Research Square

Preprints are preliminary reports that have not undergone peer review.
They should not be considered conclusive, used to inform clinical practice,
or referenced by the media as validated information.

A New Non-invasive Micturition Graphs Measurement

Xiaohua Yang
Jianlin Xie
Rong Ma
Peng Zhou
Xian Chen
Tongxin Yang
Haifeng Zhong
Xiande Huang
huangxiande720@163.com

Research Article

Keywords: Bladder outflow obstruction (BOO), Expedite flow (EF), Micturition graph, Multi-parameter composite function formula chain, Non-invasive Q-v measurement, The small flow quantity (urine) hydromechanics

Posted Date: July 30th, 2026

DOI: https://doi.org/10.21203/rs.3.rs-10180778/v1

License: This work is licensed under a Creative Commons Attribution 4.0 International License.
Read Full License

Additional Declarations: No competing interests reported.

A New Non-invasive Micturition Graphs Measurement

Abstract

Objectives: The small flow quantity (urine) hydromechanics is taken as the first principle, micturition graph was established by multi-parameter composite function formula chain. The micturition graph can provide doctors with voiding function diagnosis.

Method: A new micturition graphs Q-v equipment is used to measure the actual patients voiding, using the multi-parameter composite function formula chain, to obtain the six point report and the the four micturition graphs so as to provide doctors with clinical medical voiding function diagnosis. From June 2024 to February 2025, 520 patients, including 456 male adults, 47 female adults, 17 male and female children and adolescents, were measured by Q-v equipment.

Results: Apply to micturition graphs in 520 patients allow for the qualitative and quantitative were evaluated the degree of BOO and EF. The micturition weakness, micturition enhancement, and normal micturition can also be qualitatively and quantitatively evaluated using the micturition power (Nves).

Conclusion: A new non-invasive Q-v equipment were measured the actual patients voiding. A new micturition graph is very good theory and method and to provide doctors with voiding function diagnosis.

Key word：Bladder outflow obstruction (BOO)；Expedite flow (EF) ； Micturition graph ； Multi-parameter composite function formula chain ； Non-invasive Q-v measurement ； The small flow quantity (urine) hydromechanics

Introduction

The Phenomenon of all things are with mathematical connection, which were discovered cognition or were undiscovered cognition. The discover of the micturition graph involves that the cognition is associated with mathematical formulas. When the maximum urine flow rate (Q_{max}), $Q = Q_{max}$, The voiding urodynamics realizes micturition energy conservation [6] symmedrical mathematical formula:

Generated energy ----------Consumed energy

$$Pdet \cdot Q + Pabd \cdot Q = Ndet + Nabd = Nves = Pves \cdot Q = Ndif + No = Pdif \cdot Q + Po \cdot Q. \quad (1)$$

$$Nves = Pves \cdot Q. \quad (2)$$

$$Eves = Pves \cdot v. \quad (3)$$

$$No = Po \cdot Q. \quad (4)$$

$$Cmax = v \cdot Q. \quad (5)$$

The theory of small flow quantity (urine) hydromechanics is taken as the first principle and is introduced here. When $Q=Q_{max}$, the F value [3] of that urine flow line is determined by the Q as regular standard cylindrical shape (Fig. 1.). The following

mathematical formula can be established:

$$Q = V/t = A \bullet v = r2\ \pi \bullet v = [(F/10) / 2\pi]^2 \cdot \pi \cdot v\ . \quad (6)$$

Then obtain Q and v: $F = 20 \cdot (k \cdot Q \cdot \pi / v_{.reality})^{0.5}$. (7)

Note: Q is urine flow rate (ml/s), $Q = Q_{max}$, V is urine volume (ml), t is time (second), A is area (cm^2), v is urine flow velocity (cm/s), r is radius (cm), F is urine flow line F value [3] (F= mm, the circumference mm of the circular surface), k is sliding coefficient (k=Q/30), When $Q \geq 30$ ml/s, k=1.

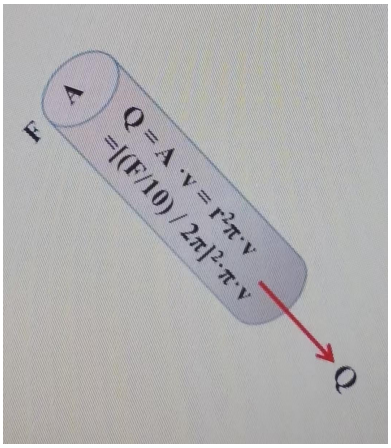


Fig. 1. Anatomy Q, $Q = A \cdot v = r^2\pi \cdot v = [(F/10) / (2\pi)]^2 \cdot \pi \cdot v$. (6)
$F = 20 \cdot (k \cdot Q \cdot \pi / v)^{0.5}$. (7)

We have successfully migrated from the hydromechanics formula or Blasiu's [1] formula to the voiding urodynamics the formulas:

$$Pdif = (0.316/Re^{0.25}) \cdot [L/2r] \cdot [Q^2/(A^2 \cdot 2 \cdot 980)].\ [1] \quad (8)$$

$$Pdif = (0.316/\ Re^{0.25}) \cdot [L/\ (2F/20\pi)] \cdot [Q^2/(\pi^2 \cdot r^4 \cdot 2 \cdot 980)]. \quad (9)$$

$$Pdif = (0.316/\ Re^{0.25}) \cdot [L/\ (2F/20\pi)] \cdot \{Q^2/[\pi^2 \cdot (F/20\pi)^4 \cdot 2 \cdot 980]\}. \quad (10)$$

$$Pdif = [1+(1.2/Q)] \cdot 258\pi^3\ LQ^2/(Re^{0.25} \cdot F^5).\ [2] \quad (11)$$

$$R = Pdif/Q^2 = [1+(1.2/Q)] \cdot\ 258\pi^3\ L/[\ (5000Q/F)^{0.25} \cdot F^5]. \quad (12)$$

Note: L is urethral length (cm). R is urine flow resistance [H= $cmH_2O/(ml/s)^2$], [1+(1.2/Q)] is collapse tube (soft tube) coefficient. $\xi = [1+(1.2/Q)]$. (13)

Re were Reynolds numbers, [4] $Re = 5000Q/F$. (14)

$4000 < Re < 10^5$, It is a smooth region of turbulent as rolling urine flow. When $Q \leq 4$ ml/s, $Re < 4000$. The above Blasiu's [1] formula could not be used to calculate the voiding urodynamic parameters!

We were calculated according to pressure difference (Pdif) to apply tangent trigonometric function (*Po*=tanα°×*Pdif)* to obtain urethral outlet pressure *Po* (Fig. 6.). The tangent trigonometric function formula:

$$tana°=Po/Pdif. \quad (15)$$

$$Po = tana°\cdot Pdif. \quad (16)$$

R units: $H = cmH_2O/(ml/s)^2 = g\cdot cm^{-8}\cdot s^2$.
N units: $y = cmH_2O\cdot ml/s = (g/cm^2)\cdot(cm^3/s) = g\cdot cm/s.$ $10000\ y \approx 1$ W (Watt).
E units: $u = cmH_2O\cdot cm/s = (g/cm^2)\cdot(cm/s) = g / (cm\cdot s).$
Q units: $ml/s = A(cm^2)\cdot v(cm/s) = cm^3/s.$ $\{ Q = r^2\pi\cdot v = [(F/10) / (2\pi)]^2\cdot\pi\cdot v. \}$
Re were Reynolds numbers, not units, as constant. *L* units: cm.
F units: (*F*) = mm. *v* units: cm/s. *P* units: $cm.H_2O$. *Cmax* units: m = ml/s·cm/s.
Argument: $N = P\cdot Q$. *N* (power) = *P* (pressure)·*Q* (urine flow rate). [6] (17)

$$P = f/A = f\,(\text{force})\,/A(\text{area}). \qquad f = P\cdot A. \quad (18)$$

$$Q = v\cdot A = v\ (\text{urine flow velocity})\cdot A\ (\text{cross-sectional area}). \quad v = Q/A. \quad (19)$$

$$N\ (\text{power}) = f\ (\text{force})\cdot v\ (\text{urine flow velocity}). \qquad N = f\cdot v\ . \quad (20)$$

Substitute (17), (18) into (20): $N = f\cdot v = P\cdot A\cdot Q/A = Q\cdot P$. (21)
N units: $y = cmH_2O\cdot ml/s = (g/cm^2)\cdot(cm^3/s) = g\cdot cm/s.$ $10000\ y \approx 1$ W (Watt).

