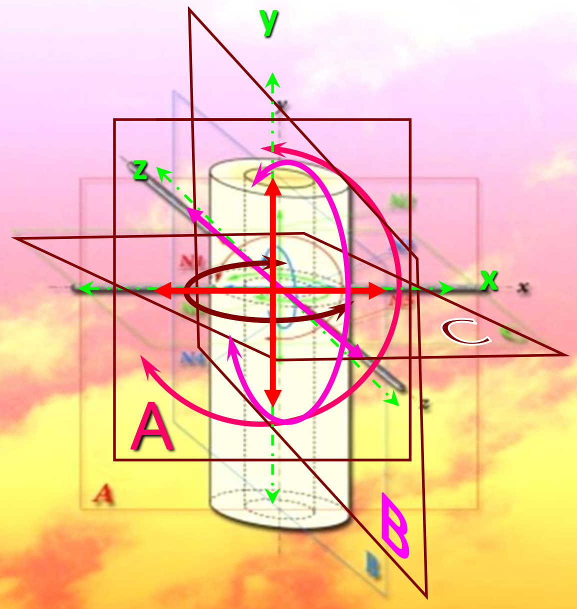
Fractures of the Pelvis

From TWO-DIMENTIONAL
to THREE-DIMENTIONAL
CONCEPTION
FOR REPOSITION AND FIXATION
OF THE BONE FRAGMENTS

A STEP TOWARDS FUTURE TRAUMATOLOGY AND ORTHOPAEDICS

-for reposition and
-for fixation of the
bone fragments

«Degree of freedom» № 1 - № 6



CLINICAL & BIOMECHANICAL CLASSIFICATION OF FRACTURES OF THE PELVIS

BCL&PBF

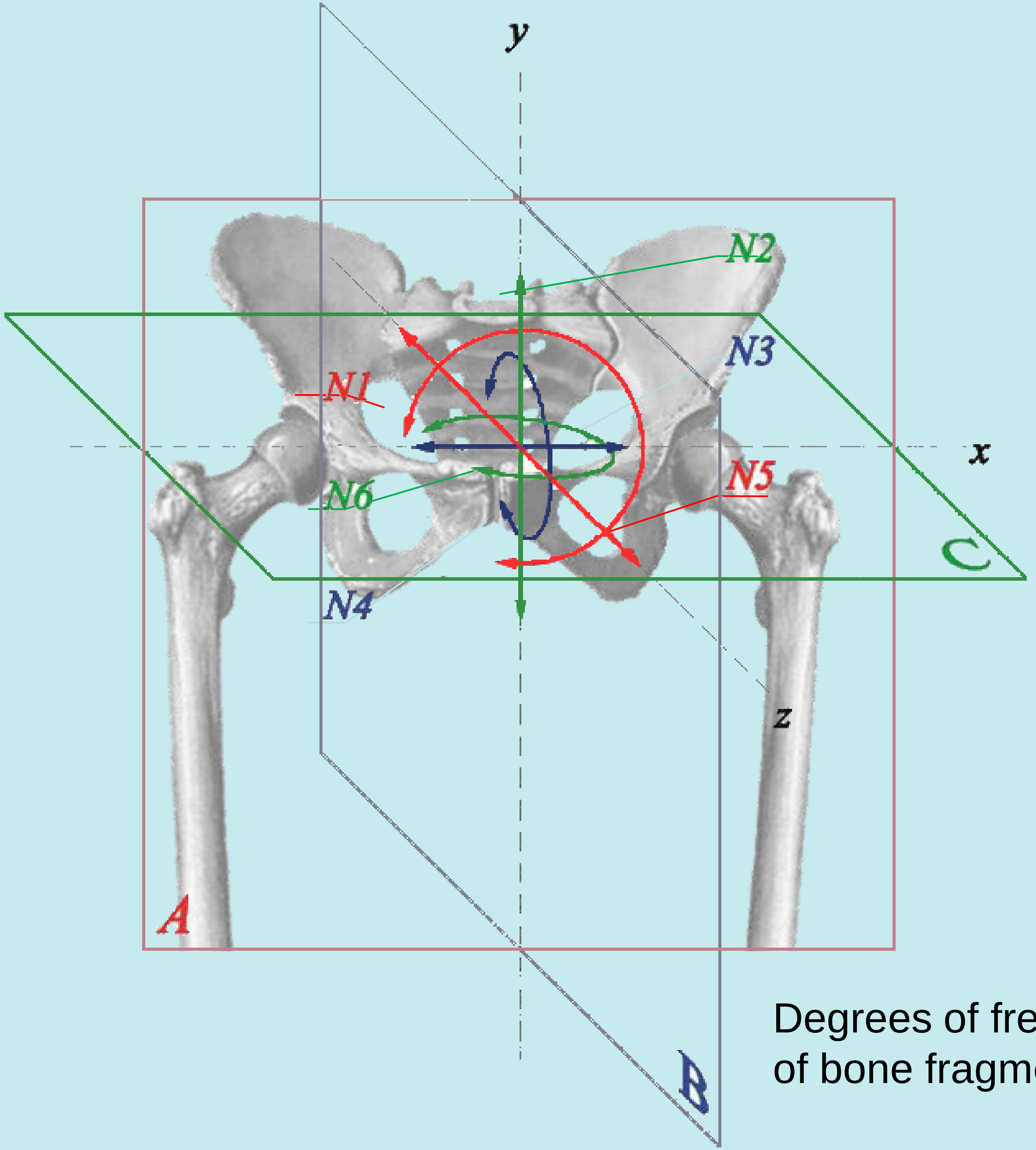
Prof. I.M. PICHKHADZE

CLINICAL & BIOMECHANICAL CONCEPTION FIXATION OF FRACTURES OF THE PELVIS

CLINICAL & BIOMECHANICAL CLASSIFICATION OF PELVIS BONES OF FRACTURES

by Pichkhadze

CLINICAL & BIOMECHANICAL CLASSIFICATION OF THE PELVIS BONE FRACTURES by Pichkhadze

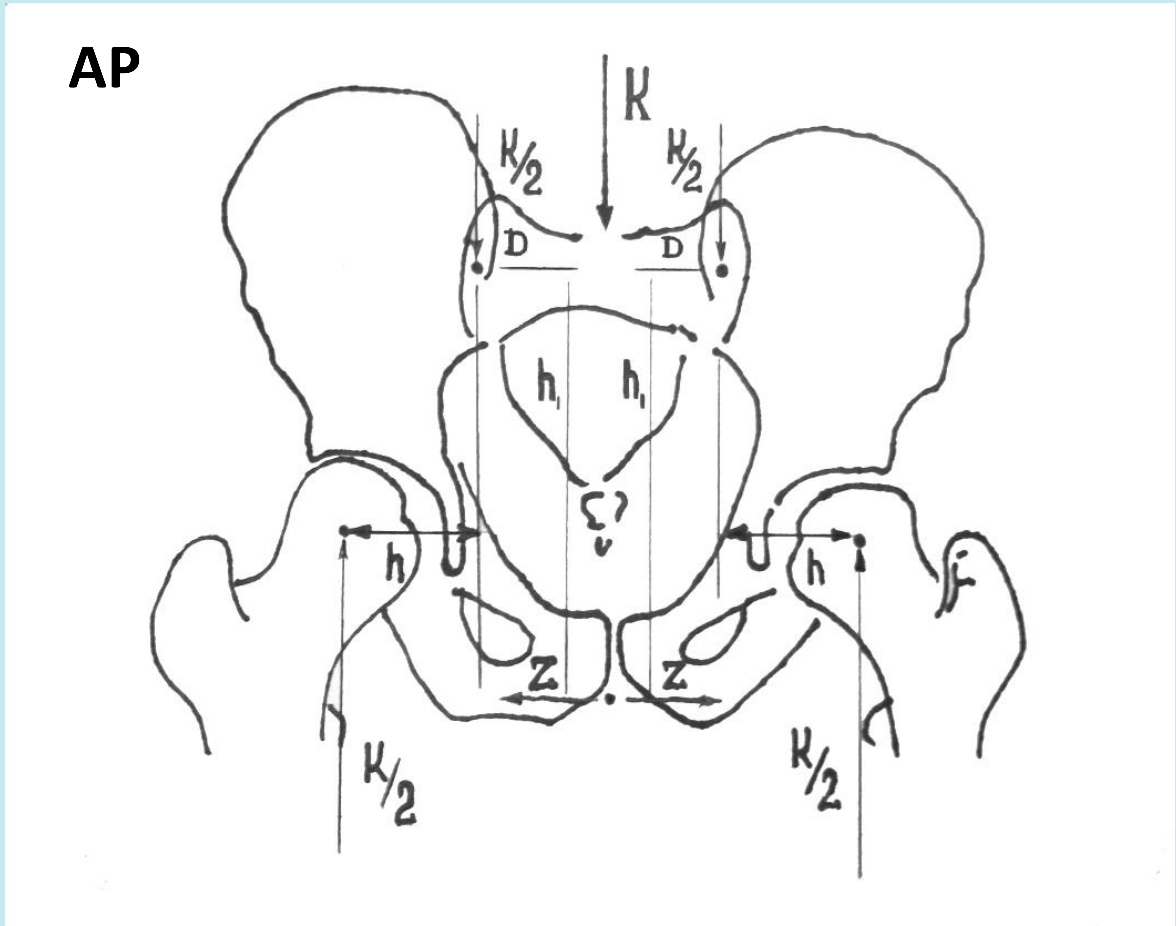


«Degree of freedom»
№ 1 - № 6

Degrees of freedom (directions of movement of bone fragments): ***N1***, ***N2***, ***N3***, ***N4***, ***N5***, ***N6***.

Static load distribution according to F. Pauwels

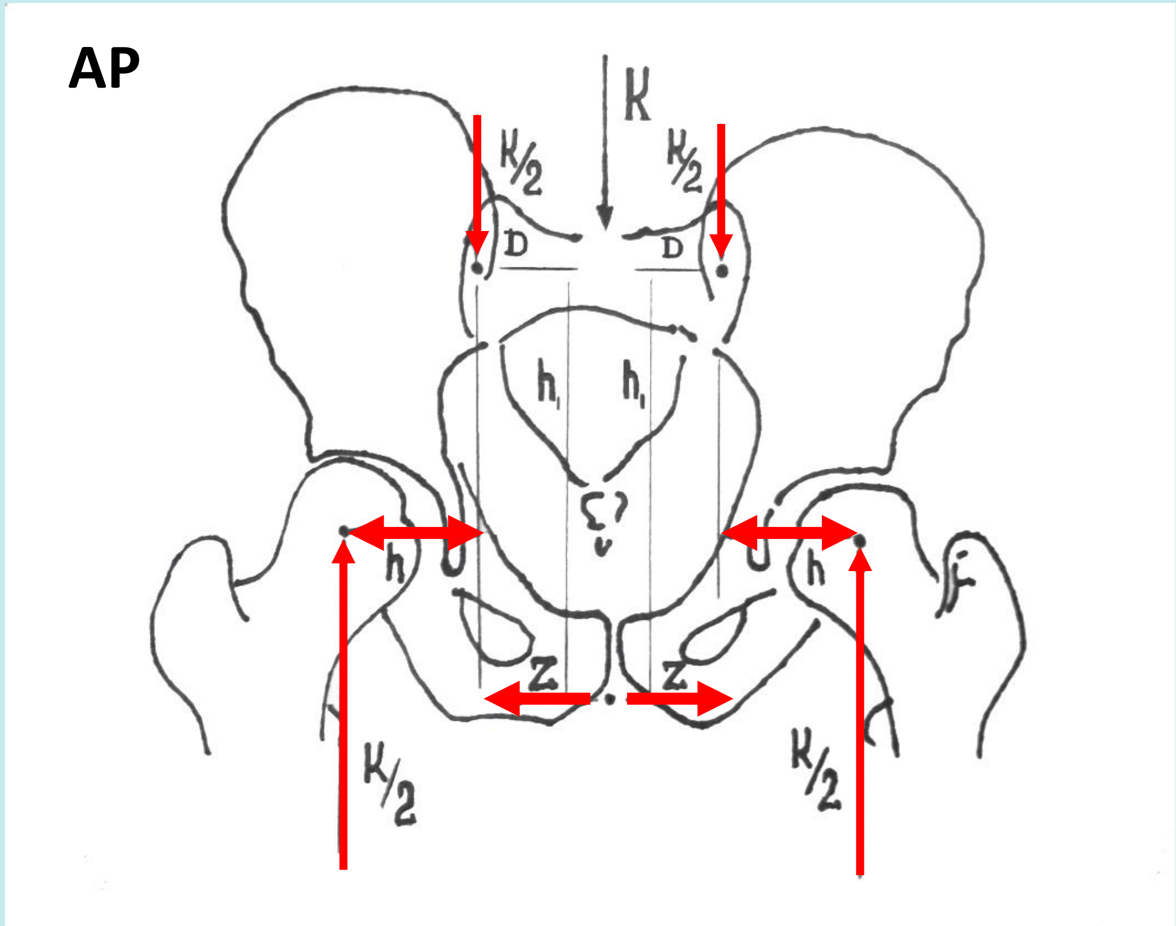
Two-dimentional plane



Pauwels F. Biomechanics of the Locomotor Apparatus. – New York. 1980.– 518 p.

Static load distribution according to F. Pauwels

Two-dimentional plane



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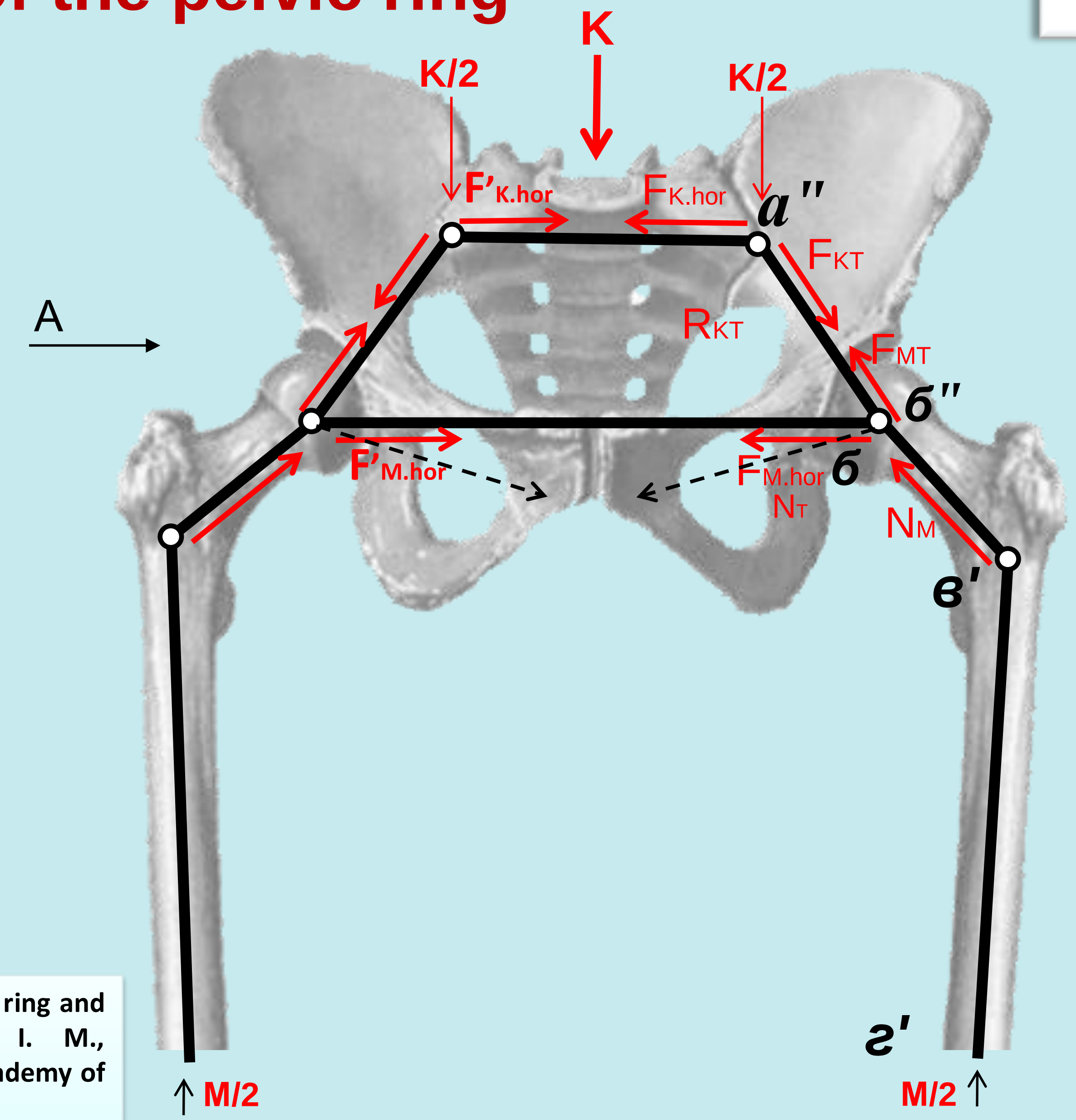
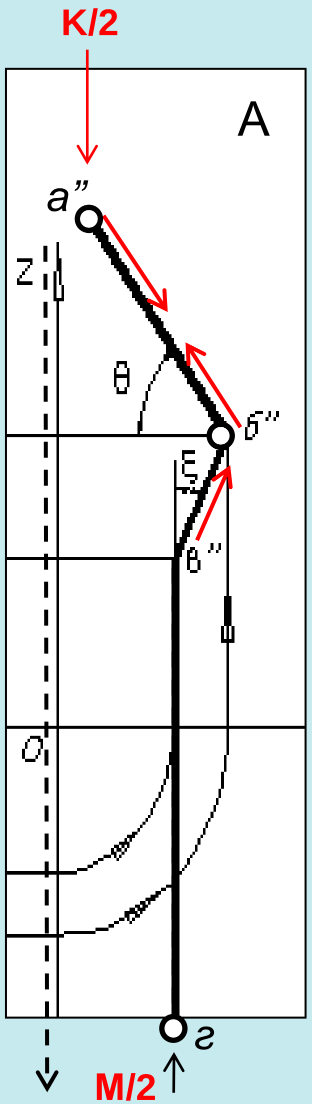
Static load distribution according to I. Pichkhadze - 2008

