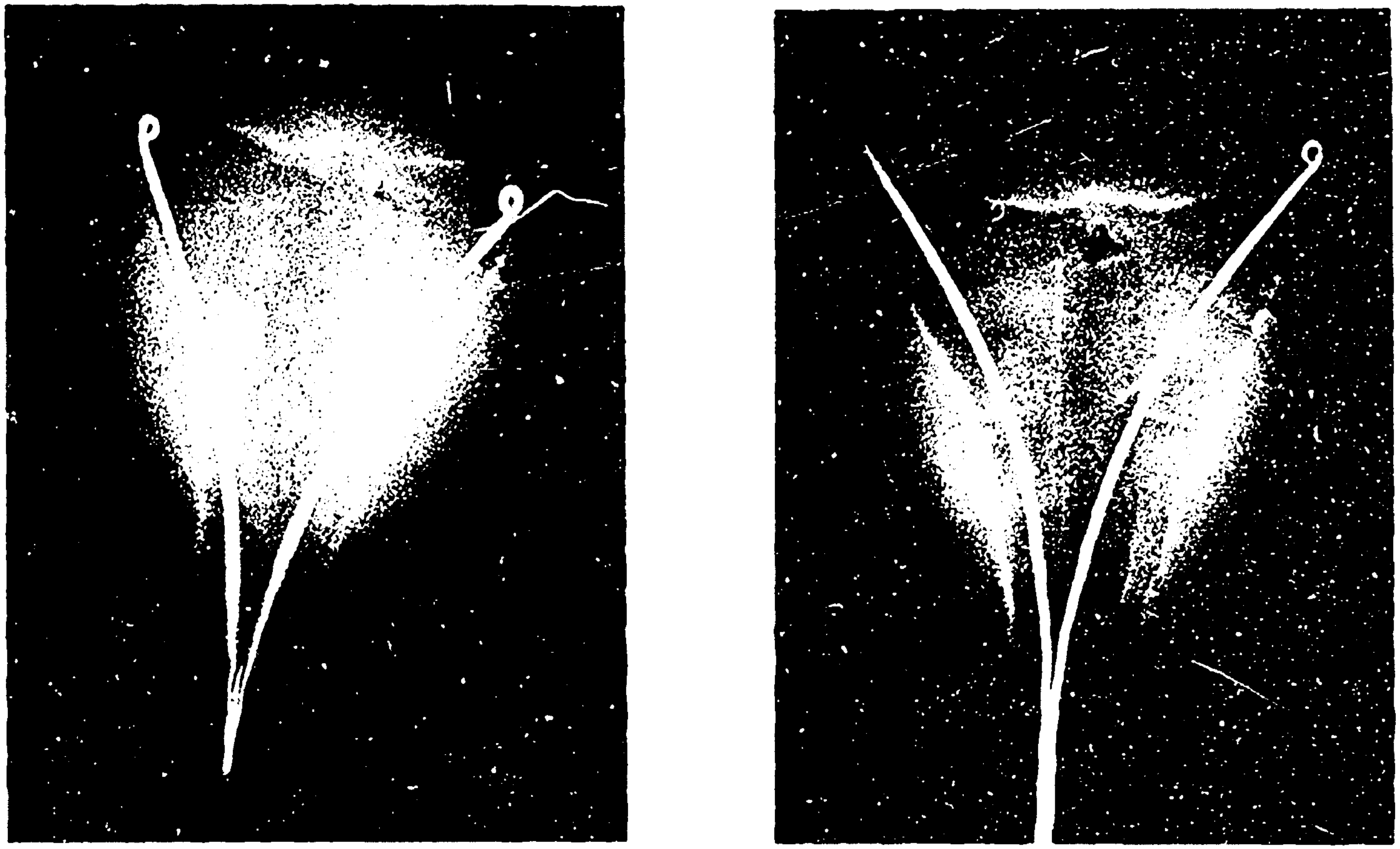


Figure 4.

(Top) Cavimeter II, process of depth measurement.
(Bottom) Process of measuring the fundus transversal. The 4-mm long extensions of the thickened tips of the wings avoid penetration into the utero-tubal junctions.



a b

Figure 5.