2. Materials and Methods

2.1. Participants (Clinical cases determinations for data)

From June 2024 to February 2025, 520 patients, including 456 male adults, 47 female adults, 17 male and female children and adolescents, were measured by *Q*-*v* equipment (the commodity prototype machine) (Fig. 4.).



Fig. 2. The Mini Anemometer (DT-82), Huashengchang CEM.



Fig. 3. The urodynamic equipment (LUD4100).

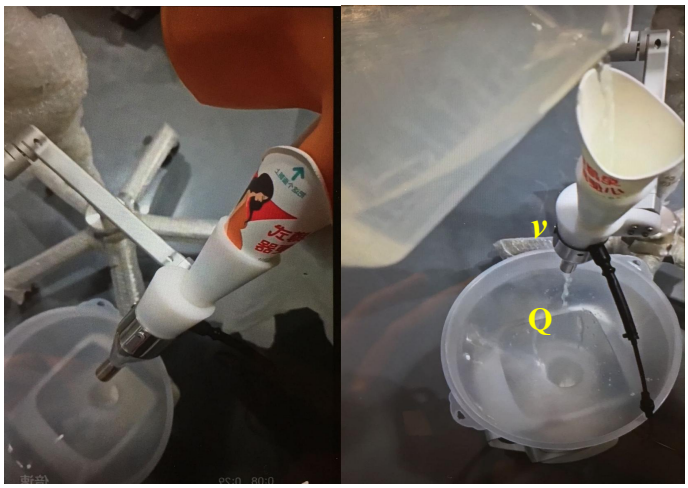


Fig. 4. The commodity prototype machine. At present, the micturition graph equipment are entering the production process procedure, only the commodity prototype machine is available, and there is no sales and circulation.

2.2. Measuring Device and Measure the calculation path and Assessment (technology design)

Use ordinary urodynamic equipment with uroflowmeter (Fig. 3.), The urine flow velocity *(v)* was measured with the DT -82 Mini Anemometer (Fig. 2.) purchased from Shenzhen Huashengchang CEM, and the urine flow rate *(Q)* was measured uroflowmetry (Fig. 3.) only with Wuhan Lidwei Urodynamic equipment (the commodity prototype machine) (Fig. 4.).

F values were obtained from a non-invasive *Q*-*v* determination method：

$F= 20 \cdot (k \cdot Q \cdot \pi / v)^{0.5}$. Then, R is obtained from the migration of the hydromechanics equation which the 258 for small flow quantity (urine) hydromechanics (The voiding urodynamics mathematical formulas):

$$R=[1+(1.2/Q)]\cdot 258\pi^3 L/[（5000Q/F）^{0.25}\cdot F^5]. \text{[2]} \quad (22)$$

Thus, *Pdif* is obtained from *R*:

$$Pdif = R\cdot Q^2 . \tag{23}$$

Finally, Pves is obtained from *Pdif* by adding *Po*:

$$Pves=Pdif+Po.[5] \tag{24}$$

Note: $Po = tana°\cdot Pdif.$ (16)

$$F = 20\cdot(k\cdot Q\cdot\pi/v)^{0.5} = 20\cdot[(Q/30)\cdot Q\cdot\pi/v]^{0.5}. \quad \text{When } Q = Qmax . \tag{25}$$

$$Pdif/Q^2 = R = [1+(1.2/Q)]\cdot 258\pi^3 L/[(5000Q/F)^{0.25}\cdot F^5]. [2] \tag{26}$$

$$Pdif = R\cdot Q^2 . \quad Po = tana°\cdot Pdif. \tag{27}$$

$$Pdif + Po = Pves = Pdif + tana°\cdot Pdif. \tag{28}$$

$$Pdif + Po = Pves = Pdet + Pabd. \tag{29}$$

Note: $Po = tana°\cdot Pdif.$ When $Q = Qmax$. (16)

$$Pdet\cdot Q+Pabd\cdot Q = Ndet+Nabd = Nves = Pves\cdot Q = Ndif+No = Pdif\cdot Q+Po\cdot Q. \tag{1}$$

$$Pdif = Ndif / Q. \tag{30}$$

$$Pves = Nves/Q. \tag{31}$$

$$Pdif = Edif/v. \tag{32}$$

$$Pves = Eves/v. \tag{33}$$

$$v = Cmax/Q. \tag{34}$$

$$Nves = Pves\cdot Q. \tag{2}$$

$$Eves = Pves\cdot v. \tag{3}$$

$$Ndif = Pdif\cdot Q. \tag{35}$$

$$No = Po\cdot Q. \tag{4}$$

$$Cmax = Q\cdot v. \tag{5}$$

The above formulas chain and parameters (the multi-parameter composite function formula chain), the positions of the marked dots on each function micturition graph (four different micturition graphs) (Fig. 9., Fig. 10., Fig. 11., Fig. 12.) using the application parameters method, the standard division of the functions curves of normal and abnormal micturition graphs, etc., are edited by computer software and combined on the Windows terminal to form an automatically generated patient 's four different micturition graphs and six-point micturition graphs report.

The *Po* was calculated according to pressure difference (*Pdif*) to apply tangent trigonometric function ($Po=tana°\cdot Pdif$), which was achieved successfully (Fig. 6.). Let the opposite side and the adjacent side of the tangent trigonometric function (Fig. 7.) *tana°* be *Po* and be *Pdif*, respectively. Then $tana° = Po/Pdif$ and $Po = tana°\cdot Pdif$. The numerical relationship between *Po* and *Pdif* is "more for you and less for me or less for you and more for me". It is just in line with the numerical relationship between the opposite side (*Po*) and the adjacent side (*Pdif*) of the tangent trigonometric function $tana° = Po/Pdif$ (Fig.7.).

2.3. The Micturition Graphs Standard Curves to Establish

According to the standard of International Continence Society (ICS), $Qmax >$ 15ml/s in male adult micturition is normal, $Q_{max} <$ 10ml/s is abnormal, and 10ml/s ~ 15ml/s is gray zone. $Q_{max} >$ 20ml/s in female adult micturition is normal, $Q_{max} <$ 15ml/s is abnormal, and 15ml/s ~ 20ml/s is gray zone [9]. The above standard data of *Q* is used as a reference value to determine the basic criterion of the standard line of the micturition graphs. Then, the multiple standard lines of male adult micturition graphs are as follows: *F* value as 8.8F, *R* value as 0.33H (Fig. 5, 10.) (See Table 1.), *Nves* value as 600y~1000y (Fig. 5, 10.), Eves value as 3000u~9000u (Fig. 5, 11.), C_{max} value as 1200m~2400m (Fig. 12.) (See Table 1.), these multiple standard lines of micturition graphs apply to male adult patients. The patients of female adult have different standard lines of micturition graphs. The multiple standard lines of micturition graphs are as follows: *F* value as 10F, *R* value as 0.0356H (See Table 2.), *Nves* value as 400y~800y (See Table 2.), *Eves* value as 2000u~7000u, C_{max} value as 1400m~2600m (See Table 2.), these multiple standard lines of micturition graphs apply to female adult patients. The male and female children and adolescents have different standard lines of micturition according to the different urethral lengths L in different age groups (See Table 1, 2.).