Biomechanics of the pelvic ring



Three-dimentional plane

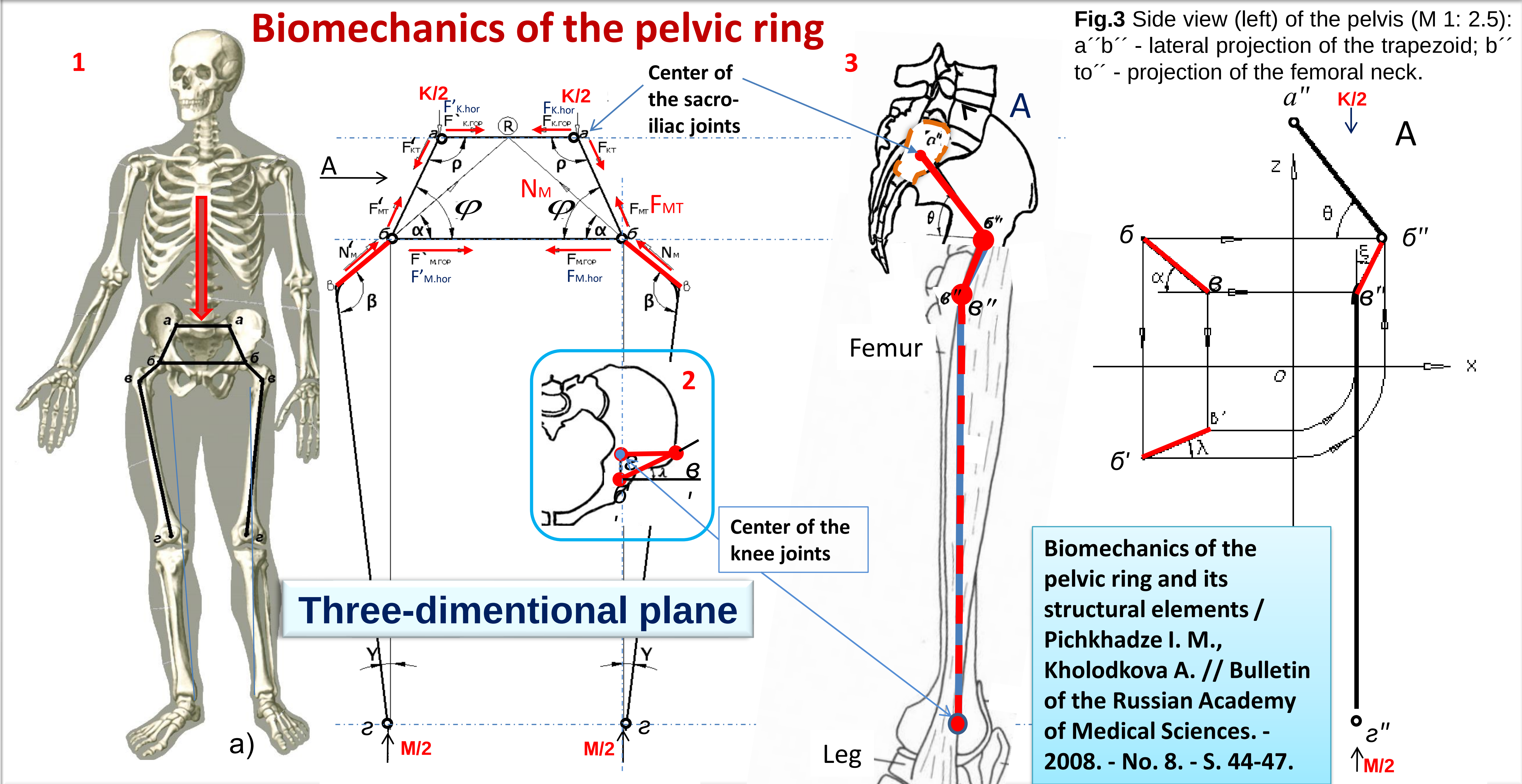


Pichkhadze I. M. Biomechanics of the pelvic ring and its structural elements / Pichkhadze I. M., Kholodkova A. // Bulletin of the Russian Academy of Medical Sciences. - 2008. - No. 8. - S. 44-47.

Static load distribution according to I. Pichkhadze - 2008

Biomechanics of the pelvic ring

Fig.3 Side view (left) of the pelvis (M 1: 2.5): a´´b´´ - lateral projection of the trapezoid; b´´ to´´ - projection of the femoral neck.



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Biomechanics of the pelvic ring and its structural elements
Pichkhadze I. M., Kholodkova A.

Calculations and diagrams of the force distribution in the pelvic bones' zone are presented. In persons without injuries and skeletal abnormalities, all forces functioning on the pelvic ring are shown to be in balance. The proposed method of calculations enables to detect the treatment tactics (either conservative or operative management) in patients with pelvic bone fractures, including the correction of their congenital anomalies.

Static load distribution according to I. Pichkhadze - 2008

Pichkhadze I. M. Biomechanics of the pelvic ring and its structural elements / Pichkhadze I. M., Kholodkova A. // Bulletin of the Russian Academy of Medical Sciences. - 2008. - No. 8. - S. 44-47.

BIOMECHANICS OF THE PELVIC RING AND ITS STRUCTURAL ELEMENTS

The pelvic ring is the center of the locomotor complex, i.e. one of the most important supporting parts of the human skeleton, connecting the lower limbs with the upper parts of the skeleton bones and providing transmission, distribution and amortization of mechanical loads (forces and moments) from the spine to the lower limbs at different positions of the body.

Since the base ring is a unique structure of the human body, the problems of pelvic biomechanics have interested scientists since the mid-18th century. In his famous works, Mayer considered the pelvic ring as a vaulted structure, where the sacrum is the closing link in the upper part, and the pubic bones fused in the symphysis are the closing links in the lower part.

Works by N.I. Napalkova, M.I. Bystritsky, research P.F. Lesgaft, et al. deepened knowledge about the biomechanics of the pelvis and confirmed Mayer's theory. Most specialists who have studied the biomechanics of the pelvic ring consider F. Pauwels studies to be the most comprehensive. Currently, there are a number of theories and concepts, but, unfortunately, none of them fully explains the structure, biomechanics of the pelvic ring, and the role of its individual elements.

Static load distribution according to I. Pichkhadze - 2008

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BIOMECHANICS OF THE PELVIC RING AND ITS STRUCTURAL ELEMENTS

Based on the previous works of scientists and using the basic principles of mechanics, the authors of the article tried to consider the forces and moments acting on the pelvic ring and its elements in a spatial, three-dimensional coordinate system, and determine by graphical-analytical method their magnitude and direction.

The pelvic ring - a spatial vaulted structure (Fig. 1, a, b) can be conventionally represented as a trapezium, the vertices of which are the centers of the sacro-vertebral joints (S-I J) - points a - a, and the centers of the hip joints (HIP) - points *b - b*. From the spine, a force K of approximately ~ 0.64 M acts on the pelvic ring, where M is body weight. Therefore, distributing it symmetrically between the two S-I J, we obtain the load at point a equal to K/2, i.e. ~ 0.32M.

From the side of the femurs, a reactive force equal to M acts on the pelvic ring, i.e. symmetrically on each hip - M/2.

The femur in the form of a hinge is articulated with the pelvic ring in of the hip joint (HIP) - point *b* - through the head and neck of the femur *б-в* (*b-B*) (see Fig. 1, b), which makes the angle β equal to 125˚ - 135˚ with the thigh. The femoral neck, in turn, is deflected in the horizontal plane (anteversion) to the sacrum by an angle *λ* equal to 12˚ - 15˚ (Fig. 2). Therefore, the force M/2 will create a moment relative to the HIP (point *б*(*b*)).

Static load distribution according to I. Pichkhadze - 2008

Reposition & stabilization in three-dimentional plane

«Degree of freedom»
№ 1 - № 6

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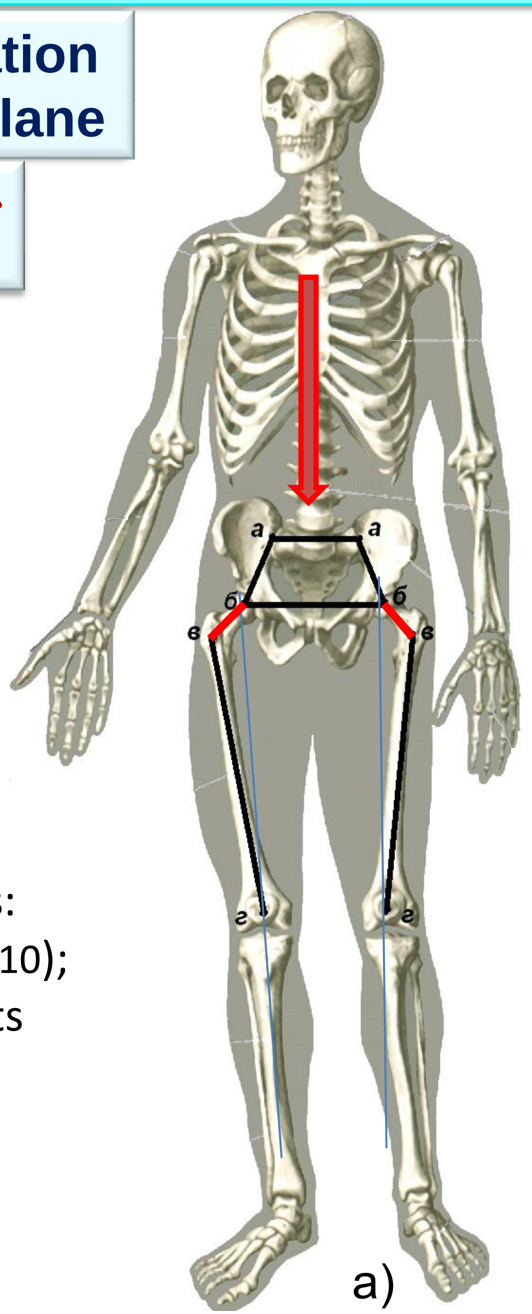

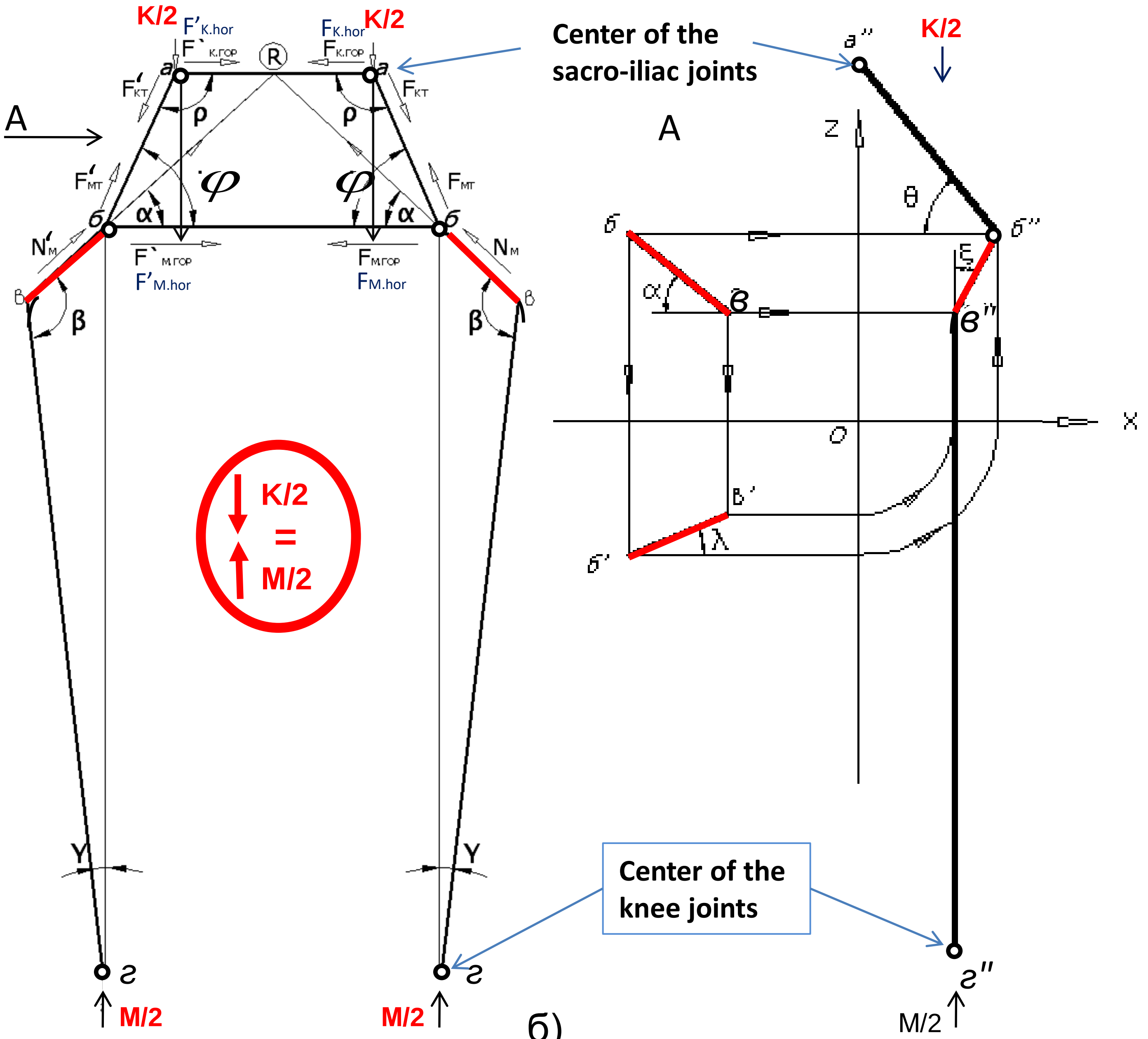

<u>Fig. 1</u> The layout of the elements of the skeleton and the pelvic ring and the interaction of forces:

a - skeleton (front view, M 1:10);

b - a diagram of the elements of the pelvis and femurs;

a,a - sacro-iliac joints (S-I J);

b,b - hip joints (HIP J);

вб - the neck of the thigh;

вг – thigh.