X-ray photos demonstrate the correct measurement of the fundus transversal (a) and the shortest distance between the utero-tubal junctions caused by pushing the instrument deeper after release of the wings (b, incorrect measurement).

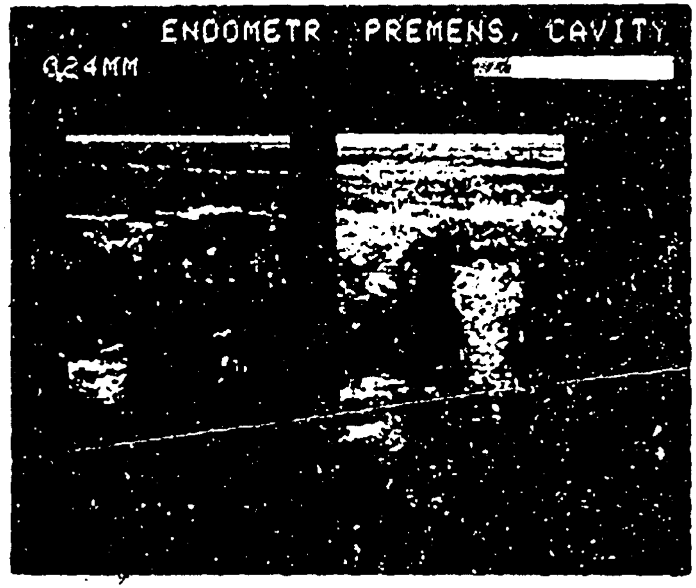


Figure 6.

Ultrasonography demonstrates form and size of a premenstrual cavity. The fundus transversal determined by a Cavimeter revealed 26 mm.

Date:
Name:
Date of birth: . .
Parity / Abort: /
OP D+S: D+C: Sect:
Others: e.g. Con.

Longitudes mm
Uterine sound length (USL) :
Cervical length +Zone os internum (Ce.L) :
Cavity length (Difference) (Ca.L) :

T_1 Fundus transversal :
T_2 1 cm (minus) :
T_3 2 cm " :
T_4 3 cm " :
Ø os internum (diam.) :

Versio A ☐ O ☐ R ☐
Flexio A ☐ O ☐ R ☐

Uterus: arcuatus ☐
subseptus ☐

Remarks:

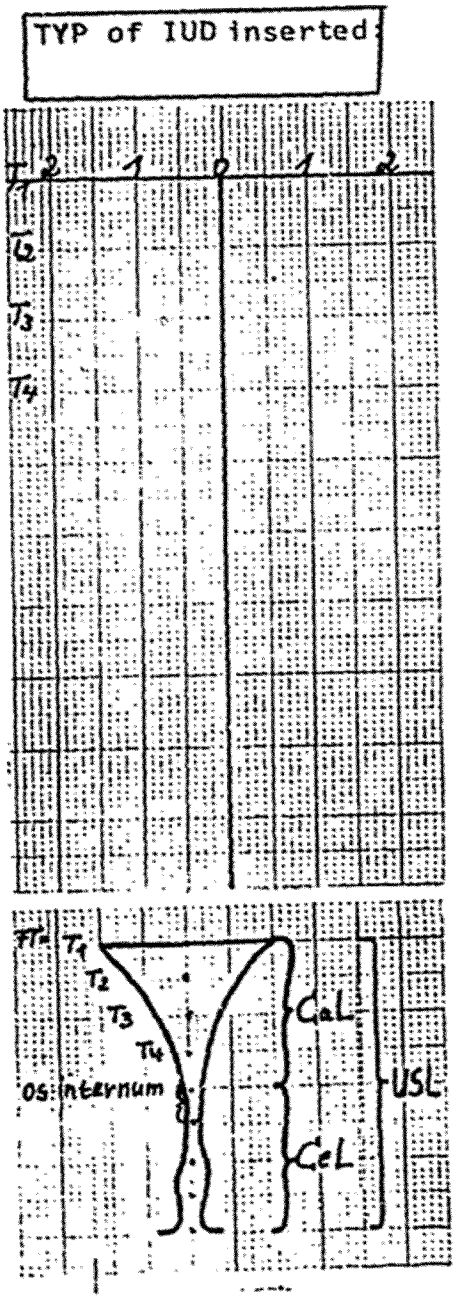


Figure 7.