Table 1. male (♂)

Age	Q(ml/s)	L (cm)	F	R (H)	Nves (y)	Cmax (m)
2~4	7~9	7	6.5	0.66H	250---350---450y	600---1000---1400m
5~7	8~10	9	7	0.5666H	300---400---500y	700---1150---1600m
8~11	9~12	11	7.5	0.478H	400---500---600y	800---1400---2000m
12~14	9~13	13	8	0.4H	450---600---750y	1000---1600---2200m
15~16	10~14	15	8.4	0.36H	500---700---900y	1100---1700---2300m
17	10~15	18	8.7	0.349H	600---800---1000y	1200---1800---2400m
≥18	10~15	18	8.8	0.33H	600---800---1000y	1200---1800---2400m

Table 2. female (♀)

Age	Q(ml/s)	L (cm)	F	R (H)	Nves (y)	Cmax (m)
1~2	8~11	2.8	6	0.363H	200---300---400y	600---800---1000m
3~6	9~12	3.2	6.5	0.269H	250---350---450y	800---1300---1800m
7~11	11~15	3.6	7.5	0.141H	300---450---600y	1000---1600---2200m
12~16	13~18	4.0	9	0.06H	350---550---750y	1200---1800---2400m
17~18	15~20	4.2	10	0.0356H	400---600---800y	1400---2000---2600m
≥18	15~20	4.2	10	0.0356H	400---600---800y	1400---2000---2600m

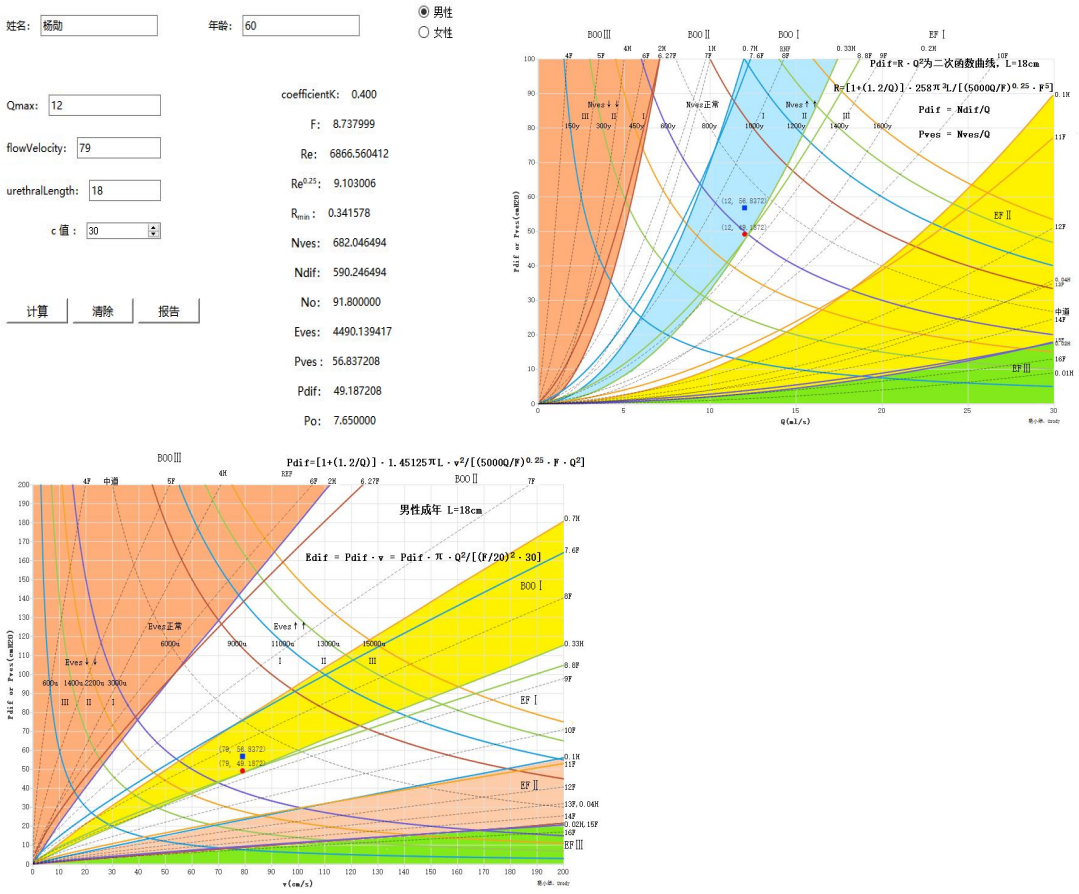


Fig. 5. The micturition graphs mark the positions of red circular dots and blue square dots, according to the corresponding parameters values. Where *Po* participates in the position of the blue square dots, *Pves* = *Pdif* + *Po*. *Nves* = *Pdif*·*Q* + *Po*·*Q*. The formulas chains are edited in the micturition graphs computer software. The normal and abnormal *R, F* values, BOO and EF grades as well as *Nves, Eves, Cmax* normal and abnormal and enhancement or weakening were determined by "the left-leaning boundary rule method (*R, F*) and the tennis boundary rule method (*Nves, Eves and Cmax*)", respectively. Therefor, there are no blind area (suspicious area) and blind spots in the four micturition graphs.

The boundaries of BOO and EF of *F* value and *R* value (See Table 1, 2.) were respectively determined in the multi-parameter composite function formula chain, and then the boundaries of BOO grades I, II and III and EF grades I, II and III were respectively divided.

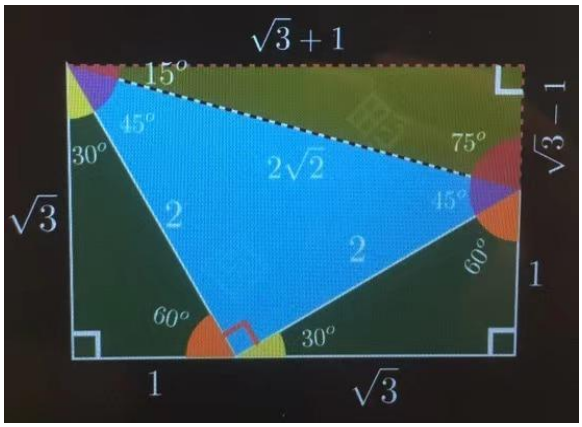
The *Nves, Eves*, and *Cmax* in the micturition graphs were respectively divided into median lines, and the standard lines (See Table 1, 2.) for the division of normal regions of *Nves, Eves*, and C_{max} were determined, and the enhancement grades I, II and III of *Nves, Eves*, and C_{max} were respectively divided into regions, and weakened I, II and III grades of *Nves, Eves*, and C_{max} were respectively divided into regions.

tanα°	Q (ml/s)	tanα°=Po/Pdif
tan0.3°	4 灰区	0.005236
+0.2°		
tan0.5°	5 ml/s	0.00872687
+0.3°		
tan0.8°	6 ml/s	0.01396354
+0.4°		
tan1.2°	7 ml/s	0.020947
+0.6°		
tan1.8°	8 ml/s	0.031426266
+0.8°		
tan2.6°	9 ml/s	0.04541
+1.0°		
tan3.6°	10 ml/s	0.062914667
+1.2°		
tan4.8°	11 ml/s	0.083972346
+1.5°		
tan6.3°	12 ml/s	0.110401
+1.8°		
tan8.1°	13 ml/s	0.142321
+2.0°		
tan10.1°	14 ml/s	0.17812713
+2.5°		
tan12.6°	15 ml/s	0.223526483
+3.0°		
tan15.6°	16 ml/s	0.279205
+3.5°		
tan19.1°	17 ml/s	0.346281
+4.0°		
tan23.1°	18 ml/s	0.426536
+4.5°		
tan27.6°	19 ml/s	0.522787366
+5.0°		
tan32.6°	20 ml/s	0.63952668
+5.5°		
tan38.1°	21 ml/s	0.784100158
+6.0°		
tan44.1°	22 ml/s	0.969067472
+5.0°		
tan49.1°	23 ml/s	1.1544316
+4.0°		
tan53.1°	24 ml/s	1.33187495

tanα°	Q (ml/s)	tanα°=Po/Pdif
+3.0°		
tan56.1°	25 ml/s	1.488157
+2.5°		
tan58.6°	26 ml/s	1.638263
+2.5°		
tan61.1°	27 ml/s	1.811496875
+2.0°		
tan63.1°	28 ml/s	1.97110768
+2.0°		
tan65.1°	29 ml/s	2.154315584 3
+1.5°		
tan66.6°	30 ml/s	2.310863654
+1.5°		
tan68.1°	31 ml/s	2.487578
+1.5°		
tan69.6°	32 ml/s	2.688919
+1.5°		
tan71.1°	33 ml/s	2.920761
+1.5°		
tan72.6°	34 ml/s	3.19100388
+1.0°		
tan73.6°	35 ml/s	3.3977085
+1.0°		
tan74.6°	36 ml/s	3.6304771
+1.0°		
tan75.6°	37 ml/s	3.894742855
+1.0°		
tan76.6°	38 ml/s	4.19756064
+1.0°		
tan 77.6°	39 ml/s	4.5482608
+1.0°		
tan78.6°	40 ml/s	4.95944736
+1.0°		
tan79.6°	41 ml/s	5.4485715
+1.0°		
tan80.6°	42 ml/s	6.04051
+0.8°		
tan81.4°	43 ml/s	6.61219186
+0.8°		
tan82.2°	44 ml/s	7.300178
+0.8°		
tan83°	45 ml/s	8.144346428

tanα°	Q (ml/s)	tanα°=Po/Pdif
+0.8°		
tan83.8°	46 ml/s	9.20515643
+0.6°		
tan84.4°	47 ml/s	10.198789
+0.6°		
tan85°	48 ml/s	11.4300523
+0.5°		
tan85.5°	49 ml/s	12.7062
+0.5°		
tan86°	50 ml/s	14.300666
+0.4°		
tan86.4°	51 ml/s	15.894545
+0.4°		
tan86.8°	52 ml/s	17.88631
+0.3°		
tan87.1°	53 ml/s	19.740291
+0.3°		
tan87.4°	54 ml/s	22.02171
+0.3°		
tan87.7°	55 ml/s	24.897826
+0.3°		
tan88°	56 ml/s	28.63625
+0.3°		
tan88.3°	57 ml/s	33.69351
+0.3°		
tan88.6°	58 ml/s	40.9174116
+0.2°		
tan88.8°	59 ml/s	47.7395
+0.2°		
tan89°	60 ml/s	57.28996

Fig. 6. The tangent trigonometric function $tana° = Po/Pdif$ matching distribution the *Q* correspondence. $Po = tana° \cdot Pdif$.