Static load distribution according to I. Pichkhadze - 2008

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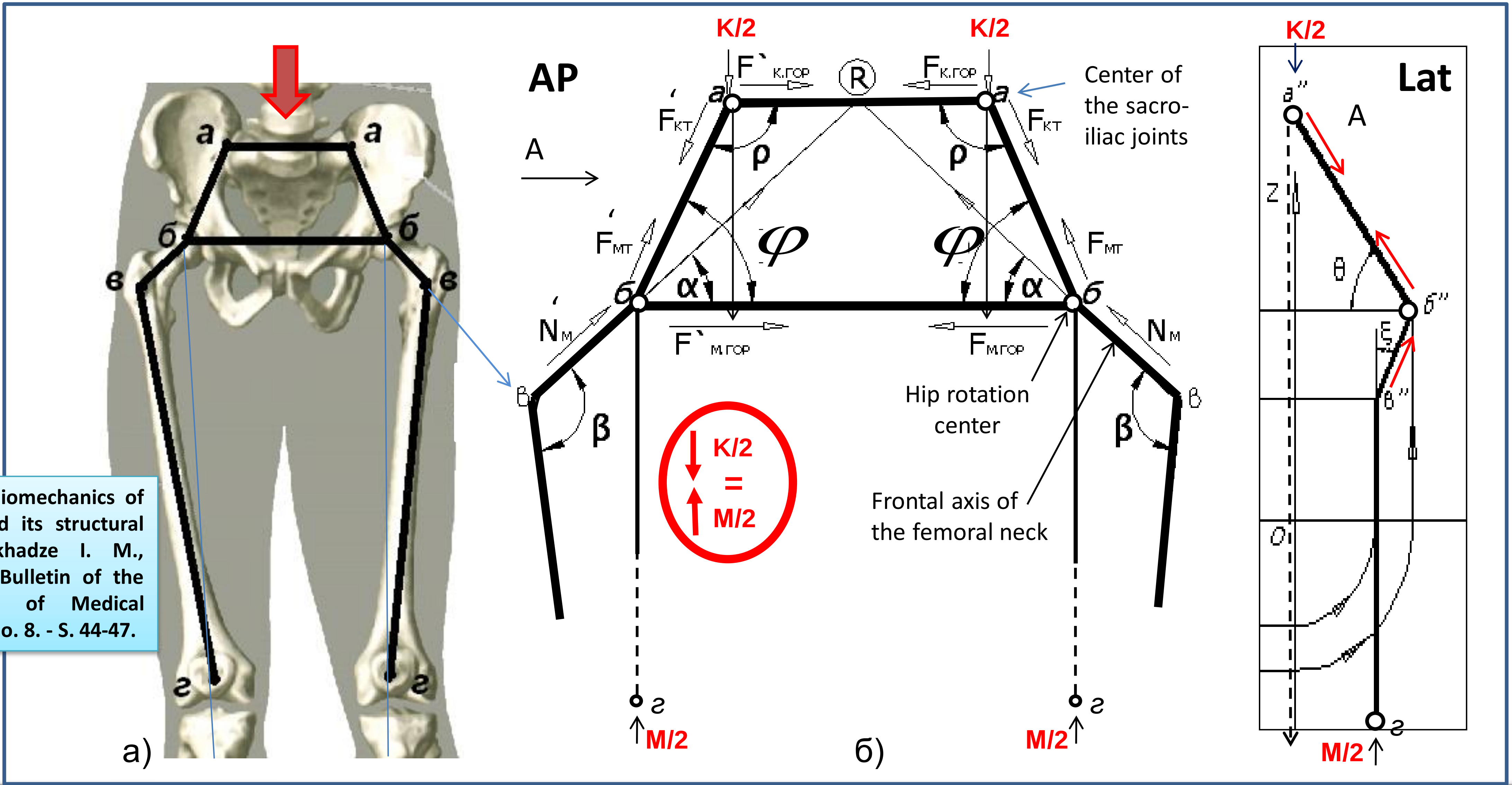
Three-dimentional plane



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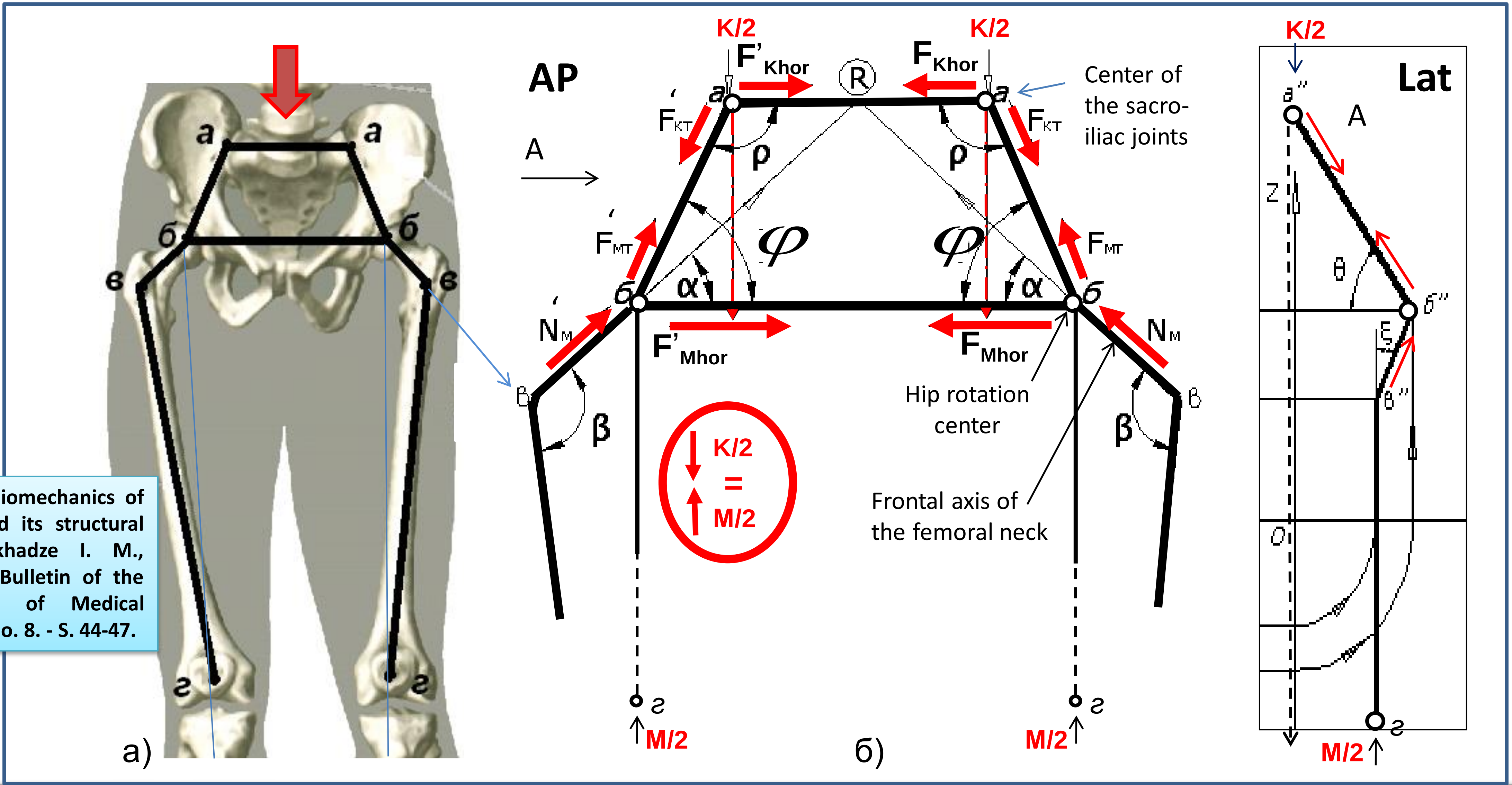

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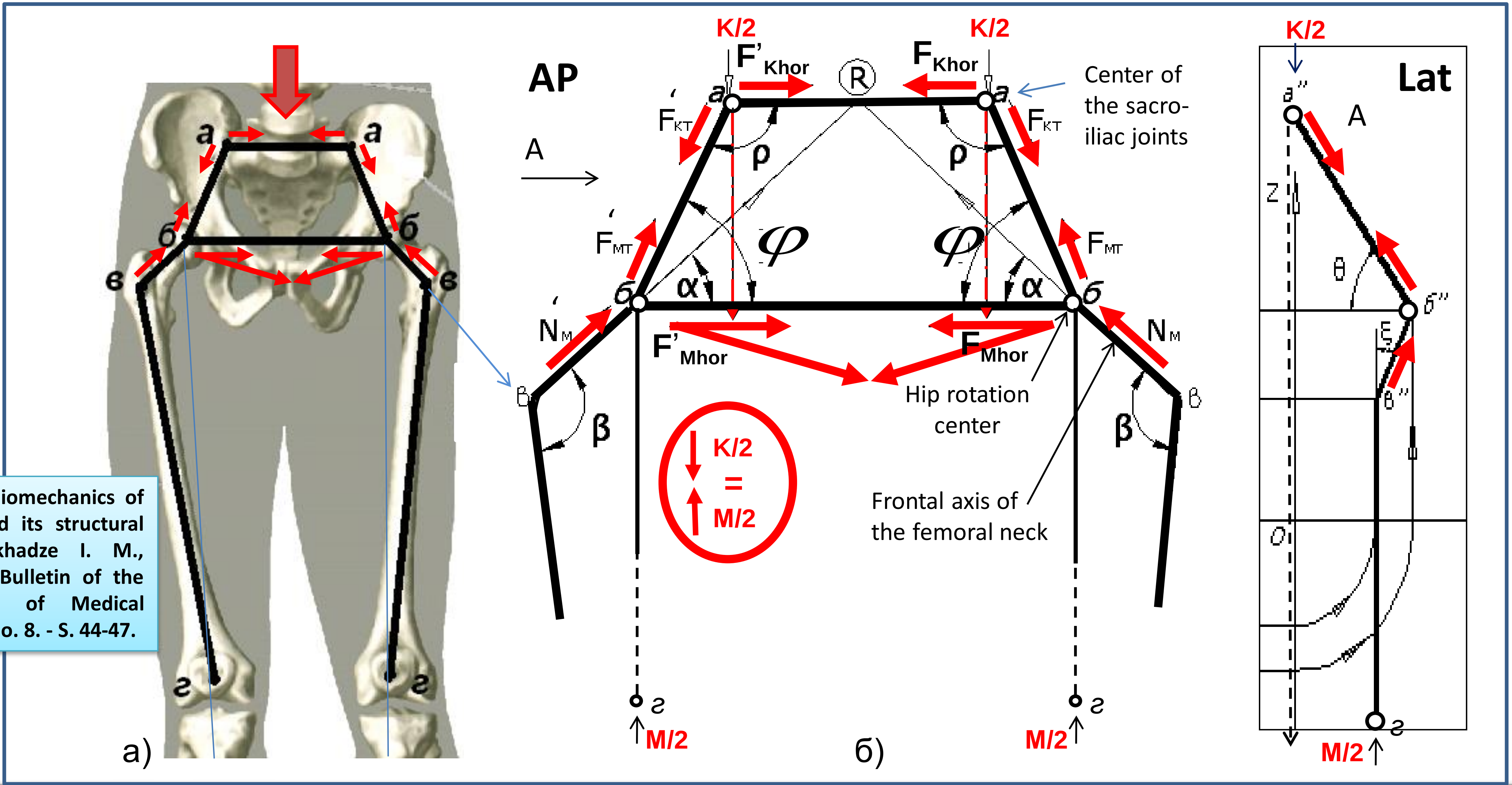

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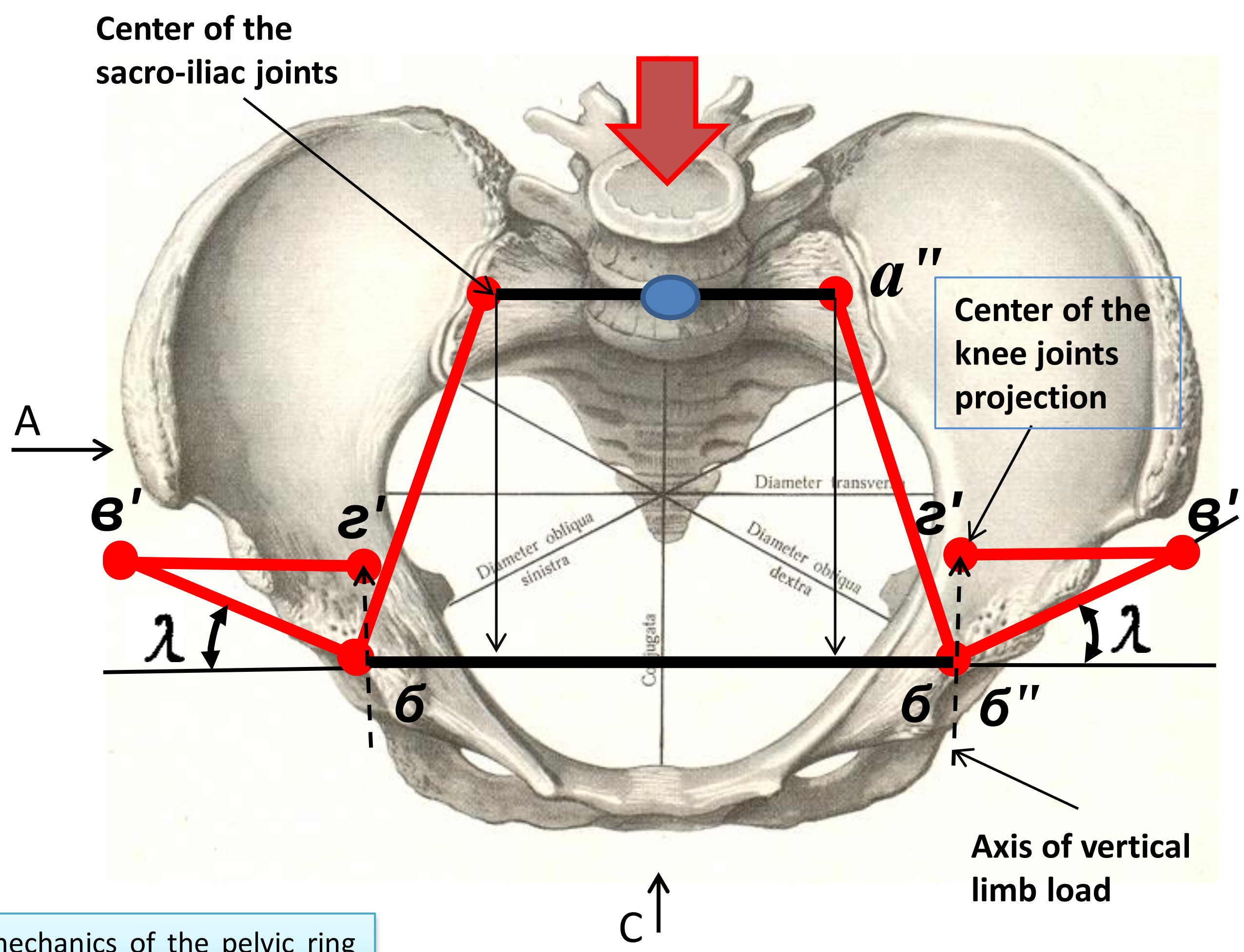
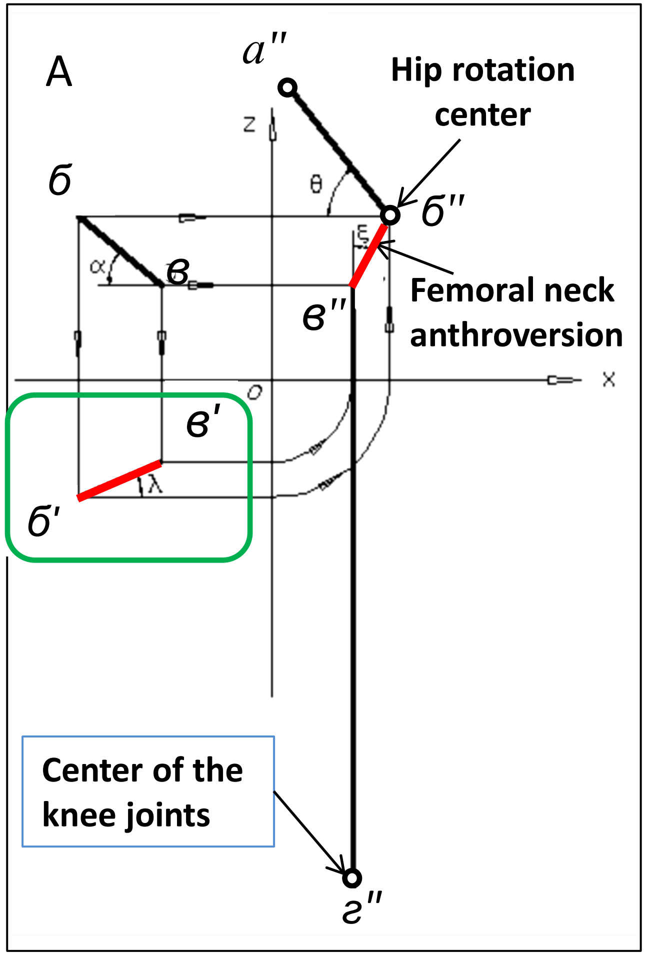
Three-dimentional plane

Fig. 2 Top view of the pelvic section of the hip joint (M 1: 2.5): б́ - в́ - horizontal projection of the femoral neck; г′ - projection of the knee joint.