Uterus and uterine cavity fact sheet.

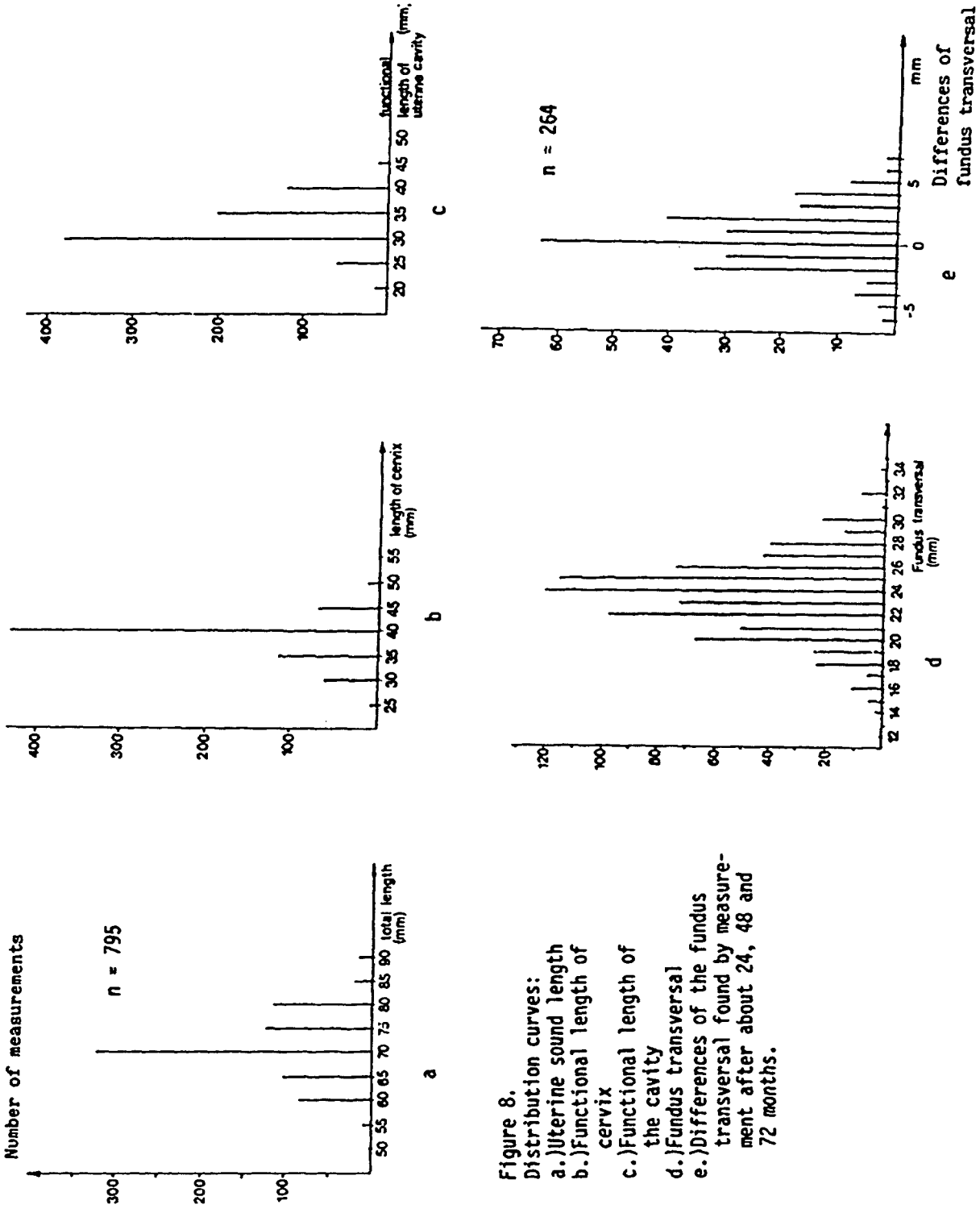


Figure 8.
Distribution curves:
a.)Uterine sound length
b.)Functional length of cervix
c.)Functional length of the cavity
d.)Fundus transversal
e.)Differences of the fundus transversal found by measurement after about 24, 48 and 72 months.