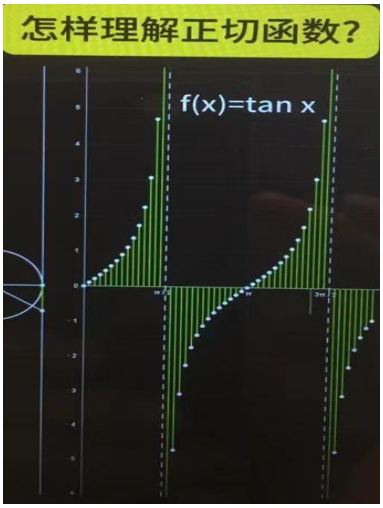


Fig. 7. Understanding tangent trigonometric function *tana°* = *Po/Pdif*, represents the relationship of the tangent trigonometric function values between the opposite side (*PO*) and the adjacent side (*Pdif*) ratio, then *Po* = *tana°· Pdif.*

tan0.46°	4.8灰区	0.008028687
tan0.48°	4.9灰区	0.0083777764
tan0.5°	5	0.00872687
tan0.53°	5.1	0.00925051
tan0.56°	5.2	0.009774155
tan0.59°	5.3	0.0102978
tan0.62°	5.4	0.01082146
tan0.65°	5.5	0.011345
tan0.68°	5.6	0.0118688
tan0.71°	5.7	0.01239247
tan0.74°	5.8	0.012916
tan0.77°	5.9	0.01344
tan0.8°	6	0.01396354
tan0.84°	6.1	0.0146618
tan0.88°	6.2	0.0153601
tan0.92°	6.3	0.01605841
tan0.96°	6.4	0.01675673
tan1.0°	6.5	0.017455065
tan1.04°	6.6	0.018153418
tan1.08°	6.7	0.0188518
tan1.12°	6.8	0.01955
tan1.16°	6.9	0.020248586
tan1.2°	7	0.020947
tan1.26°	7.1	0.0219947
tan1.32°	7.2	0.023042423
tan1.38°	7.3	0.0240902
tan1.44°	7.4	0.025138
tan1.5°	7.5	0.0261859
tan1.56°	7.6	0.0272338663
tan1.62°	7.7	0.02828187
tan1.68°	7.8	0.02933
tan1.74°	7.9	0.030378
tan1.8°	8	0.031426266
tan1.88°	8.1	0.03282397

tan7.2°	12.5	0.1263294
tan7.38°	12.6	0.1295224
tan7.56°	12.7	0.132718
tan7.74°	12.8	0.1359163
tan7.92°	12.9	0.13911727
tan8.1°	13	0.142321
tan8.3°	13.1	0.1458842
tan8.5°	13.2	0.149451
tan8.7°	13.3	0.1530215
tan8.9°	13.4	0.15659582
tan9.1°	13.5	0.160174
tan9.3°	13.6	0.16375628
tan9.5°	13.7	0.16734261
tan9.7°	13.8	0.17093313
tan9.9°	13.9	0.17452794
tan10.1°	14	0.17812713
tan10.35°	14.1	0.18263243
tan10.6°	14.2	0.1871449
tan10.85°	14.3	0.19166477
tan11.1°	14.4	0.1961922
tan11.35°	14.5	0.2007273845
tan11.6°	14.6	0.20527052
tan11.85°	14.7	0.2098218
tan12.1°	14.8	0.214381424
tan12.35°	14.9	0.218949585
tan12.6°	15	0.223526483
tan12.9°	15.1	0.22903
tan13.2°	15.2	0.23454788
tan13.5°	15.3	0.24007876

tan87.79°	55.3	25.912833553
tan87.82°	55.4	26.2697837
tan87.85°	55.5	26.63669
tan87.88°	55.6	27.0139763
tan87.91°	55.7	27.40209
tan87.94°	55.8	27.8015
tan87.97°	55.9	28.2127109
tan88.0°	56	28.63625
tan88.03°	56.1	29.07269
tan88.06°	56.2	29.52262
tan88.09°	56.3	29.98667757
tan88.12°	56.4	30.46554
tan88.15°	56.5	30.959928
tan88.18°	56.6	31.4706085
tan88.21°	56.7	31.9984
tan88.24°	56.8	32.54418
tan88.27°	56.9	33.10888
tan88.3°	57	33.69351
tan88.33°	57.1	34.29913379
tan88.36°	57.2	34.926909
tan88.39°	57.3	35.5780736
tan88.42°	57.4	36.253959
tan88.45°	57.5	36.956
tan88.48°	57.6	37.68575
tan88.51°	57.7	38.4448744
tan88.54°	57.8	39.23519
tan88.57°	57.9	40.058659
tan88.6°	58	40.9174116
tan88.62°	58.1	41.510652
tan88.64°	58.2	42.1213372
tan88.66°	58.3	42.7502483
tan88.68°	58.4	43.3982

tan88.74°	58.7	45.46551
tan88.76°	58.8	46.19906
tan88.78°	58.9	46.9566558
tan88.8°	59	47.7395
tan88.82°	59.1	48.54888
tan88.84°	59.2	49.3861646
tan88.86°	59.3	50.2528233
tan88.88°	59.4	51.15043
tan88.9°	59,5	52.08067
tan88.92°	59.6	53.0453644
tan88.94°	59.7	54.046455
tan88.96°	59.8	55.086045
tan88.98°	59.9	56.1664
tan89.0°	60	57.28996
tan89.02°	60.1	58.45938
tan89.04°	60.2	59.6775185
tan89.06°	60.3	60.947488
tan89.08°	60.4	62.27267
tan89.1°	60.5	63.65674
tan89.12°	60.6	65.10372

Fig. 8. The software of tangent trigonometric function for *Po* = *tana*°· *Pdif*. is edited in the software of micturition graphs. The corresponding matching distribution of *tana*° and *Q* is as follows: tan0.5° corresponds to 5ml/s; tan1° corresponds to 6.5ml/s; tan45° corresponds to 22.2ml/s; tan86° corresponds to 50ml/s; tan89° corresponds to 60ml/s. For example, tan12.6° = 0.223526483, the corresponding matching *Q* is 15 ml/s; tan12.9° = 0.22903, the corresponding matching *Q* is 15.1 ml/s; tan13.2° = 0.23454788, the corresponding matching *Q* is 15.2 ml/s; tan13.5° = 0.24007876, the corresponding matching *Q* is 15.3 ml/s etc.

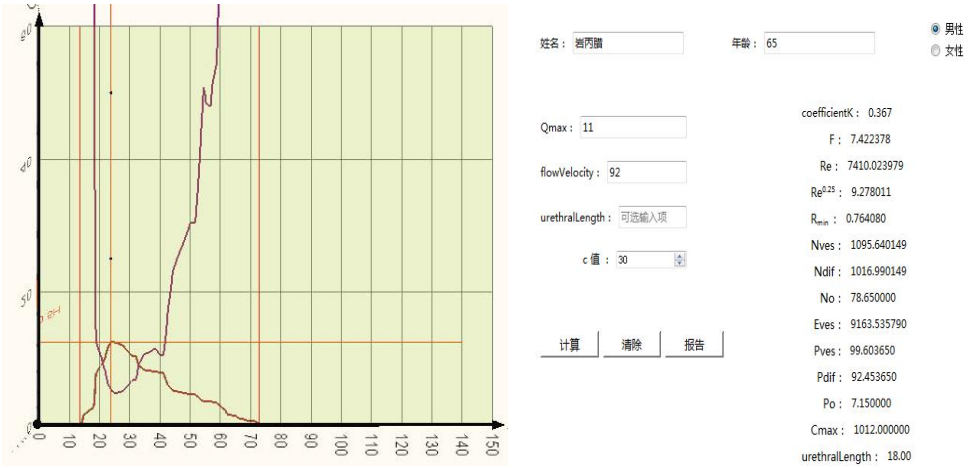


Fig. 9. This is male adult *Q* ~ *R* diagram. *Q* and *R* are inverted relative to each other as wave curves. All parameters values are obtained from the *Q*-*v* measurement.