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Three-dimentional plane

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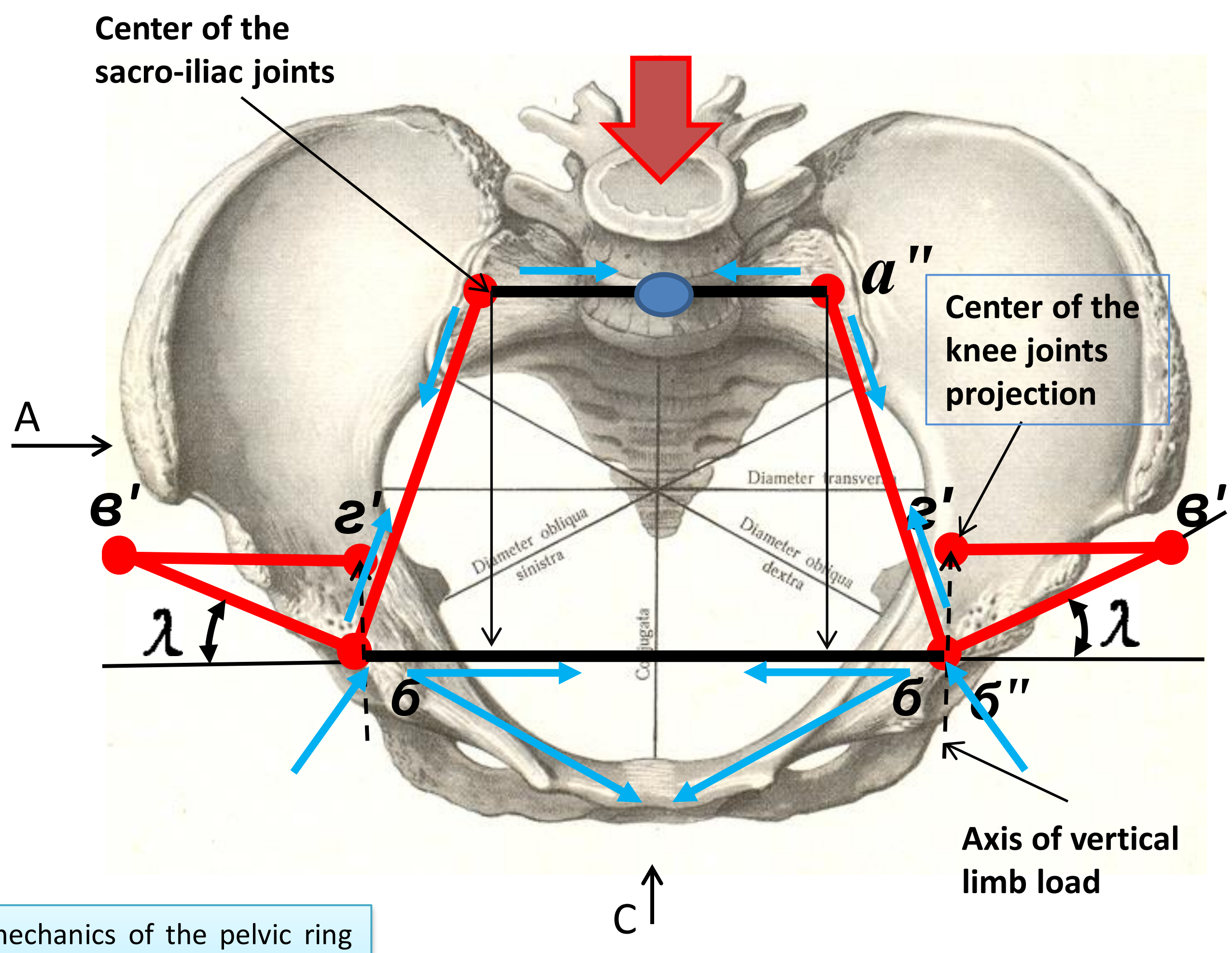

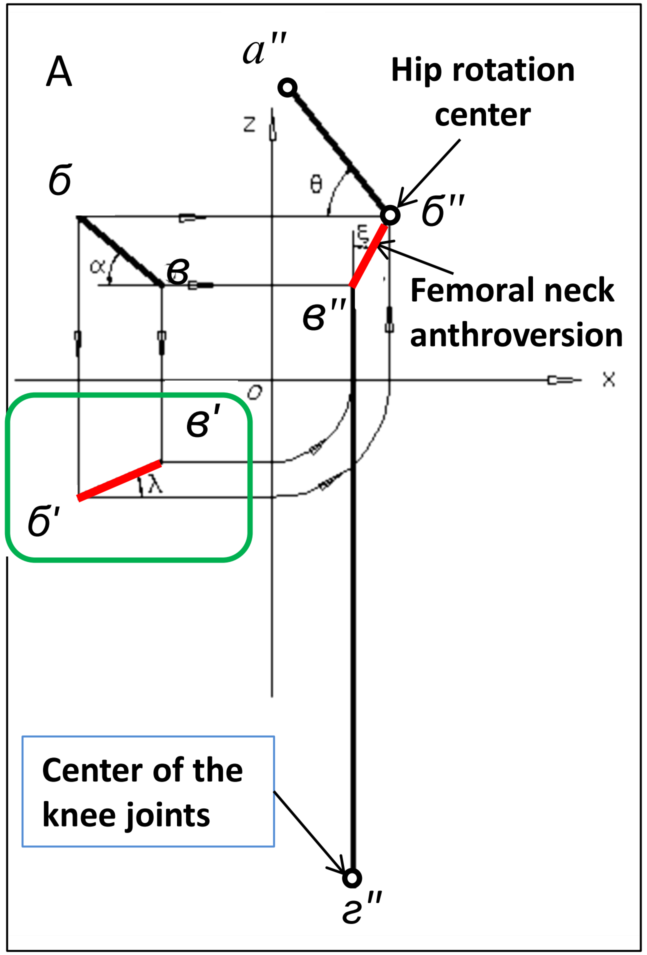

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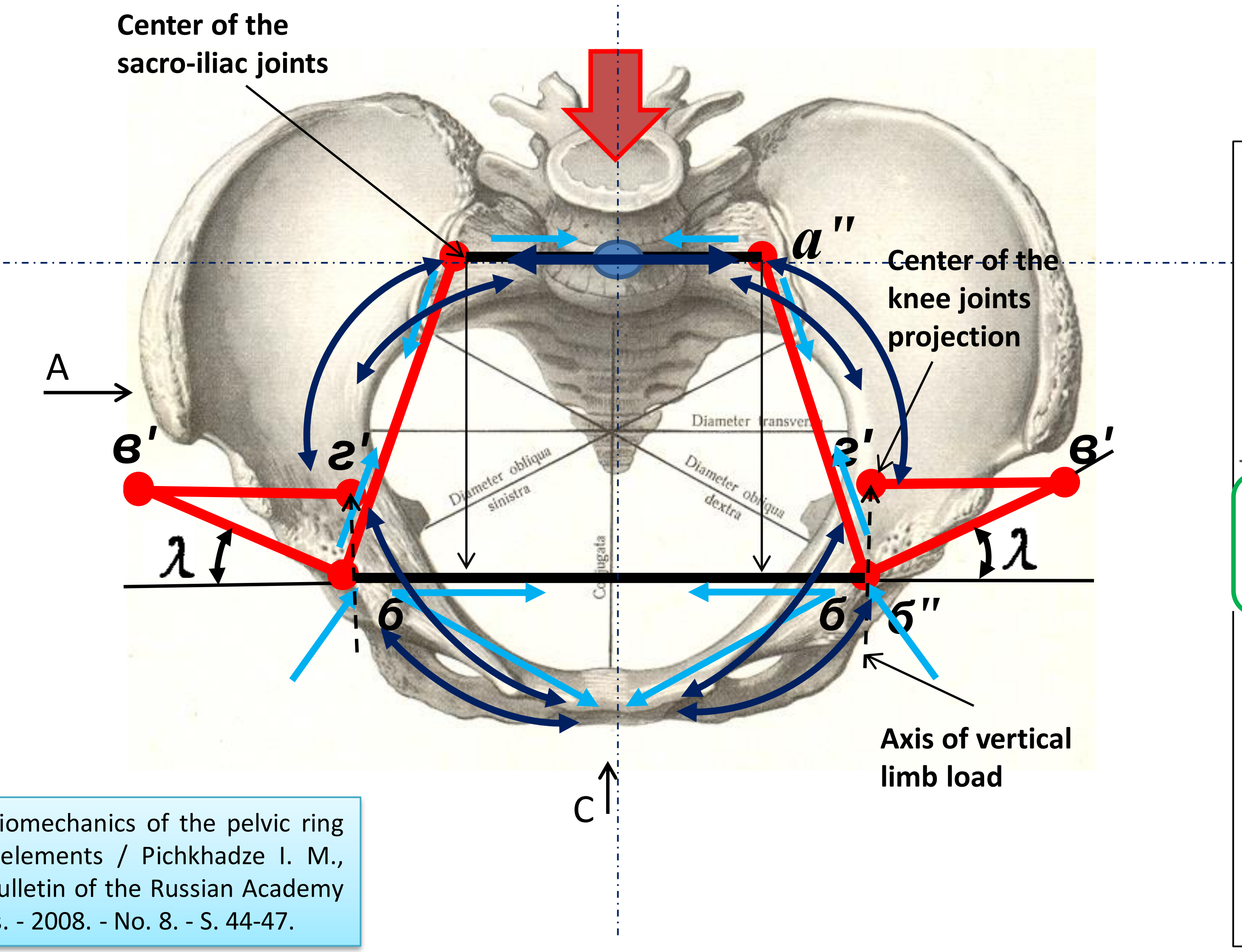

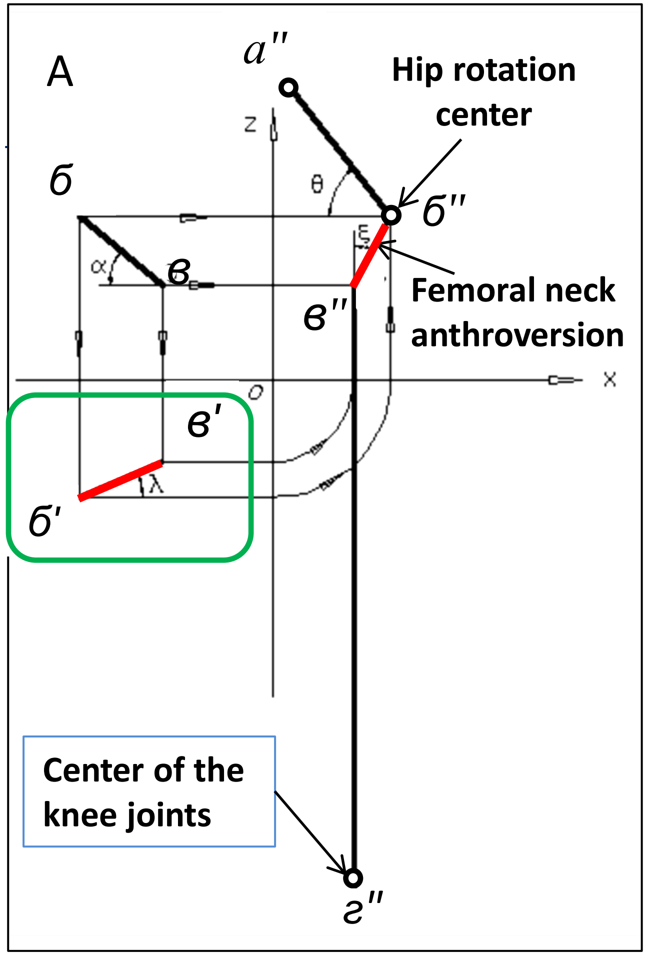

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BIOMECHANICS OF THE PELVIC RING AND ITS STRUCTURAL ELEMENTS

The very plane of the trapezoid imitating the pelvic ring is deflected on the side projection (Fig. 3) from the horizontal to the sacrum by an angle θ equal to ~ 50˚ (line *а´´- б´´* (a´´- *b´´*)).

To determine the forces and moments perceived by the pelvic ring at the joints of the S-I J and HIP, we construct the projections of the femoral neck according to the rules of descriptive geometry in three mutually perpendicular planes (Fig. 4).

In fig. 4 thigh neck projections constructed for angle β (see Fig. 1, b), equal to 125˚, and the angle *λ* (see Fig. 2), equal to 15˚. On the frontal projection, the angle α of the inclination of the femoral neck *бв* (*bв*) to the horizontal can be determined from the *бвг* (*bвg*) triangle (see Fig. 1, b).

The value of the angle γ - the deviation of the femur is ~ 5˚ - 7˚. Then the angle *вбг* (*вbg*) is equal to 180˚- (*γ* + β) ≈180˚- (130˚-132˚), respectively, the angle α is equal to 90˚- the angle *вбг* (*вbg*) (as additional), i.e. ~ 40˚-42˚.