Tables I and II and Figure 9 demonstrate that the functional length and the fundus transversal of the uterine cavity increase with the number of parity, whereas age has not such a distinct influence. After age 35 (+) particularly the cavity length is reduced reflecting the shrinking uterus due to the decreasing levels of the female sex hormones. However, firm conclusion cannot be drawn, as there were only few women of age 35 and above.

DISCUSSION

There are doubts concerning the usefulness of measurements of the uterine cavity because of its cyclic change.

Therefore, measurements of the uterine cavity were taken in 6 fertile women on day 15 and 25 of the last cycle and on day 5 to 7 of the following cycle prior to insertion of an adapted IUD. Deviations of the fundus transversal of 0 (zero) to $\pm$ 3 mm could only be found probably partly due to the measuring procedure. The deviations of the functional length of the cavity varied from 0 to $\pm$ 5 mm. The intrauterine length seems not to be of such clinical importance as the fundal width, because the stems of the various copper IUDs may slide through the regularly more than 3 mm wide os internum. At the oviduct angles the anatomical facts are different due to the narrow utero-tubal junctions with their triggered nervous complexes. During labour, contractions commence at this sensitive area. T-devices can also induce strong contractions, if the tips of the transversal arm irritate the tissue of the oviduct angles or the utero-tubal junctions. We have even found transversal arms of T-devices reaching into the isthmical part of a tube after penetration of the utero-tubal junctions.

The mean value of the fundus transversal of 24.6 $\pm$ 2.9 mm corresponds with findings of Reynoso and co-workers (12), who detected, with the help of the Batelle Caliper device, in 583 Mexican women the fundus transversal being 24.5 mm in nullipara and 26.7 mm in para 5 or more. They concluded that the IUDs, distributed in their country, were too large for the uterine cavities of Mexican women.

Since contractions causing pressures between 50 mm up to 150 mm (+) Hg with low frequency occur during the first days of menstruation (13), no measurements should be taken to determine the mean values of the size of the uterine cavity during that phase. Determinations should be made during the end-phase of menstruation, the bleeding-free follicular phase or during the luteal phase of the cycle. Cyclic changes, e.g. the increased basal pressure during periovulation, did not show a distinct influence on the results of the measurement of the uterine cavity in our study.

Table I. The mean values ± SD (standard deviation) of the functional length of the uterine cavity in millimeter and the 95% confidence limits, relating to parity and age. n = Number of women; 0.1 (+) = no parity, one abortion or more.