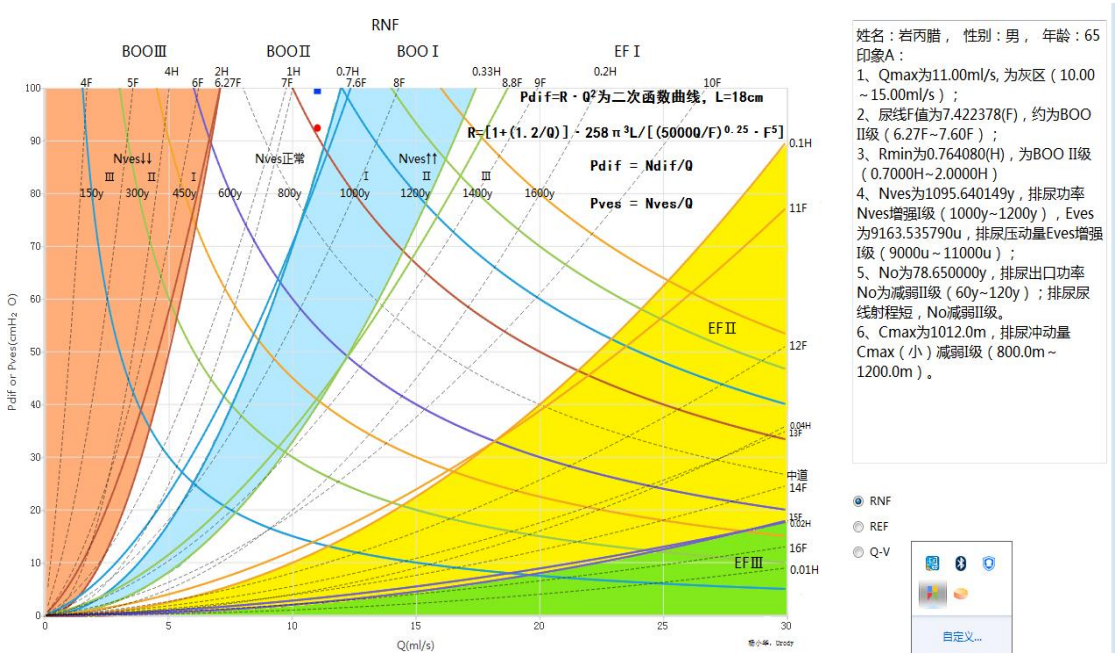


Fig. 10. The red circular dot and the blue square dot on male adult the *P - Q* micturition graph respectively represent these parameter values (*F, R, Ndif, Q* and *Pdif*) and these parameter values (*Nves, Pves* and *Q*).

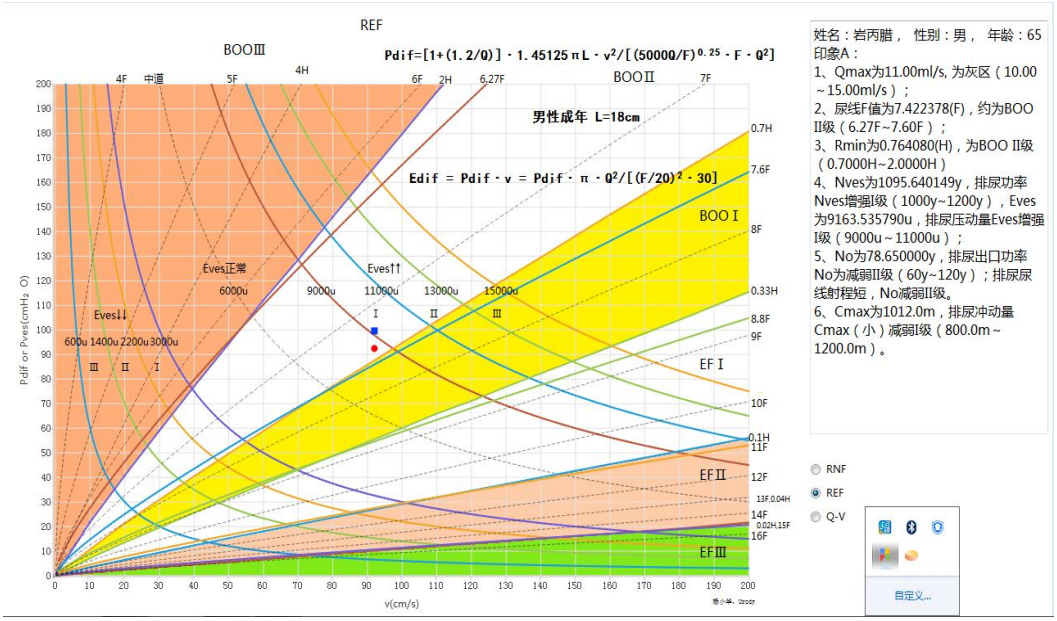


Fig. 11. The red circular dot and the blue square dot on male adult the P - v micturition graph express these parameter values (*F, R, Edif, v* and *Pdif*) and these parameter values (*Eves, Pves* and *v*), respectively.

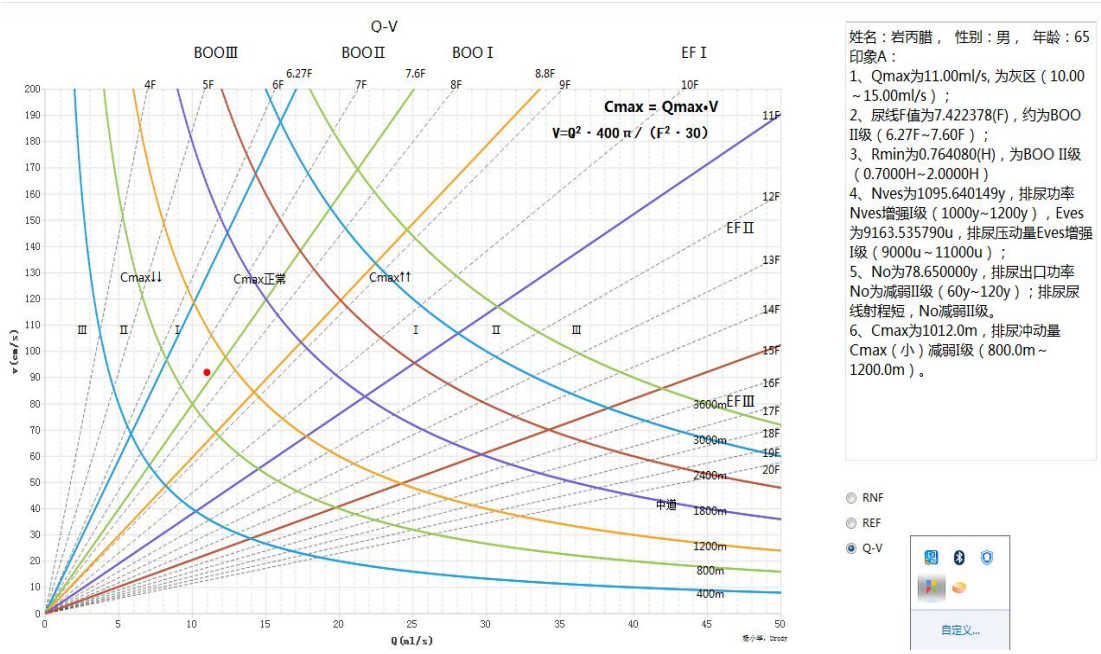


Fig. 12. The red circular dot on male adult the *v*-*Q* micturition graph can be expressed these parameter values (*F, Cmax, v* and *Q*).

The six-point parameters report (Fig. 13.) was used for micturition functionality assessment.

1. The Qmax: It is the earliest common micturition function reliable examination method. But there are equivocal zones (grey regions), it is not accurate assessment.