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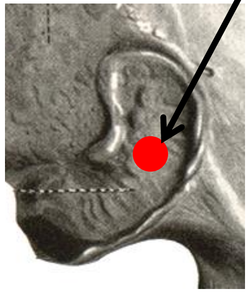

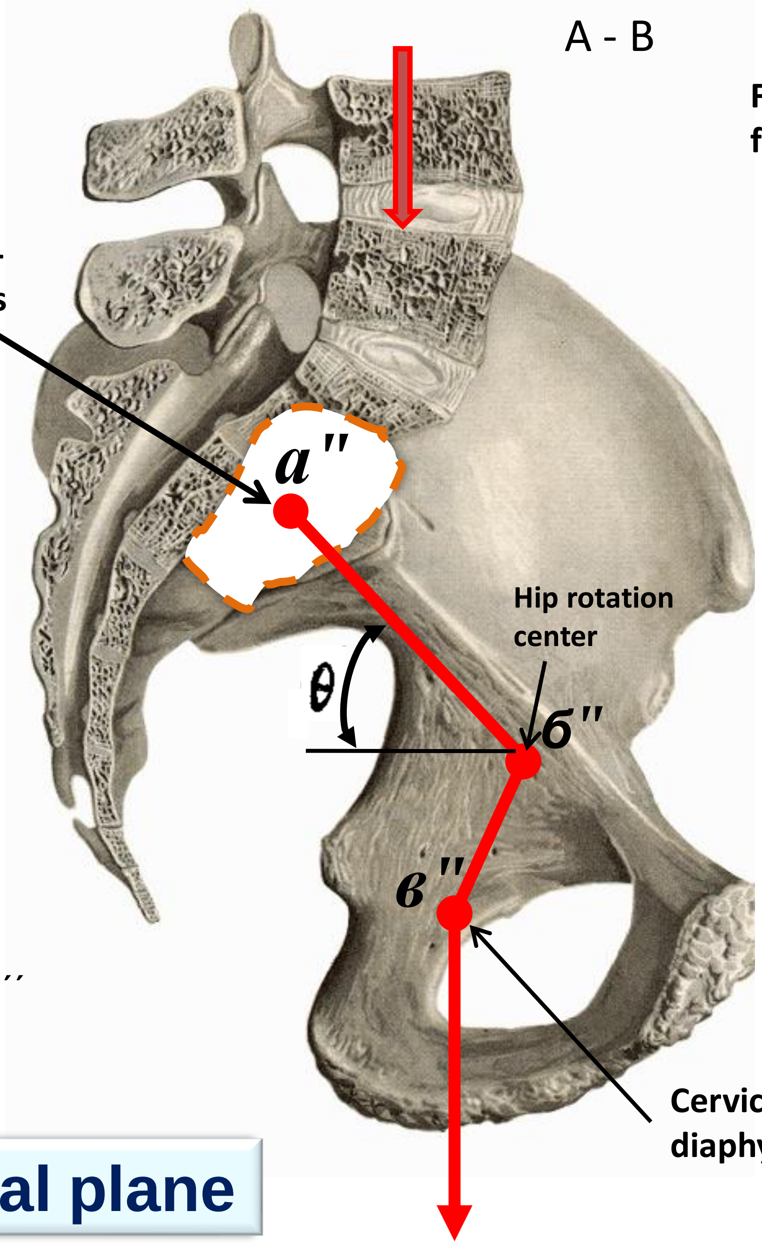

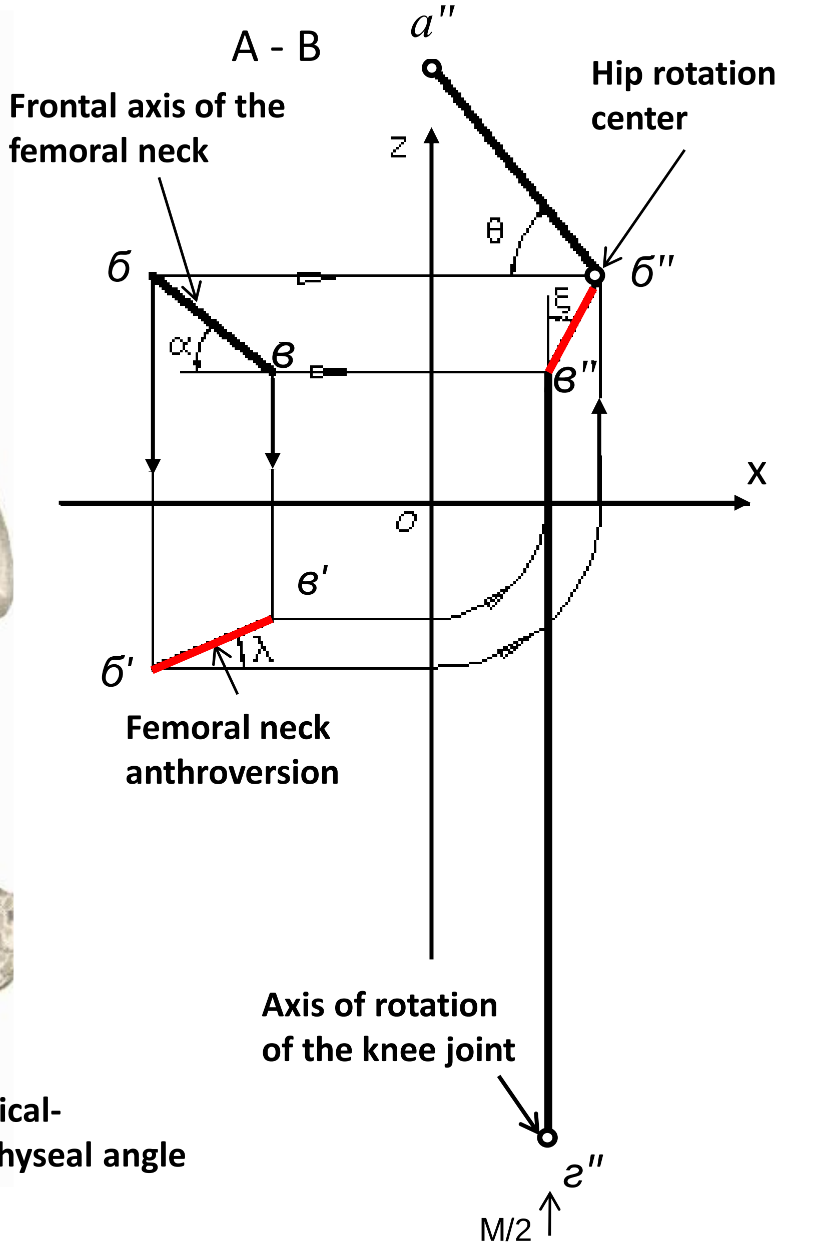

Fig. 3 Side view (left) on the pelvis (M 1: 2.5): a´´ *b´´* - lateral projection of the trapezoid; *b´´ в´´* - projection of the femoral neck

Three-dimentional plane

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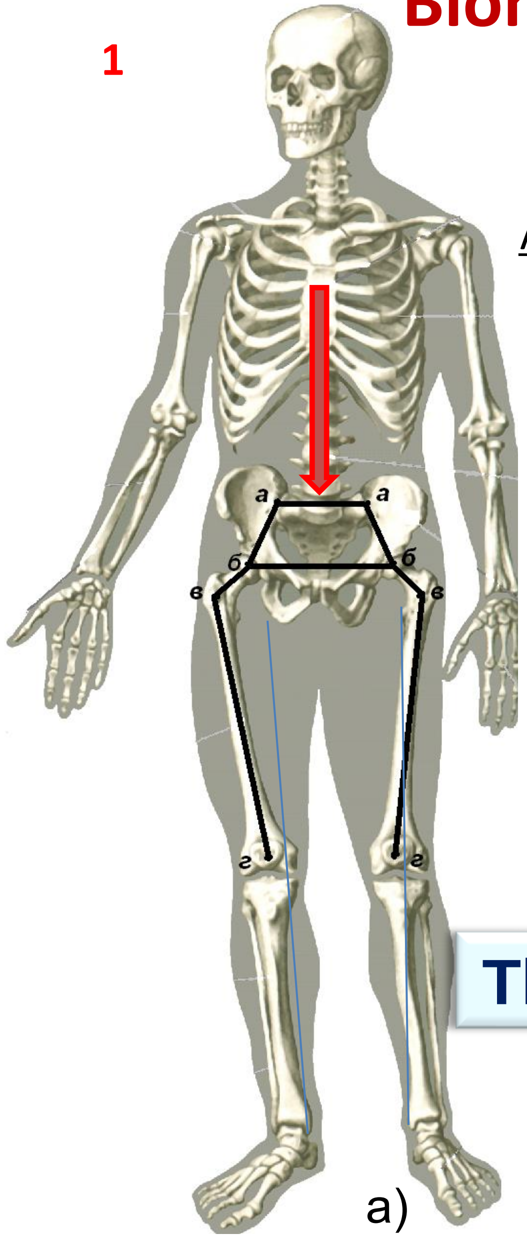
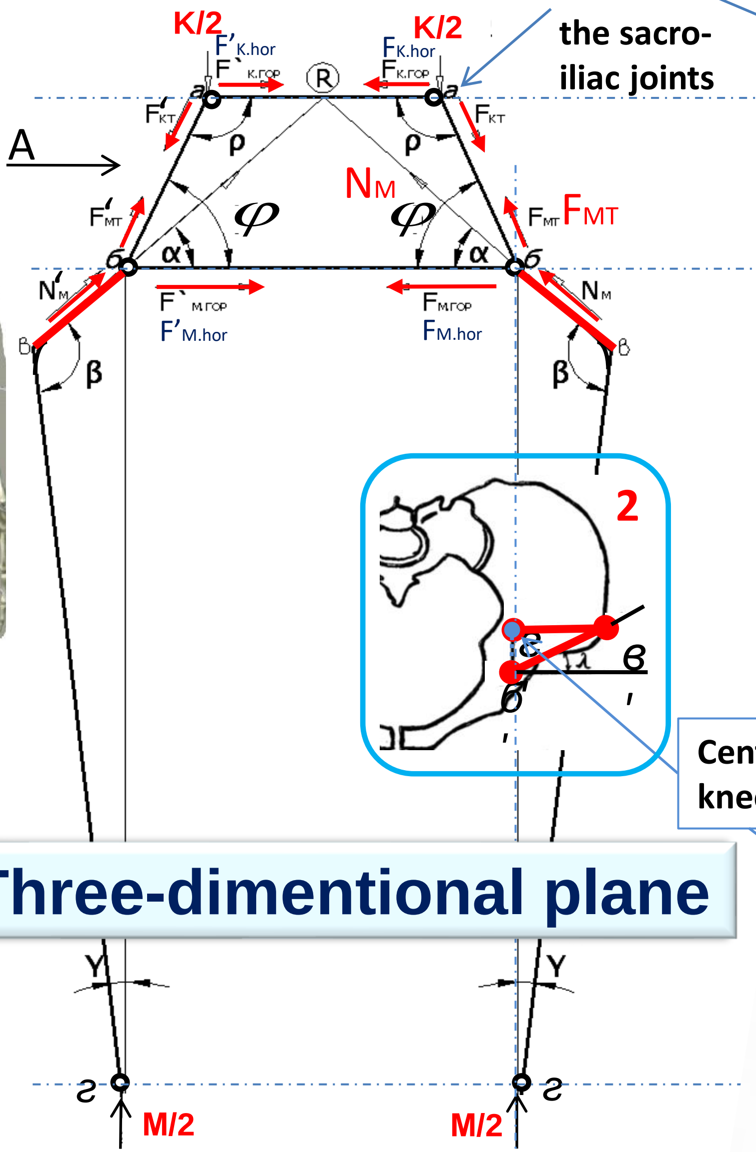
Biomechanics of the pelvic ring

1





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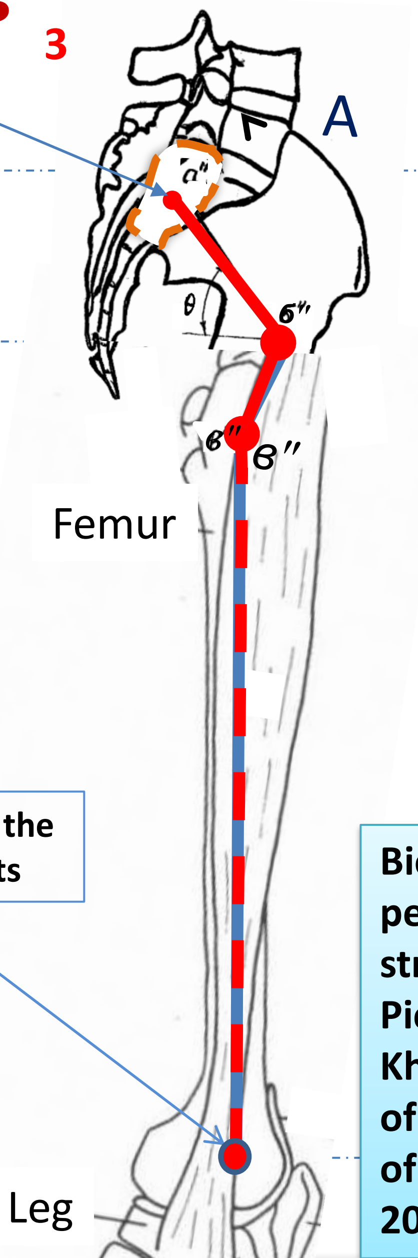
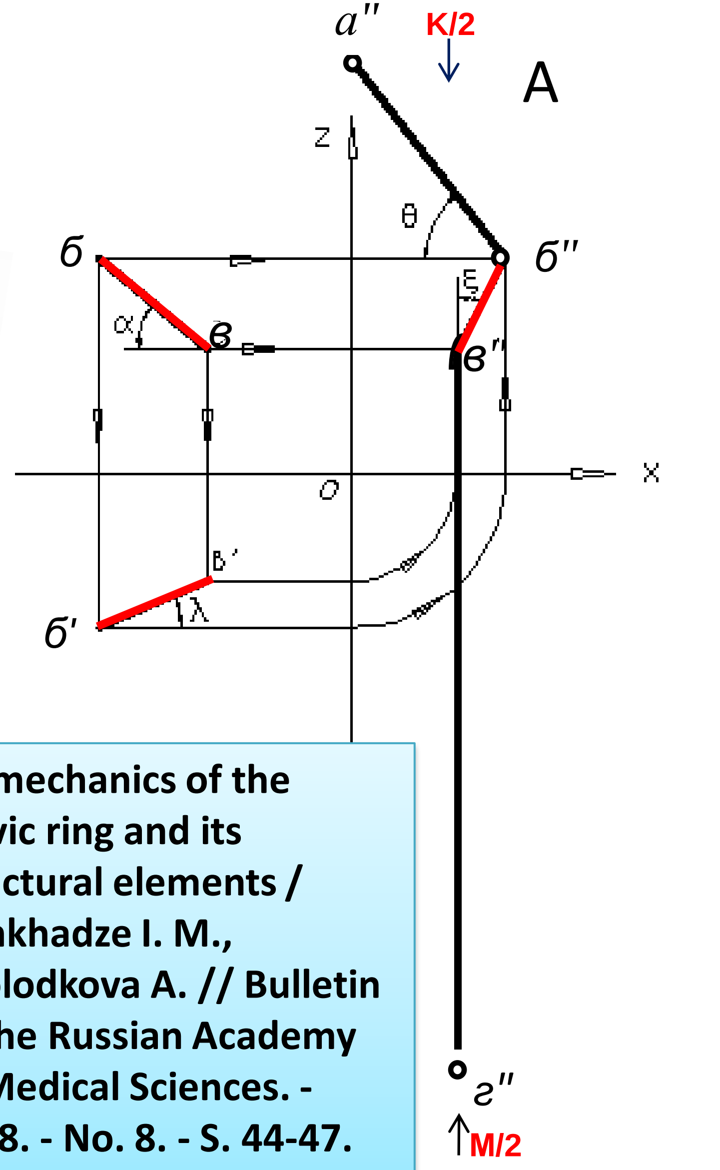


Fig.3 Side view (left) of the pelvis (M 1: 2.5): a´´b´´ - lateral projection of the trapezoid; b´´ to´´ - projection of the femoral neck.



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All graphical constructions were performed for averaged bone lengths: femur 420 ... 450 mm, femoral neck 100 ... 105 mm; the dimensions of the pelvis are taken from the drawings of the anatomical atlas, taking into account the scale of their implementation.

The constructed lateral projection of the femoral neck *б´´в´´* (*b´´в´´*) makes with vertical, angle *ξ* equal to ~ 25˚ - 26˚. Adding a lateral projection of the trapezium of the pelvic ring a´´*b*´´ (see Fig. 4, left view) and the hips *в´´г´´*, we obtain a picture of their relative position (view along arrow A in Fig. 1b), allowing calculation forces and moments acting on the base ring in the lateral plane.

In fig. 5a, a triangle of forces acting on the pelvic ring in the center of the hip joint (point *б´´* (*b´´*)) is presented. The reactive force M/2 acts on the femoral bone *г´´в´´*(*g´´в´´*), which is decomposed into two components: $N_м$ - along the femoral neck *б´´в´´* (*b´´в´´*), and $R_{мт}$ - along the projection of the pelvis *а´´б´´*(a´´*b*´´) – on the height of the trapezoid. Since the angles between the directions of the forces are known: *ξ* ≈ 25˚, *ψ* = 90˚ - θ ≈ 40˚, the third angle is η = 180˚- (25˚ + 40˚) ≈ 115˚. To determine the forces $N_м$ and $R_{мт}$, we solve the oblique triangle.