Parity / Age	0.0 X ± SD	0.1 (+)	1	2	3 (+)	AGE
15 - 19	32.0 ± 3.8	33.3 ± 5.8				32.7 ± 4.0
n	25	3				28
95% cl	30.2 - 33.6	19.0 - 47.7				31.1 - 34.2
20 - 24	32.1 ± 4.1	32.2 ± 5.4	33.8 ± 4.8		37.5 ± 3.5	33.9 ± 4.6
	171	36	12		2	221
	31.5 - 32.6	30.5 - 34.0	31.0 - 36.6		5.7 - 69.3	33.3 - 34.5
25 - 29	31.5 ± 4.5	32.8 ± 4.5	34.5 ± 4.9	35.8 ± 4.9	35.0 ± 7.1	33.9 ± 4.7
	168	27	29	6	2	232
	30.8 - 32.1	31.0 - 34.5	32.6 - 36.3	30.6 - 41.0	-28.0 - 98.5	33.3 - 34.5
30 - 34	32.5 ± 4.8	33.4 ± 4.7	33.8 ± 5.1	33.4 ± 5.6	36.7 ± 2.9	34.7 ± 5.1
	87	34	32	19	3	175
	31.5 - 33.6	31.8 - 35.0	32.0 - 35.5	34.7 - 40.1	29.5 - 43.8	33.9 - 35.5
35 - 39	31.3 ± 3.8	31.5 ± 6.1	31.5 ± 3.7	34.2 ± 4.6	36.7 ± 2.9	33.0 ± 4.8
	32	17	20	24	3	96
	30.0 - 32.6	28.1 - 34.9	29.8 - 33.2	32.2 - 36.1	29.5 - 43.9	32.1 - 34.0
40 +	31.5 ± 4.7	30.7 ± 5.4	31.5 ± 5.3	33.5 ± 5.6	26.7 ± 2.9	30.7 ± 4.9
	10	7	10	13	3	43
	28.1 - 34.9	25.8 - 35.7	27.7 - 35.3	30.1 - 36.8	19.5 - 33.9	36.3 - 37.2
PARITY	31.8 ± 4.8	32.3 ± 5.1	33.0 ± 4.8	35.2 ± 5.4	36.9 ± 5.6	33.3 ± 2.0
	493	124	103	62	13	795
	31.4 - 32.1	31.4 - 33.2	32.1 - 33.9	33.9 - 36.6	33.5 - 40.3	33.1 - 33.4

Table II. The mean values ± SD (standard deviation) of the fundus transversal in millimeter and the 95% confidence limits, relating to parity and age. n = Number of women; 0.1 (+) = no parity, one abortion or more.

Parity / Age	0.0 $\bar{X} \pm SD$	0.1 (+)	1	2	3(+)	AGE
15 - 19 n 95% cl	22.9 ± 2.2 25 22.0 - 23.2	26.7 ± 2.5 3 20.4 - 32.9				24.8 ± 2.5 28 23.8 - 25.8
20 - 24	23.5 ± 3.0 171 23.0 - 23.9	23.3 ± 3.3 36 22.2 - 24.8	24.5 ± 2.5 12 23.0 - 26.0		24.5 ± 0.7 2 18.1 - 30.9	23.9 ± 3.0 221 23.5 - 24.3
25 - 29	23.2 ± 3.2 168 22.7 - 23.7	23.5 ± 3.2 27 22.3 - 24.7	24.0 ± 1.90 29 23.7 - 25.1	22.1 ± 2.2 6 23.1 - 28.5	26.0 ± 1.4 2 13.3 - 38.9	24.6 ± 3.2 232 24.2 - 25.0
30 - 34	23.1 ± 3.2 87 22.4 - 23.8	24.1 ± 3.4 34 22.9 - 25.2	24.4 ± 3.8 32 23.1 - 25.7	26.4 ± 2.7 19 25.1 - 27.7	25.3 ± 3.1 3 17.7 - 32.9	24.7 ± 3.3 175 24.2 - 25.1
35 - 39	23.1 ± 3.0 32 22.0 - 24.3	24.2 ± 3.5 17 22.4 - 26.0	24.4 ± 2.8 20 22.0 - 25.7	25.3 ± 3.7 24 23.8 - 26.9	27.3 ± 3.1 3 19.7 - 34.9	24.9 ± 1.1 96 24.6 - 25.1
40 +	22.8 ± 3.4 10 20.4 - 25.2	20.9 ± 1.95 7 19.1 - 22.7	25.0 ± 2.4 10 23.3 - 26.7	25.1 ± 4.8 13 22.2 - 27.9	27.0 ± 2.0 3 22.0 - 32.0	24.0 ± 3.8 43 22.9 - 25.1
PARITY	23.1 ± 3.1 493 22.8 - 23.6	23.8 ± 3.3 124 23.2 - 24.3	24.5 ± 3.0 103 23.4 - 25.1	25.7 ± 3.5 62 14.8 - 26.0	26.0 ± 2.3 13 24.7 - 27.4	24.6 ± 2.9 795 24.4 - 24.8