2. The urine flow line *F* value (*F* value) [3]: it is a good parameter indexs of micturition function.

3. The urine flow resistance *R*: It is the most accurate parameter index to diagnosis BOO and EF, which can be qualitatively and quantitatively assessment.

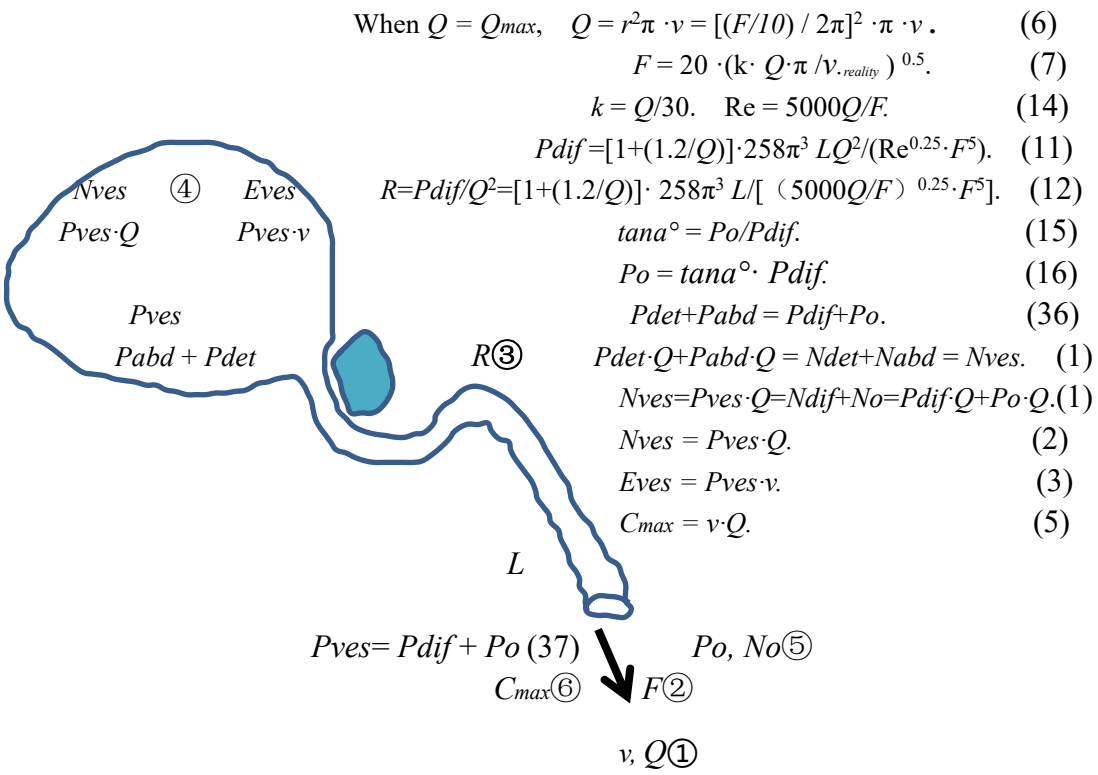
note: There is a small difference between *R* and F, which is called *F~R* separation, using *R* as accurate value.

4. The micturition power (*Nves*) [6] and bladder pressure momentum (*Eves*): The micturition weakness, micturition compensatory enhancement and normal micturition can be qualitatively and quantitatively evaluated by *Nves* and *Eves* for parameter indices.

5. The urethral outlet power (*No*): The micturition outlet power (*No*) can be obtained to evaluate as a digital parameter index.

6. The urethral outlet impulse momentum (*Cmax*): The micturition impulse momentum (*Cmax*) can be obtained to evaluate as a digitize parameter index.

The above six-point parameters reports (Fig. 13.) were the most perfect and advanced combination of parameters indices to evaluate micturition function.



After *Q-v* determination, The *Pabd* and *Pdet* could not be obtained.
All parameters of micturition (except *Pabd* and *Pdet*) can be obtained by *Q-v* determination and formulas chain calculation.

Fig. 13. All parameters of micturition, and six-point report parameters.

3. Result

According to the results of *Q-v* measurement in 520 patients, the degree of bladder outflow obstruction (BOO) and the normal voiding expeditious flow (EF) can be qualitatively and quantitatively evaluated (See Table 3), the urine flow resistance value (*R*) and urine flow line *F* value (*F* value) can be accurately obtained. In addition, micturition weakness, micturition compensatory enhancement and normal micturition can also be qualitatively and quantitatively evaluated with micturition power (*Nves*) [6] (See Table 3) and bladder pressure momentum (*Eves*). Furthermore, when voiding Q_{max}, the *Q-v* measurement can obtain the urethral outlet power (*No*) and the urethral outlet impulse momentum (C_{max}).

Table 3. Result （From June 2024 to February 2025, 520 patients）

456 male adults case：186 case EF, Nves normal; 267 case BOO abnormal, among 208 case *Nves* abnormal (38 case *Nves*↑, 170 case *Nves*↓), 59 case *Nves* normal; 3 case Q 4~5ml/s, V=50~60ml, failure.
47 female adults case：41 case EF and *Nves* normal; 6 case BOO and *Nves*↓abnormal.
17 case of children and adolescents (male and female)：15 EF and *Nves* normal; 2 case BOO, *Nves*↓ abnormal.

.

4. Discussion

The theory of small flow quantity (urine) hydromechanics is taken as the first principle in the voiding urodynamics. We have successfully migrated from the hydromechanics formula or Blasiu's formula [1] to the voiding urodynamics formulas as 258 formula [2], In addition, Anatomy Q acquired F value and k = Q/30 and *Nves* or *Eves*. The old academic theory of voiding urodynamics has stayed to the AG theory [7, 8], AG number (20~40) = $Pdet$ - $2Q_{max}$. It is sorted out by mathematical formula and changed into as $Pdet = 2Q_{max} + 20 \sim 40$. The P-Q diagram of the AG nomogram has been formed as two oblique lines in a linear function graph, which has obvious logical loopholes. it had taken imprecise logic to exclude $Pabd$ from increasing Q_{max}. This theoretical method is only a fuzzy or chaotic science and technology. The old academic AG theory of voiding urodynamics has no theoretical and logical thinking foundation, it has no theoretical source. The AG nomogram can only be qualitative, not quantitative, and BOO and EF lacks unit value. Therefor, there are suspicious area (blind area) and blind spots (on two oblique lines).

In macrophysics, there must be scalar unit or vector units to express the physical parameters. It is parameters contain physical concepts and definitions, and can be expressed qualitatively and quantitatively. Physical parameters are completely different concepts from physical constants and physical coefficients, which physical constants and physical coefficients are generally expressed without units. As used herein, the Reynolds numbers (Re), the slip coefficient (k), and the collapse tube (soft tube) coefficient (ξ) are expressed without units.

Galileo opened the door to classical physics 300 years ago by dropping two lead balls of different sizes from the Leaning Tower of Pisa at the same time. However, a book and a leaf fall together, and the book falls significantly faster than the leaf. Another phenomenon, use a large shovel to throw small clods, broken clods, fine soil and dust soil together into the air at a height of 3 meters. It is found that small clods and broken clods fall to the ground at the same time, while fine soil and dust soil fall to the ground in turn, and dust soil falls to the ground last (the dust is flying).

This shows that the free falling bodies of the same object with different size and volumes have landed at the same time. Free-falling bodies of very small size are slower to land. There is a boundary line between them. Similarly, a similar phenomenon occurs in small flow quantity (urine) hydromechanics. Then in Q-v determination experiment, we found that the v_1 obtained from the corresponding F value when Q is between 5 and 29 ml/s does not match with the v_2 obtained according

to Anatomy Q obtained. $v_1 \neq v_2$, this is due to air resistance (See Table 4). As shown, only the slip coefficient k = Q/30 is used for correction, $v_1 = k \cdot v_2$. When $Q \geq 30$ml/s (30ml/s~60ml/s), this v of the line F value must obey the formula: $Q = r^2\pi \cdot v = [(F/10) / 2\pi]^2 \cdot \pi \cdot v.$, and the slip coefficient k=1, which is less obstructed by air. The above is one of the core ideas of small flow quantity (urine) hydromechanics.

Table 4.