Denoting M/2 = *c*; $N_м$ = a; $R_{мт}$ = *в*, we get:

$$c = \frac{a \cdot \sin\eta}{\sin\psi}, \quad \text{откуда} \quad a = \frac{c \cdot \sin\psi}{\sin\eta}, \quad c = \frac{в \cdot \sin\eta}{\sin\xi}, \quad в = \frac{c \cdot \sin\xi}{\sin\eta}$$

In numerical terms:

$$N_M = a \cong \frac{M}{2} \cdot \frac{\sin 40°}{\sin 115°} \cong \frac{M}{2} \cdot \frac{0{,}643}{0{,}906} \cong 0{,}71\frac{M}{2} \cong 0{,}35M$$

$$R_{MT} = в \cong \frac{M}{2} \cdot \frac{\sin 25°}{\sin 115°} \cong \frac{M}{2} \cdot \frac{0{,}423}{0{,}906} \cong 0{,}47\frac{M}{2} \cong 0{,}24M.$$

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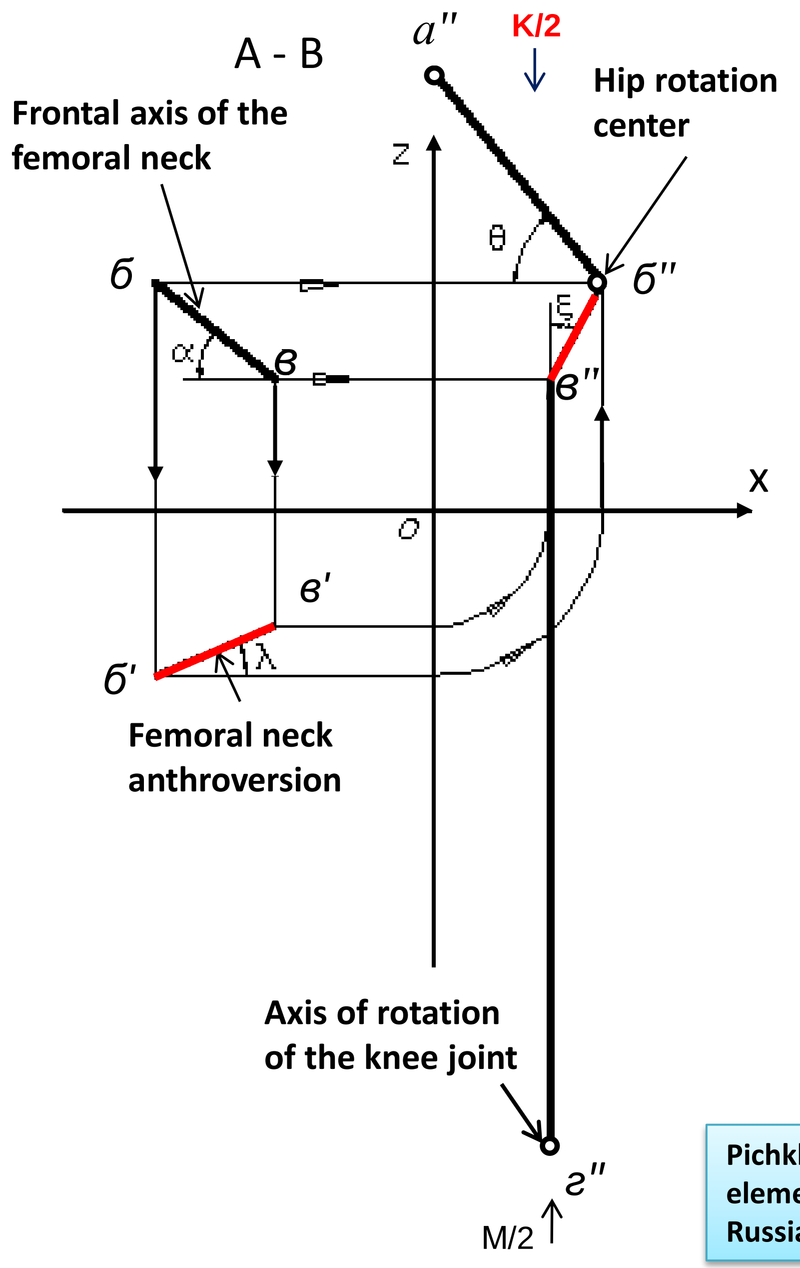

Fig. 4 The layout of the femoral neck in three mutually perpendicular planes:
b **- frontal;**
b´ в´ **- in the plan;**
b´´ c´´ **- lateral;**
a´´ b´´ **- lateral projection of the distance between the sacro-spinal and hip joints;**
в´´ г´´ **- lateral projection of the thigh (left view).**

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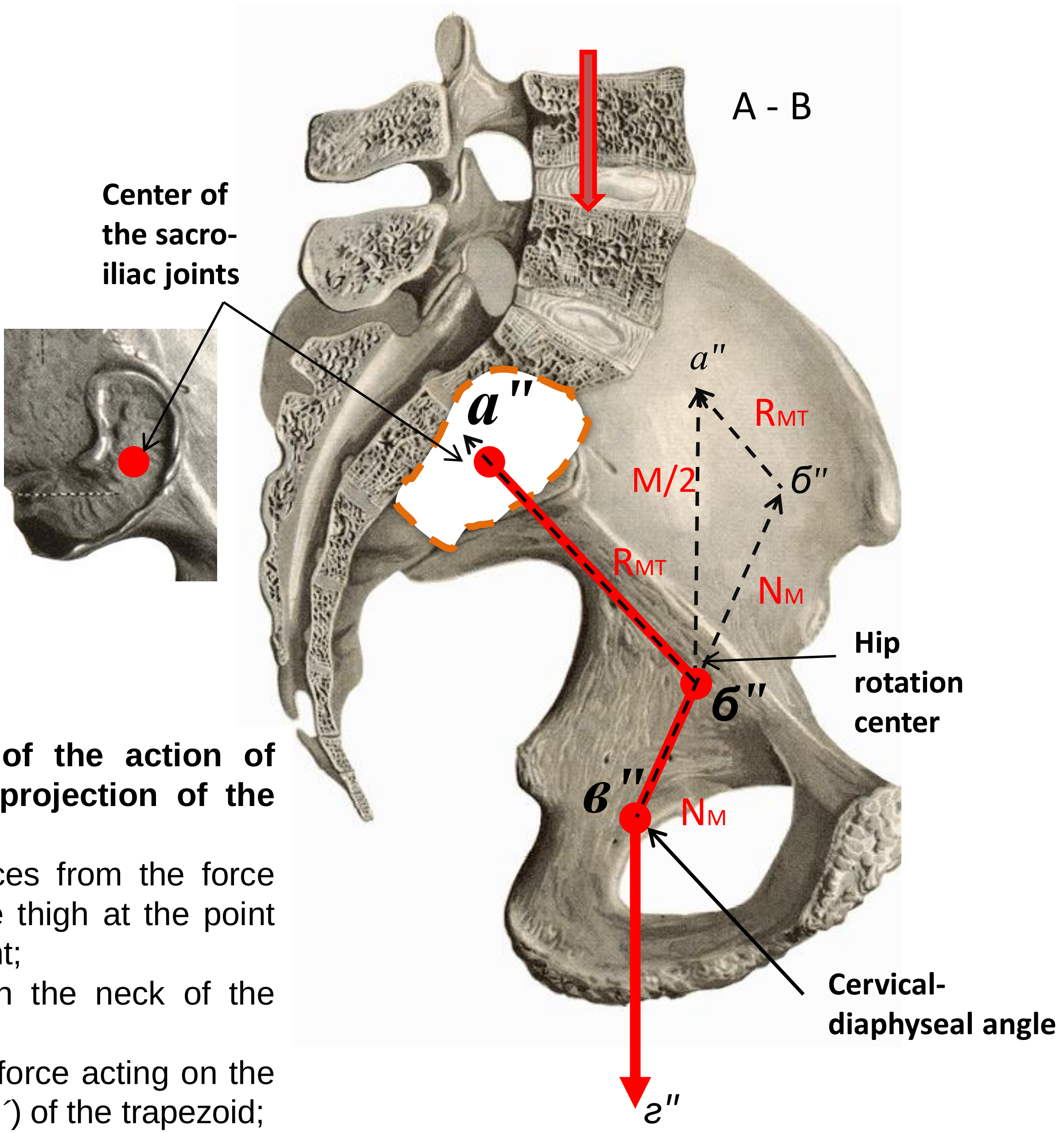

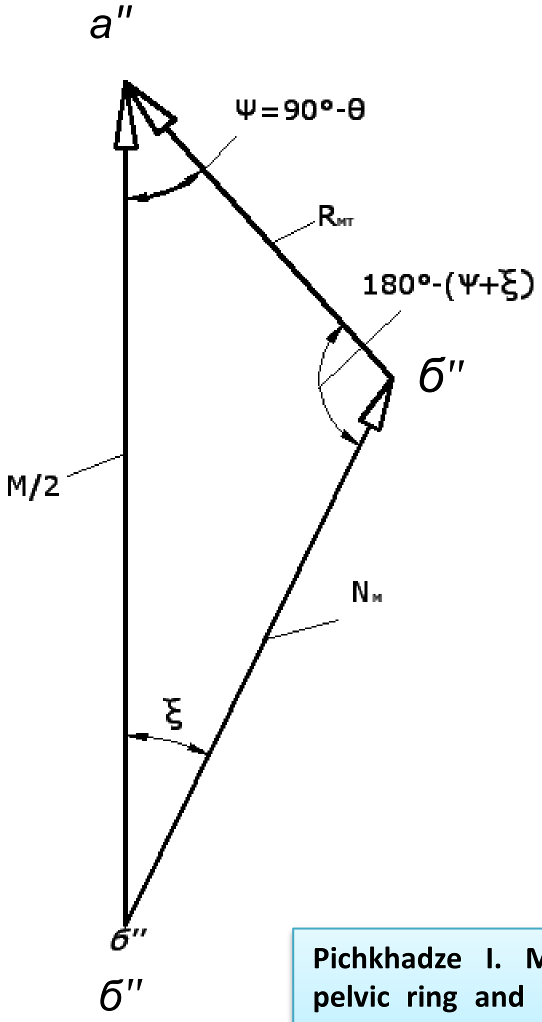

a

Fig. 5, a Scheme of the action of forces, see lateral projection of the pelvic ring:
a - a triangle of forces from the force M/2, acting along the thigh at the point *б˝*(*b˝*) - in the hip joint;
N_M – force acting on the neck of the thigh *б˝ в˝*(*b˝ в˝*);
R_{MT} – is the reaction force acting on the projection *a˝ б˝*(*a˝ b˝*) of the trapezoid;

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Consider the force triangle acting in the center of the S-I J (point a´´) from the force K/2 **(Fig. 5, *б*(b))**. Force K/2 is decomposed into two components: $R_{кт}$ - along the line *a´´б´´*(a´´*b´´*) - projections of the pelvic ring and force $N_т$, perpendicular to it, creating a moment counterclockwise, tending to turn the pelvis to a horizontal plane relative to the line *б – б´*(*b – b´*) - of the hip joints.

The component $R_{кт}$ of a right triangle is defined as:

$$R_{KT} = \frac{K}{2} \cdot \cos\psi \approx \frac{K}{2} \cdot \cos 40^\circ$$

Substituting the value K = 0.64M, we obtain in numerical expression:

$$R_{KT} \cong \frac{0{,}64 \cdot M}{2} \cdot 0{,}766 \cong 0{,}49 \cdot \frac{M}{2} \cong 0{,}25M.$$

Since the values of the angles and sizes of the bones fluctuate between 2° -5° and 5 ... 10 mm, respectively, their values for the calculation are selected approximately. Therefore, with sufficient reliability (0.4% error), we can assume that the forces $R_{МТ}$ and $R_{КТ}$ are equal and opposite in direction, i.e. these forces are balanced.

Strength $N_т$, as already noted, creates a tipping moment. The value of $N_т$ is determined from the force triangle (see **Fig. 5, *б*(*b*)**).

$$N_T = \frac{K}{2} \cdot \sin\psi \cong \frac{0{,}64 \cdot M}{2} \cdot 0{,}643 \cong 0{,}41\frac{M}{2} \cong 0{,}21 \cdot M.$$

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Static load distribution according to I. Pichkhadze - 2008

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The magnitude of the moment M_{NT} will be equal to:

M_{NT} = N_T*(а´´б´´) (a´´ b´´),

where а´´б´´(a´´ b´´) ≈ 112 ... 115mm, then

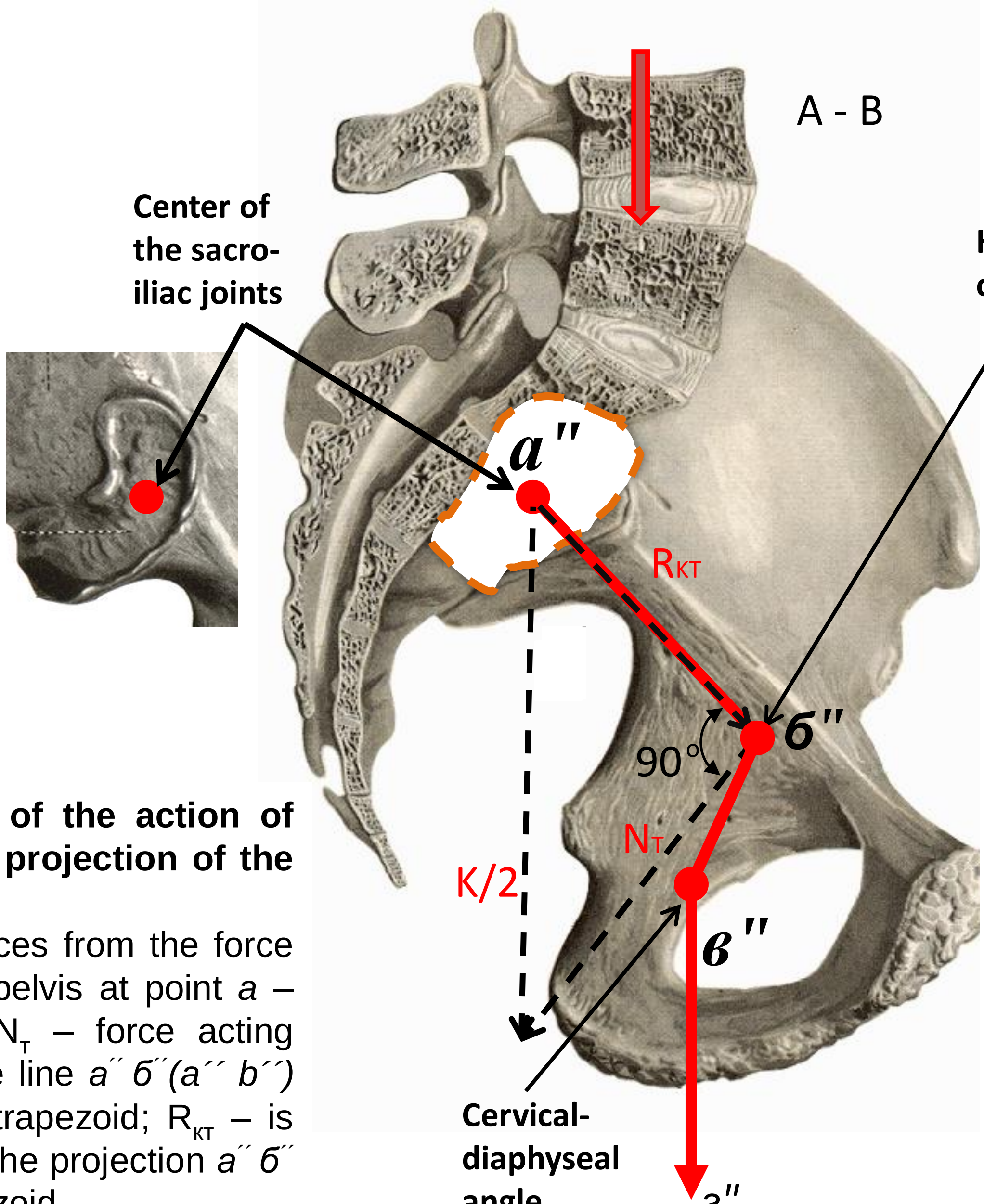
$$M_{NT} \cong 0{,}41\frac{M}{2}\cdot 112\text{мм} = 45{,}9\frac{M}{2} = 22{,}95\cdot M\,(H\cdot \text{мм}).$$

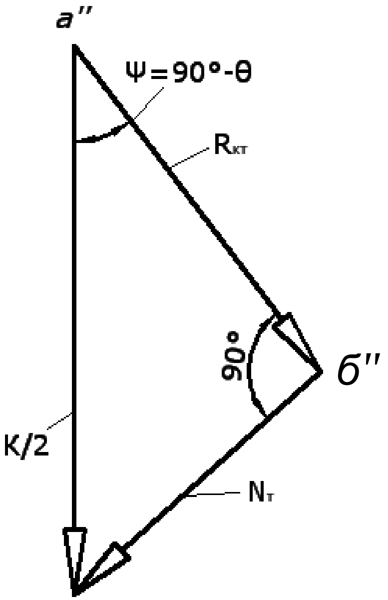
This moment is balanced by the moment created by the mass of the human body, applied at the center of gravity.