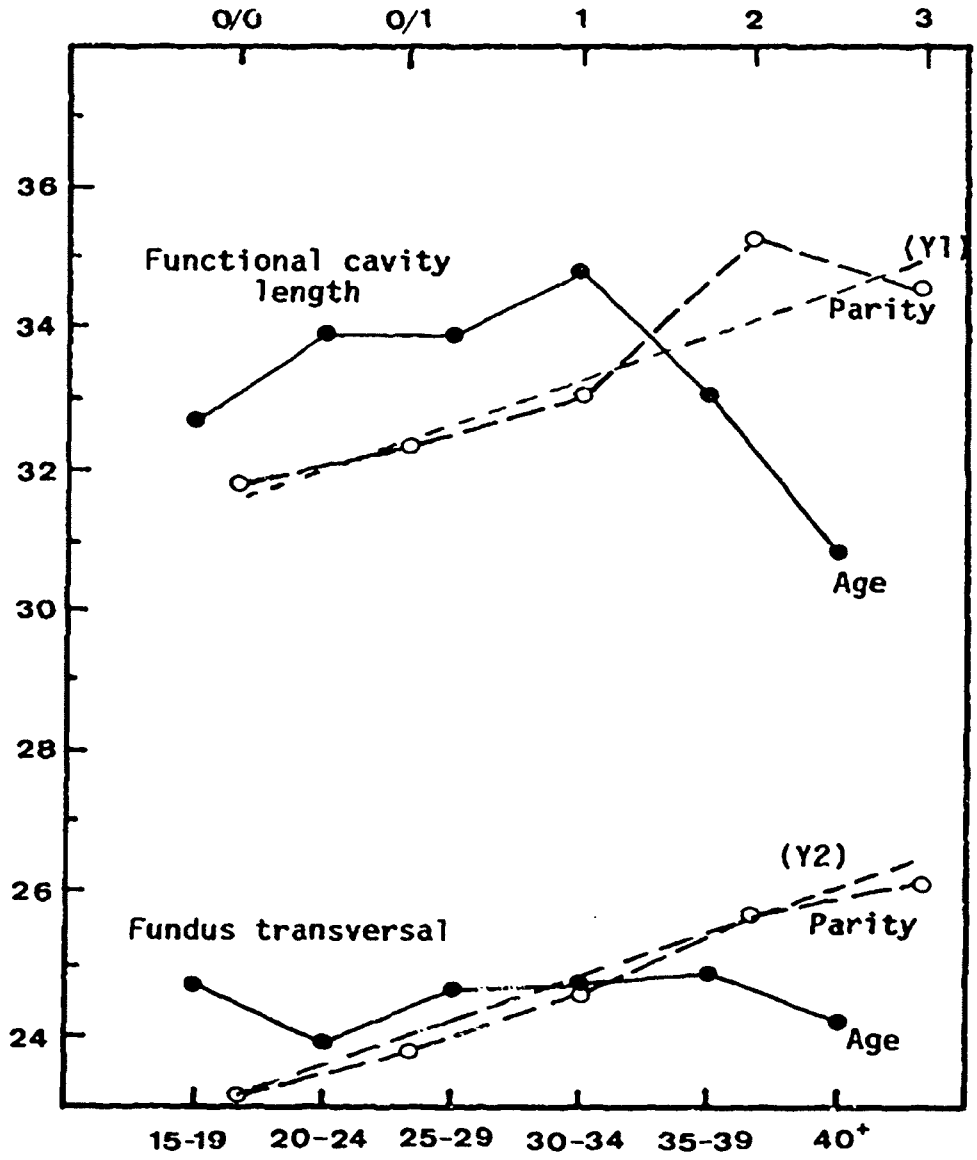


Figure 9.

Functional uterine cavity lengths (F CaL) and the lengths of the fundus transversal (FT) relating to age and parity. Straight broken line: Using the linear regression method, the results are represented by linear equations (F CaL) Y1 = 30.888 + 0.826x with correlation of 0.91 and (FT) Y2 = 22.279 + 0.779x with correlation of 0.99.

Additionally, the adapted medicated IUD should be some millimeters smaller in its dimensions than the size of the uterine cavity found during measurements between day 5 to day 7 of the cycle. Therefore, spatial tolerance avoids dimensional incompatibility during the initial phase of menstruation with its stronger contractions of the uterine muscle.