Q	5	5.5	6	8	10	12	15	20	25	30	40	50
F	5.3	5.5	5.8	6.4	7.5	8	9.5	11	13	15	18	21.5
v_2	223.68	228.48	224.13	245.44	223.4	235.6	208.86	207.7	185.89	167.55	155.14	135.93
v_1	37.28	41.89	44.83	65.45	74.47	94.25	104.43	138.47	154.9	167.55	155.14	135.93
k	Q/30	Q/30	Q/30	Q/30	Q/30	Q/30	Q/30	Q/30	Q/30	Q/30 =1	1	1

note: $v_1 = k \cdot Q \cdot 4\pi / (F/10)^2.$; $Q = r^2\pi \cdot v_1 \cdot (1/k) = [(F/10) / 2\pi]^2 \cdot \pi \cdot v_1 \cdot (1/k)$.; $F = 20 \cdot (k \cdot Q \cdot \pi / v_1)^{0.5}$.

$$F = 20 \cdot (k \cdot Q \cdot \pi / v)^{0.5} = 20 \cdot [(Q/30) \cdot Q \cdot \pi / v]^{0.5}. \quad (25)$$

$$R = Pdif/Q^2 = [1+(1.2/Q)] \cdot 258\pi^3 L/[（5000Q/F）^{0.25} \cdot F^5]. \quad (12)$$

$$Pdif = [1+(1.2/Q)] \cdot 258\pi^3 LQ^2/[（5000Q/F）^{0.25} \cdot F^5]. \quad (38)$$

$$Po = tana° \cdot Pdif. \quad (16)$$

The multi-parameter composite function formula chain are expressed on the function graphs of the micturation graphs.

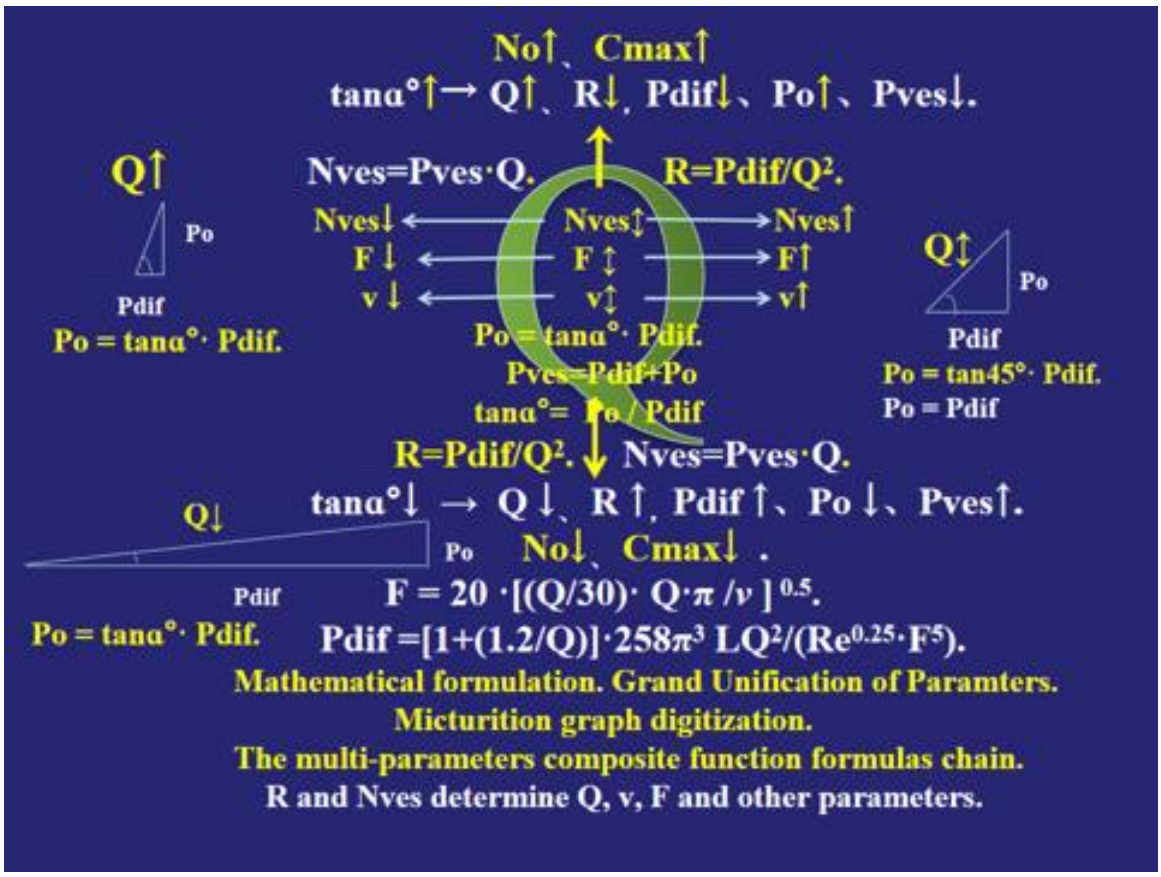


Fig. 14. Mathematical formulation, Grand Unification of parameters, Micturition graph digitization, The multi-parameter composite function formula chain leads to all parameters in changes. The multi-parameter composite function formula chain.

Four micturition graphs (Fig. 9, 10, 11, 12.) have been edited in the micturition graph software, The first micturition graph (Fig. 9.) mainly expresses the curve wave change of *Q* and *R* values in the micturition time, *Q* and *R* are inverted relative to each other as wave curves. When Q_{max}, The red circular dots and the blue square dots on the second and the third micturition graphs (Fig. 10, 11.) express these parameter values (*F, R, Ndif, Q* and *Pdif*) and these parameter values (*Nves, Eves, Pves* and *Q*), respectively（Fig. 10, 11.) . When Q_{max}, the red circular dots on the fourth micturition graph（Fig. 12.) express these parameter values (*F,* C_{max}, *Q* and *v*). These positions marked of the red circular dots and the blue square dots on the micturition graphs are edited by computer software.

The standard boundary curves of each function of the micturition graph are used as "the left-leaning boundary rule method (*R, F*) and the tennis boundary rule method (*Nves, Eves* and C_{max})", respectively. Therefor, there are no blind area (suspicious area) and blind spots in the four micturition graphs.

According to the different urethral length L and the different voiding power (*Nves*) of adult males, adult females, as well at different ages group of (males and females) children and adolescents, there are different standard micturition graphs of adult males and adult females, which at different ages group of (males and females) children and adolescents there are different standard micturition graphs （Fig. 15, 16,

17.) (See Table 1, 2.).

The software for micturition graphs is like a big pocket, containing comprehensive information, such as the rules and standards of the functional curve of micturition graph; normal and abnormal six-point parameter values; grading, enhancement and attenuation (weakening) levels for grading; applicable to men, women, children and adolescents of all ages（Fig. 15, 16, 17.); the tangent trigonometric function $Po = tan\alpha° \times Pdif$ (Fig. 6, 7.) with corresponding matching distribution of $tana°$ and Q (Fig. 7, 8.), The value of Q (4ml/s to 60ml/s) is kept to one place after the decimal point (for example, 4.0ml/s, 4.1ml/s ... ... 59.8ml/s, 59.9ml/s, 60.0ml/s.), distribution according to the curve of the tangent trigonometric function graph, then each Q value corresponds to $tan\alpha°$ value (Fig. 7, 8.), that matches the value of $\alpha°$, as follows: tan0.5° corresponds to 5ml/s; tan1° corresponds to 6.5ml/s; tan45° corresponds to 22.2ml/s; tan86° corresponds to 50ml/s; tan89° corresponds to 60ml/s. For example, tan12.6° = 0.223526483, the corresponding matching Q is 15 ml/s; tan12.9° = 0.22903, the corresponding matching Q is 15.1 ml/s; tan13.2° = 0.23454788, the corresponding matching Q is 15.2 ml/s; tan13.5° = 0.24007876, the corresponding matching Q is 15.3 ml/s etc., all of which are included in the micturition graph computer software.