Consider the forces acting on the pelvic ring of the plane a´´ *b*´´, conditionally depicting it in a vertical (frontal) plane **(see Fig. 1, *а,б* (a, *b*))**. The N_M force acting on the hip neck bb is decomposed into two components on the sides of the trapezoid *бб* and *аб* (bb and ab) **(see Fig. 1, *б*(*b*))**.

With the existing proportions of the pelvic ring and for the angle β equal to 125˚, we get the point R - the intersection of the forces N_M on the lumbar-sacral joint (on the line aa). At angles β greater than 125˚ (126˚ - 135˚), the N_M forces will intersect on the spine above the line aa, outside the pelvic ring, which reduces the stability of the bones of the skeleton.

Static load distribution according to I. Pichkhadze - 2008





б

Fig. 5, b Scheme of the action of forces, see lateral projection of the pelvic ring:
b - a triangle of forces from the force K/2, acting on the pelvis at point *a* – sacro-spinal joint; N_T – force acting perpendicular to the line *a´´ б´´(a´´ b´´)* - projection of the trapezoid; R_{KT} – is the force acting on the projection *a´´ б´´ (a´´ b´´)* of the trapezoid.

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Static load distribution according to I. Pichkhadze - 2008

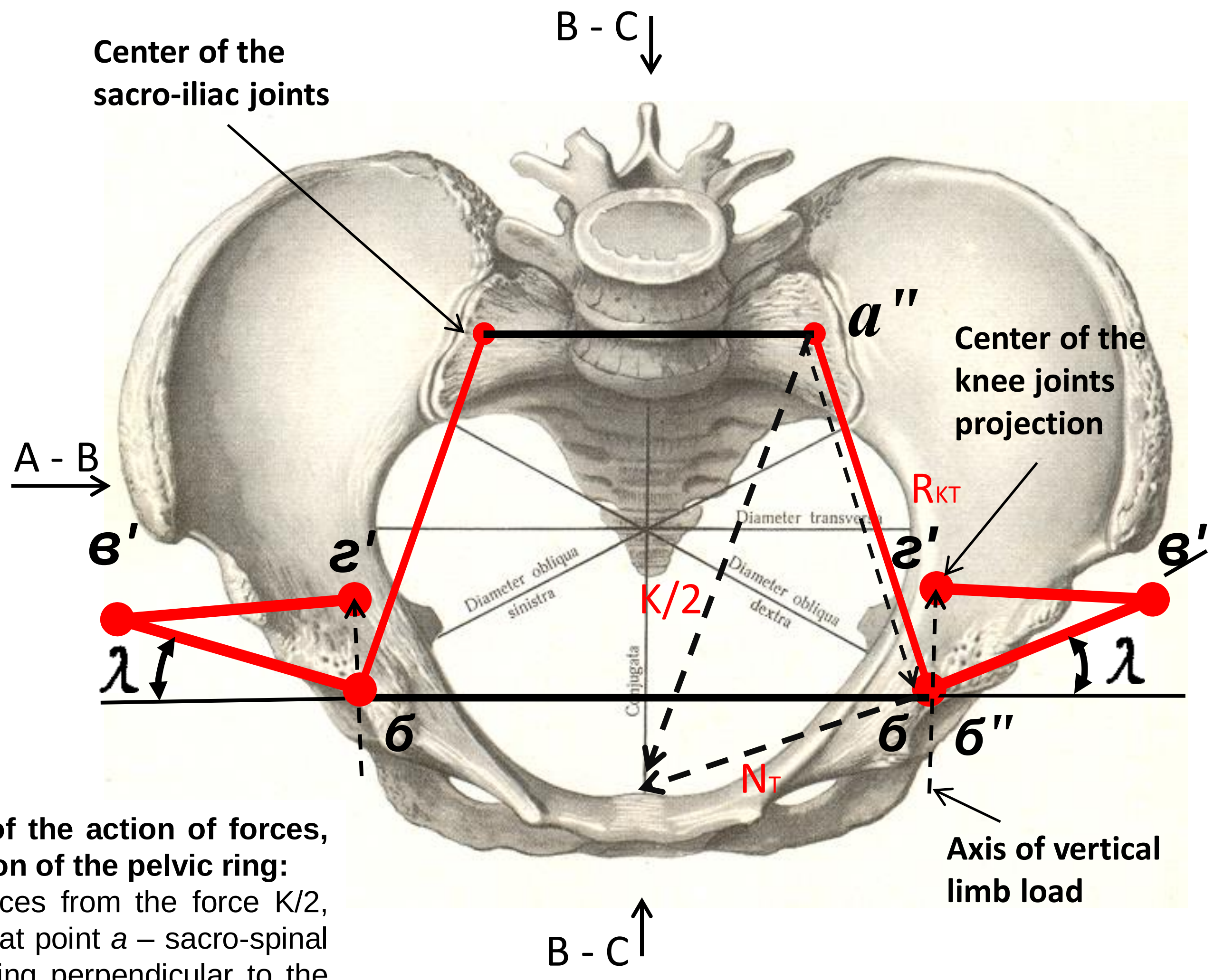
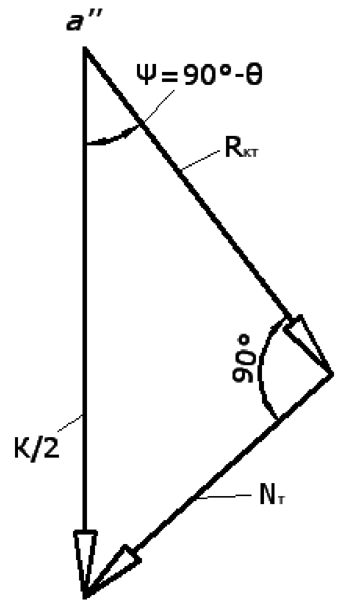


Fig. 5, b Scheme of the action of forces, see lateral projection of the pelvic ring:
b - a triangle of forces from the force K/2, acting on the pelvis at point *a* – sacro-spinal joint; N_T – force acting perpendicular to the line *a˝ б˝(a˝ b˝)* - projection of the trapezoid; $R_{КТ}$ – is the force acting on the projection *a˝ б˝ (a˝ b˝)* of the trapezoid.



б

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Static load distribution according to I. Pichkhadze - 2008

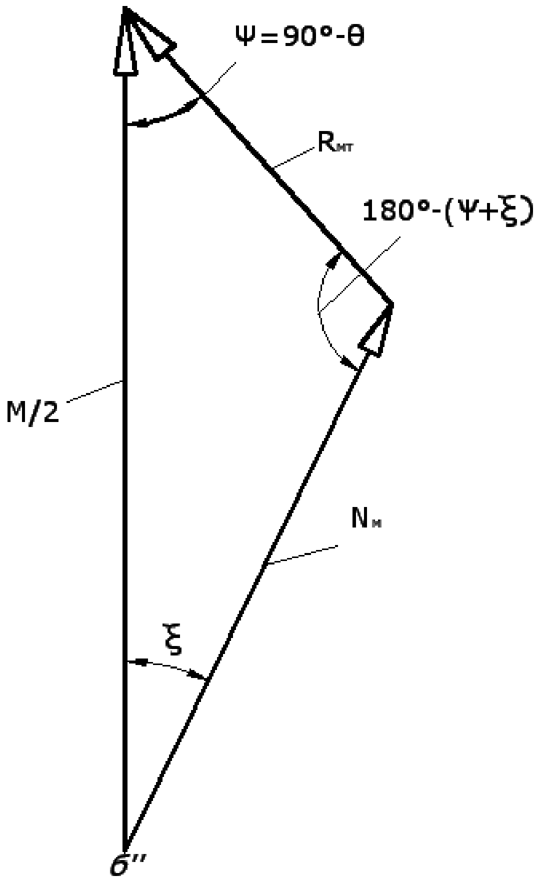
Fig. 5, a Scheme of the action of forces, see lateral projection of the pelvic ring:

a - a triangle of forces from the force M/2, acting along the thigh at the point *б´´*(*b´´*) - in the hip joint;

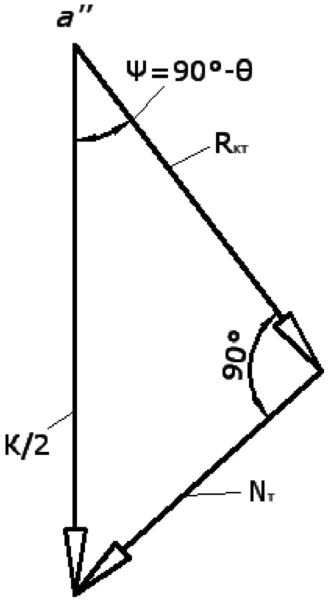
N_M – force acting on the neck of the thigh *б´´ в´´*(*b´´ в´´*);

R_{MT} – is the reaction force acting on the projection *a´´ б´´*(*a´´ b´´*) of the trapezoid;

b - a triangle of forces from the force K/2, acting on the pelvis at point *a* – sacro-spinal joint; N_T – force acting perpendicular to the line *a´´ б´´(a´´ b´´)* - projection of the trapezoid; R_{KT} – is the force acting on the projection *a´´ б´´ (a´´ b´´)* of the trapezoid.



a



б

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Static load distribution according to I. Pichkhadze - 2008

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The triangle of action of the forces acting at point б(b) (HIP) is shown in **Fig. 6,*a***. A triangle (oblique -angle), the value of the angles of which is determined by the size of the pelvic ring. The angles are: $\alpha \approx 40^\circ$ - 42°; $\varphi \approx 60^\circ$ - 65°; $\rho \approx 115^\circ$. From the solution of the oblique-angle triangle given earlier, we similarly obtain the horizontal component $F_{M.hor}$, equal to:

$$\boxed{F_{M.hor}} = \frac{N_{м} \cdot \sin(\varphi - \alpha)}{\sin(180^\circ - \varphi)} \cong N_{м} \cdot \frac{\sin 25^\circ}{\sin 115^\circ};$$

In numerical terms:

$$\boxed{F_{M.hor}} \cong \frac{0{,}71 \cdot M}{2} \cdot \frac{0{,}423}{0{,}906} \cong 0{,}32 \cdot \frac{M}{2}.$$

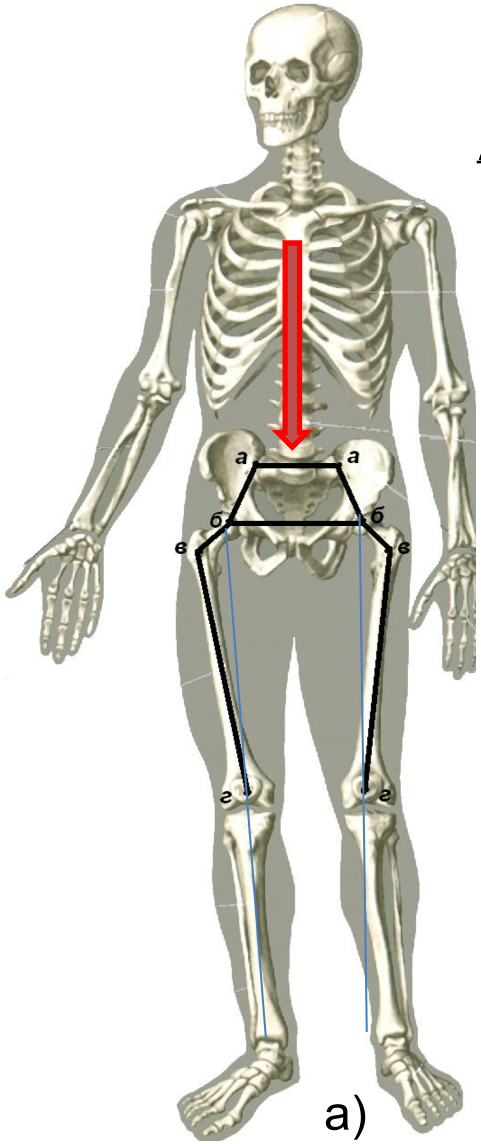
Static load distribution according to I. Pichkhadze - 2008

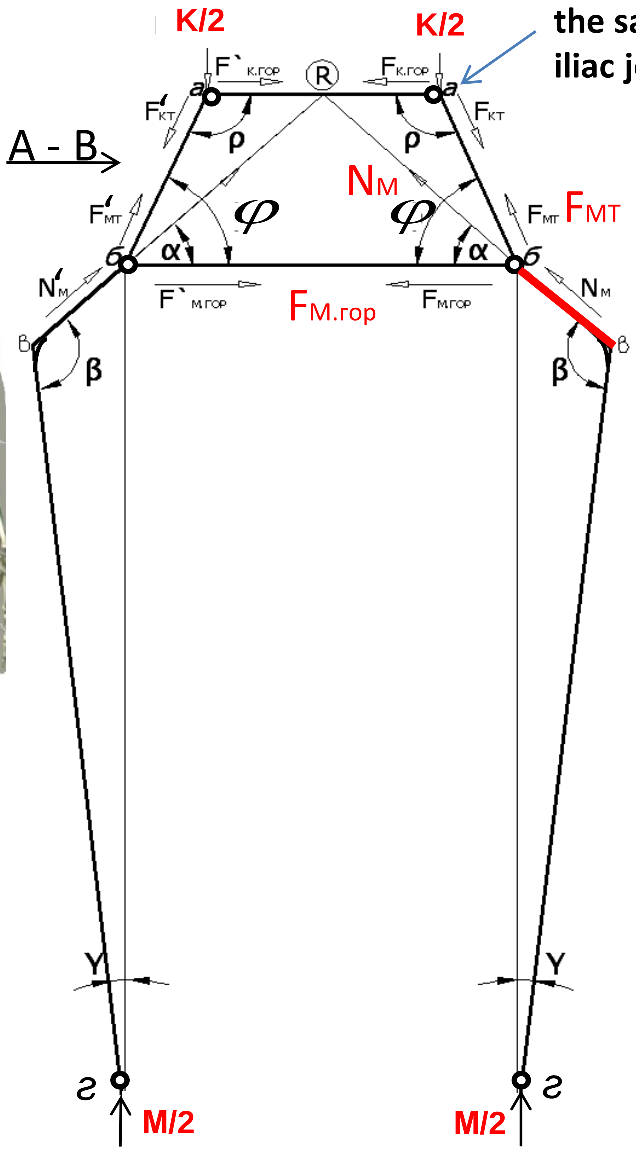
Fig. 6,a. Scheme of the action of forces in the plane *а´´ б´´*(*a´´ b´´*), depicted on the frontal projection:

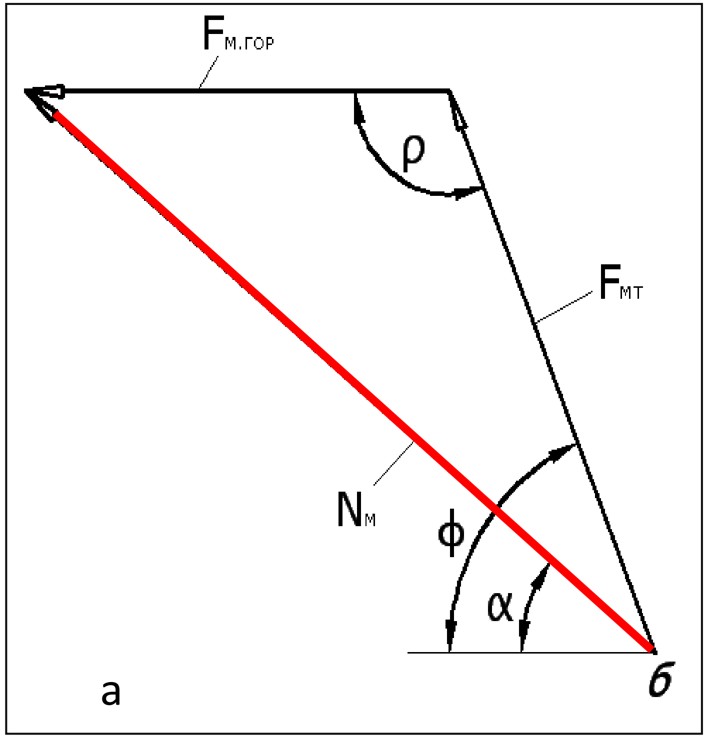
a - a triangle of forces from the force N_M acting along the neck of the thigh at point *б*(b) of the hip joint (HIP);

$F_{M.hor}$ – projection of force N_M, in the direction *б б*(b b) (connection of two HIP);

F_{MT} – is the projection of the force N_M, in the direction *а б*(a b) (connection of HIP and S-I J);







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Since the pelvic ring is a symmetrical system, a force $(F_{M.hor})$, arises in the other hip joint, which is the same in magnitude but opposite in direction **(see Fig. 1, a)**, i.e. forces are mutually balanced $F_{M.hor} \cong F'_{M.hor}$.