Further results showing a relative stability of the size of the individual cavity were found through measurements mainly after about 24, 48 and 72 months, when the copper IUD was to be changed in 264 women. The results are shown in Figure 8c.

The frequency and distribution of the uterine sound length, the functional cervical length, the functional cavity length and the length of the fundus transversal demonstrate the ultimately individual size of the uterine cavity. Hence, the use of IUDs of at least 2 to 3 sizes and the required lengths and widths measurements of the uterine cavity prior to fitting the IUD to reach dimensional compatibility throughout the cycle, seems to be justified.

Penetrating, anchoring mechanisms of the plastic part of a medicated IUD may be at least partly responsible for more frequent and stronger contractions, bleeding, destroying of the mucosal cervical plug, ascension of pathological germs and change of the local immune system.

IUDs which are too large, T devices with a horizontal arm of 32 mm, lead in some cases to a stop of one arm at the lateral muscular wall. The stem of the IUD shifts to the opposite. X-ray reveals a lateral dislocation, which may partly be responsible for pregnancies. Lateral dislocation is avoided by a new insertion procedure with the Nova T, which promptly showed a reduced failure rate in a multicentric clinical study (14).

REFERENCES

1. Liskin L., Fox G.: Intrauterine Devices, Population Reports Series B, No. 4, 1982

2. Tejuja S., Malkani P.K.: Clinical significance of correlation between size of uterine cavity and IUD: a study by planimeter-hysterogram technique. Am J Obstet Gynecol 105:620, 1969

3. Kamal I., Hefnawi F., Ghoneim M. et al.: Dimensional and architectural disporportion between the intrauterine device and the uterine cavity: a cause of bleeding. Fertil Steril 22:514, 1971

4. Wheeler R., Buschbom R.L., Marshall R.K.: Rational basis for IUD design and development. In: Intrauterine Devices: Development, Evaluation and Program Implementation (eds. R.G. Wheeler, G.W. Duncan and J.J. Speidel). New York, Academic Press, 1974

5. Hasson H.M., Berger G.S., Edelman D.A.: Factors affecting IUD performance. I: endometrial cavity length. Am J Obstet Gynecol 126:973, 1976

6. Wang J.G.: Development of a new method of insertion of IUDs. Contraception 25:405, 1982

7. Hefnawi F., Yacont M.M., Hosni M., El-Sheika Z., Hassanein M.: Medicated intrauterine devices to improve bleeding events. Int.J. Gynaecol. Obstet. 15:79, 1977

8. Tietze G., Lewit S.: Evaluation of Intrauterine Devices: Ninth Progress Report of Cooperative Statistical Program. Stud. Fam. Plan. No. 59, July 1970

9. Zipper J., Edelman D.A., Goldsmith A.: An overview of IUD research and implications for the future. Int. J. Gynaecol. Obstet. 15:73, 1977

10. Shaw S.T., Jr., Forino R.V., Poon C.H.,Moyer D.L.: Influences of copper and design of intrauterine devices on endometrial bleeding in monkeys. Contraception 14:9, 1976

11. Kurz K.H.: IUD Physiology: Avoidance of the dimensional incompatibility as the main reason for side effects in intrauterine contraception. Contracept. Deliv. Syst. 2:21-29, 1981

12. Reynoso L., Zamora G., Gonzalez-Diddi M., Lozano M., Aznar R.: Uterine cavity measurement in Mexican women performed with Batelle wing sound. Contracept. Deliv. Syst. 3:Expanded abstract No. 182, 1982

13. Akerlund M., Bengston L.P., Ulmsten U.: Recording of myometrial activity in the non-pregnant human uterus by a micro-transducer catheter. Acta Obstet. Gynaecol. Scand. 57:429, 1978

14. Nielsen N.C., Pyrörälä T., Allonen H., Nygren K.G., Lukkainen T.: Four years of a comparative study with Nova T and Copper-T 200 IUDs. Contraception 26:29, 1982