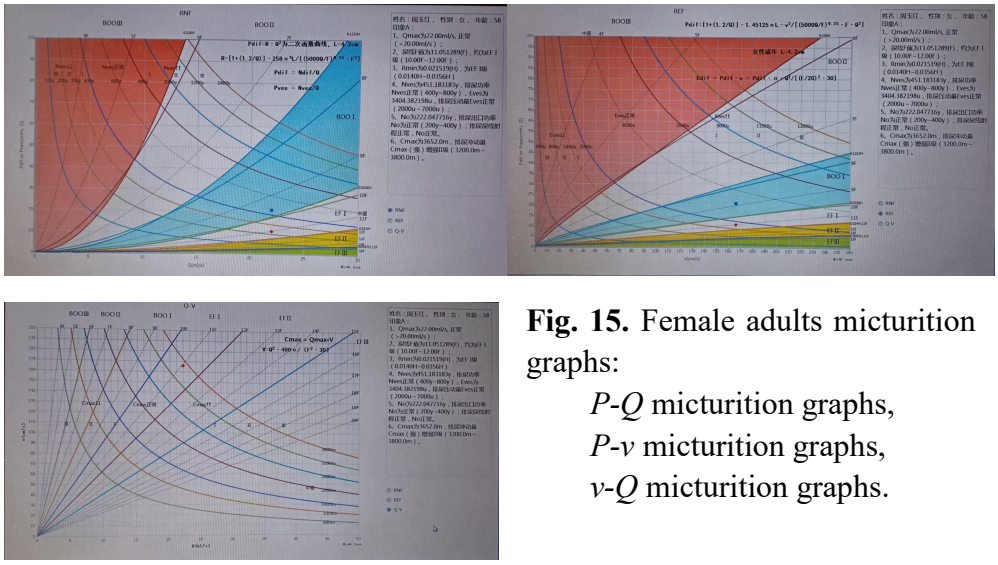


Fig. 15. Female adults micturition graphs:
P-Q micturition graphs,
P-v micturition graphs,
v-Q micturition graphs.

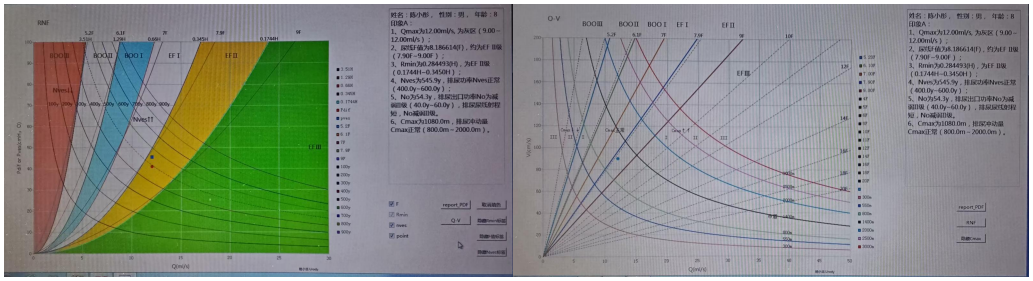


Fig. 16. Age 8 years old of male children, *P-Q* micturition graphs and *v-Q* micturition graphs.

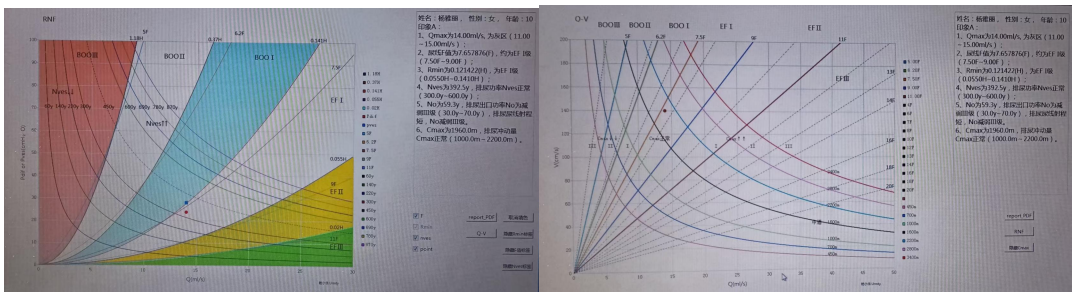


Fig. 17. Age 10 years old of female children, *P-Q* micturition graphs and *v-Q* micturition graphs.

5 . Conclusion

The theory of small flow quantity (urine) hydromechanics is taken as the first principle. The theory of micturition graph of voiding urodynamics was established by using the multi-parameter composite function formula chain (Fig. 14.) lead to grand unification of paramters. After 25 years of research and development, this theoretical digitize system of voiding urodynamics and the non-invasive application of *Q-v* measurement method have been successfully completed and presented to the world. The most simple and convenient non-invasive *Q-v* equipment is used to measure the actual patients voiding, micturition graph is very good theory and method and to provide doctors with clinical medical voiding function diagnosis. Guiding voiding urodynamics into the non-invasive measurement for the digital era allows qualitative and quantitative assessment of the bladder outflow obstruction (BOO) as abnormal and voiding expedite flow (EF) as normal. The micturition weakness, micturition compensatory enhancement and normal micturition can also be qualitatively and quantitatively evaluated by micturition power (Nves) [6] and bladder pressure momentum (*Eves*). In addition, the parameters of the micturition outlet power (*No*) and the micturition impulse momentum (*Cmax*) are also obtained to evaluate the distance of voiding-shot and the energy and the momentum of the micturition outlet. In conclusion, four digital micturition graphs (Fig. 9, 10, 11, 12.) were used as the basis for evaluation and the corresponding six-point parameters report was used for micturition function assessment.The non-digital era of old invasive voiding urodynamics is coming to an end, and the digital era of new non-invasive voiding urodynamics is coming to begin.

Author contributions

Specialist and engineer and Prof. Xiaohua Yang designed the research study this voiding urodynamics, he is chief designer of Micturition Graphs. Prof. Xiande Huang,
Jianlin Xie, Rong Ma, Peng Zhou, Xian Chen, Tongxin Yang, performed the research and the clinical application. Manufacturer General Manager, Haifeng Zhong provided Equipments. Xiaohua Yang, Xiande Huang, Jianlin Xie analysed the data. Xiaohua Yang, Jianlin Xie wrote the paper. All authors revised the manuscript critically and approved the submitted and final versions.

Clinical Trial Registration: This is a retrospective, observational diagnostic-accuracy study based solely on de-identified medical records; it involved no prospective intervention or randomization. Therefore, the study is not classified as a clinical trial and no registration is required.

Declarations Conflict of interest The authors declare no competing interests.

Ethical approval All human participants provided written informed consent prior to inclusion in the study. The study protocol was approved by the Ethics Committee of the First People's Hospital of Yunnan Province (approval number: KHLL2019-KY013; approval date: 26 March 2019).

Informed consent Informed consent was obtained from all individual participants enrolled in the study.

Funding This work was supported by the Institutional Research Grant of Gansu Provincial Hospital (Grant No. 23GSSYD-14).

Data availability statement The de-identified patient data used in this study were extracted from the medical record system of the First People's Hospital of Yunnan Province. Under the hospital's data-governance policy, the raw data cannot be made publicly available to minimise the risk of re-identification. The derived datasets and statistical code generated during the analysis may be obtained on reasonable request by contacting the first author at yxh-Urodynamics@163.com; recipients will be required to sign a data-use agreement restricting use to non-commercial research purposes and prohibiting further redistribution.

References

1. Victorl. Streeter, E. Benjamin Wylie, Keith W. Bedford. Fluid Mechanics. Ninth Edition. [M]. 1998; 290-291.
2. Xiaohua Yang. Bladder Voiding Failure [M]. China, Kunming. yunnan Science and Technology Press. 2018. 12. 023-024, 061-062.
3. Mike B. Siroky, Robert A. Edelstein, Robert J. Krane. Manual of Urology Diagnosis and Therapy. Second Edition. [M]. 1999; 33.
4. Merle C. Potter, David C. Wiggert. Mechanics of Fluids. Thid Edition. [M]. 2002; 292-293
5. Xiaohua Yang, Qiaobao Liu, Yongkang Zou, Minhui Xiao. Clinical value for Pves - Po / Qmax determination in diagnosing BOO. Journal of Clinlcal Urology. 2003; 18:204-206.
6. Xiaohua Yang, Minhui Xiao, Wei Li, Yanhong Yu. The Exploring Theory of Powers of Vesical Micturition and Clinical Application. Journal of Clinlcal Urology. 2011; 26(4):245-248.
7. Abrams PH, Griffiths DJ. The assessment of prostatic obstruction from urodynamic measurements and from residual urine. Br J Urol 1979; 51:129-134.
8. Lim CS, Abrams P. The Abrams-Griffiths nomogram. World J Urol 1995; 13:34-39.

9. Schacterle, R.S.; Sullivan, M.P.; Yalla, S. V., Combinations of maximum urinary flow rate and American Urological Association symptom index that are more specific for identifying obstructive and non-obstructive prostatism. Neurourology and urodynamics 1996, 15 (5), 459-70; discussion 470-2.