The component F_{MT}, directed along the line аб(ab), in turn, will be equal to:

$$F_{MT} = N_M \cdot \frac{\sin\alpha}{\sin(180° - \varphi)} \cong N_M \cdot \frac{\sin 42°}{\sin 115°}.$$

In numerical terms:

$$F_{MT} \cong \frac{0{,}71 \cdot M}{2} \cdot \frac{0{,}7}{0{,}906} \cong 0{,}55\frac{M}{2}.$$

Static load distribution according to I. Pichkhadze - 2008

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The force $R_{К.Т}$, acting on the sacro-vertebral joint (point a) from the side of the spine can also be decomposed into two components: along the lines aa and ab **(Fig. 6, *б*(*b*))**.

Solving a right-angled triangle, we obtain the force $F_{K.hor}$, directed along the line *a – a* towards the spine and equal to:

$$\boxed{F_{K.hor}} = R_{KT} \cdot tg(90^\circ - \varphi) \cong R_{KT} \cdot tg 25^\circ.$$

In numerical terms:

$$\boxed{F_{K.hor}} = 0,49 \cdot \frac{M}{2} \cdot 0,466 \cong 0,228 \cdot \frac{M}{2}.$$

Static load distribution according to I. Pichkhadze - 2008

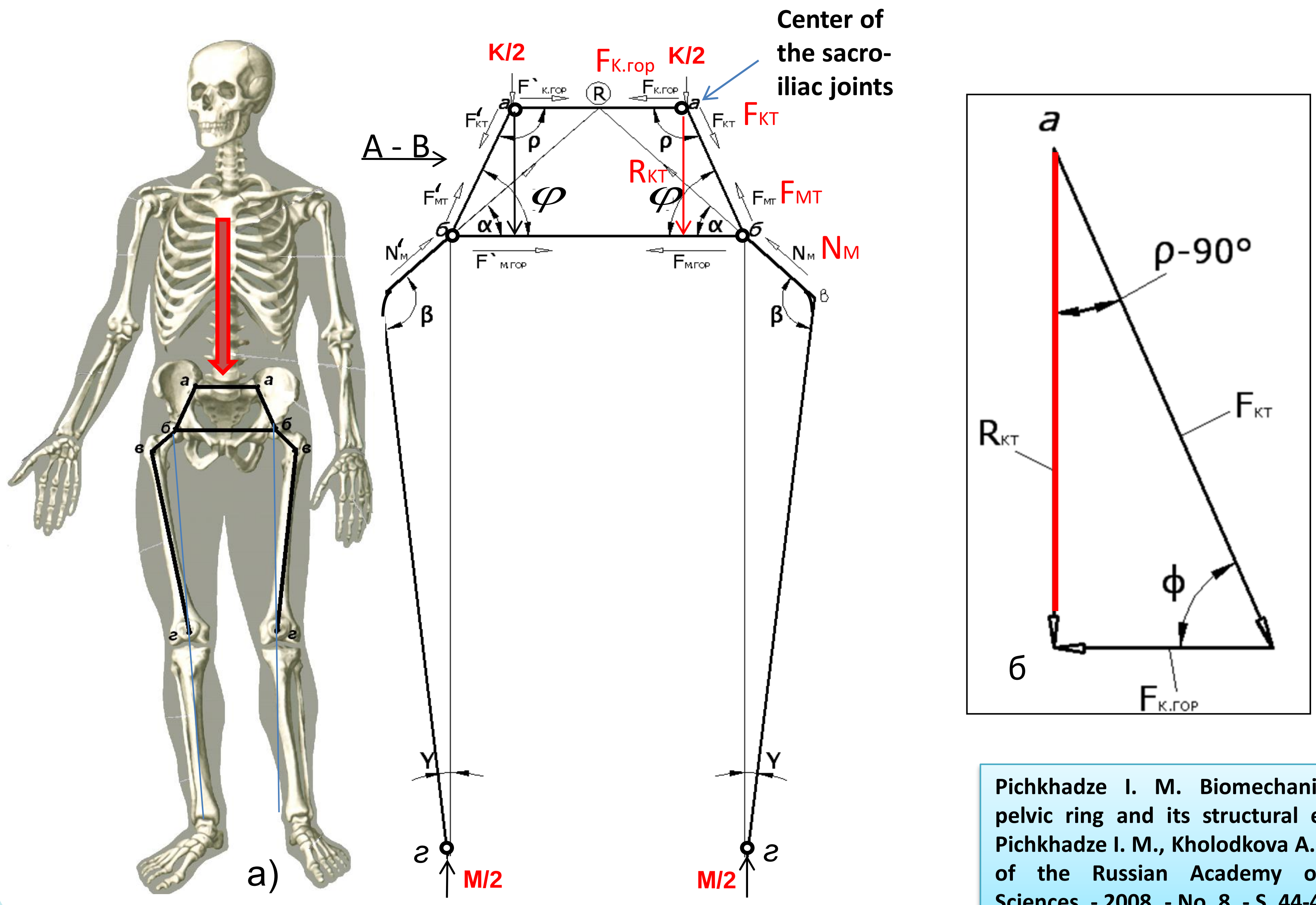

Fig. 6, b. Scheme of the action of forces in the plane *а´´ б´´*(a´´ b´´), depicted on the frontal projection:
б(*b*) - the triangle of forces from the force $R_{кт}$, acting along the height of the trapezoid *а´´ б´´*(a´´ b´´) at point a;
$F_{K.hor}$ – force, projection of force $R_{кт}$, in the direction a - a (connection of two S-I J);
$F_{кт}$ – the projection of the force $R_{кт}$, in the direction of ab towards the force $F_{мт}$.

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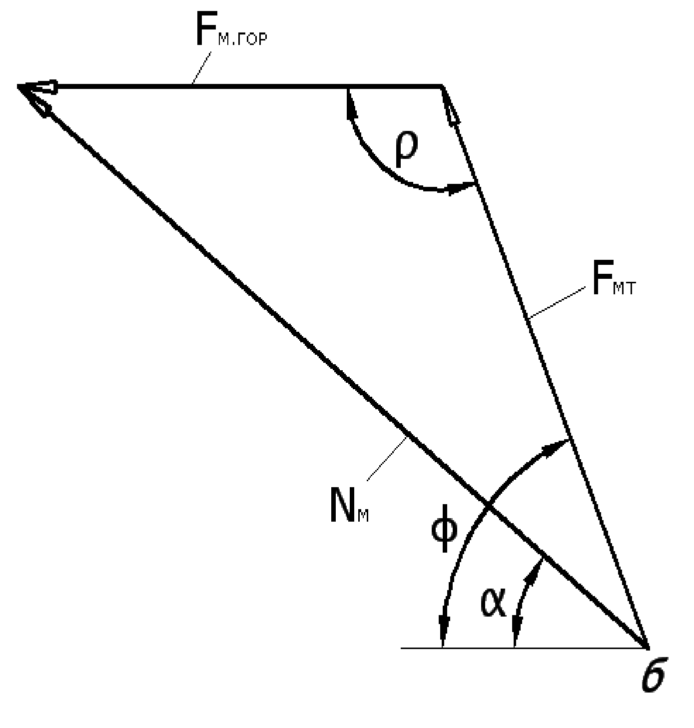
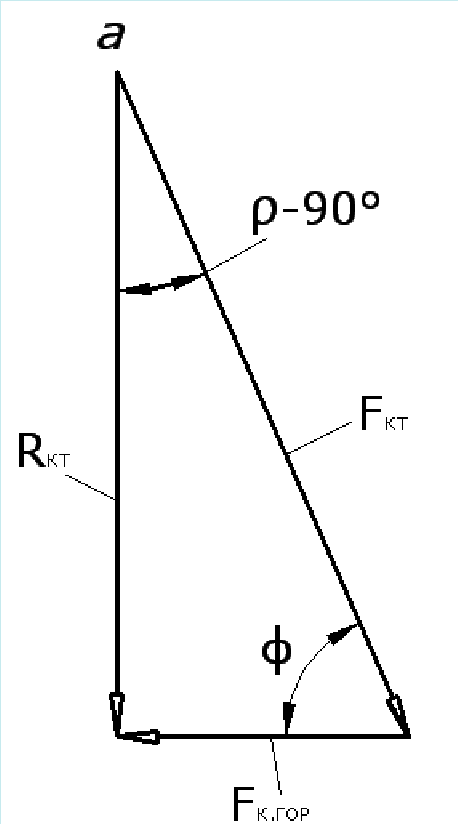
Static load distribution according to I. Pichkhadze - 2008

Fig. 6,a. Scheme of the action of forces in the plane *а´´ б´´*(*а´´ b´´*), depicted on the frontal projection:
a – triangle of forces from the force $N_м$ acting along the neck of the thigh at point *б*(*b*) of the hip joint (HIP);
$F_{M.hor}$ – projection of force $N_м$, in the direction *б б(*b b) (connection of two HIP);
$F_{мт}$ – is the projection of the force $N_м$, in the direction *а б(*a *b*) (connection of HIP and S-I J);

б(*b*) - the triangle of forces from the force $R_{кт}$, acting along the height of the trapezoid *а´´ б´´*(a´´ *b´´*) at point a;
$F_{K.hor}$ – force, projection of force $R_{кт}$, in the direction a - a (connection of two S-I J);
$F_{кт}$ – the projection of the force $R_{кт}$, in the direction of ab towards the force $F_{мт}$.



а



б

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From another sacro-vertebral joint **(see Fig. 1, б(b))**, the force $F'_{K.hor}$ acts, equal in magnitude, but opposite in direction, i.e. forces are balanced $F_{K.hor} \cong F'_{K.hor}$.

Component $F_{K.T}$, directed along the line a – *б* (a – *b*) from point a, will be equal to:

$$F_{K.T} = \frac{R_{K.T}}{\cos(90° - \varphi)} \cong \frac{R_{K.T}}{\cos 25°}.$$

In numerical terms:

$$F_{K.T} \cong \frac{0{,}49 \cdot M}{2 \cdot 0{,}906} \cong 0{,}54 \frac{M}{2}.$$

Consequently, the reactions of forces directed along the line ab connecting the S-IJ and HIP are practically equal and opposite in direction, and, therefore, mutually balanced.

Static load distribution according to I. Pichkhadze - 2008

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From the solutions of the equations considered above, it can be seen that in the region of the pelvic ring, i.e. the anterior and posterior half rings (trapezoid *aa бб*(aa *bb*)) reaction forces acting on the sacroiliac (*aa*(aa) points) and hip (*бб*(*bb*) points) joints along the lines connecting them aa, *bb* and ab are completely balanced, since they are equal in magnitude and opposite in direction (opposite each other).

Output. **From the above calculations and graphic constructions it follows that in a person who does not have injuries and anomalies in the structure of the skeleton, all the forces acting on the pelvic ring are in equilibrium. The proposed calculation technique helps to determine the tactics of treating patients with pelvic fractures both by conservative and surgical methods, including the correction of their congenital anomalies.**

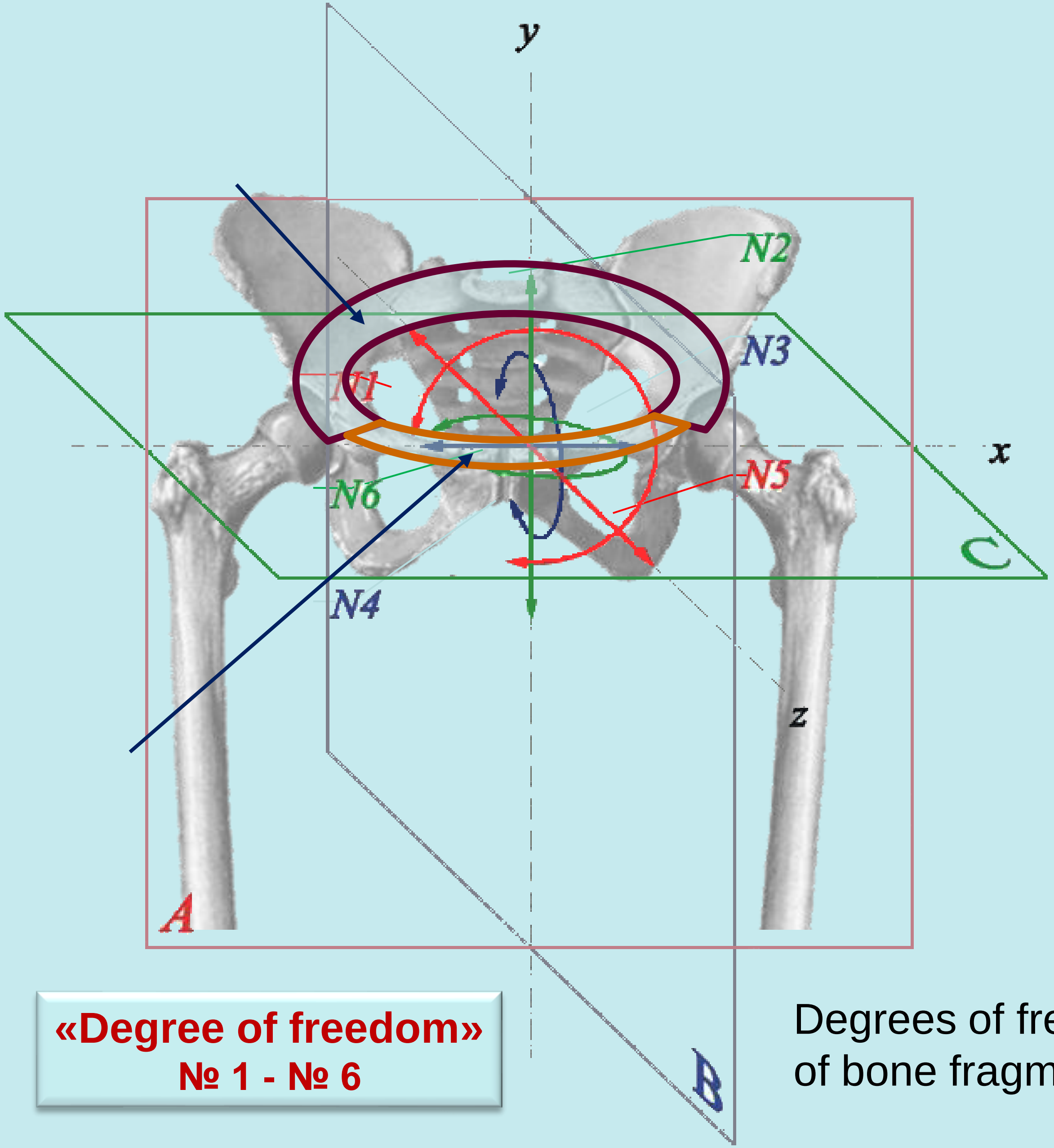
Mathematical studies have been verified by experts.

Fig. 2.47 Position of the pelvic preparation in the Zwick testing machine:
a - model of standing on two legs; b - walking position model; c - sitting position model
(together with Ch. S. Dorzhiev and N. S. Gavryushenko)

Zones of fractures of disruption of the pelvic ring.

BCPBF

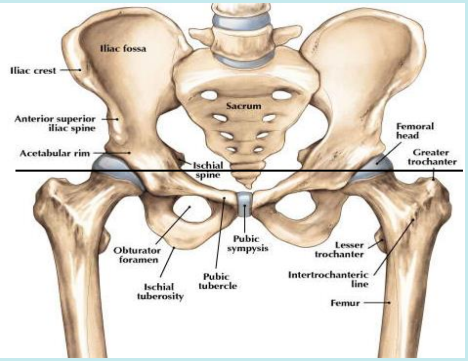
<u>Biomechanical principles of reposition and fixation of the pelvic bones.</u>
Each fracture localization in case of a multilocal fracture of the pelvic bones should be fixed, as in each individual case of a monolocal fracture, but if possible, it is more reliable to create a common fixation base for all fracture localization.



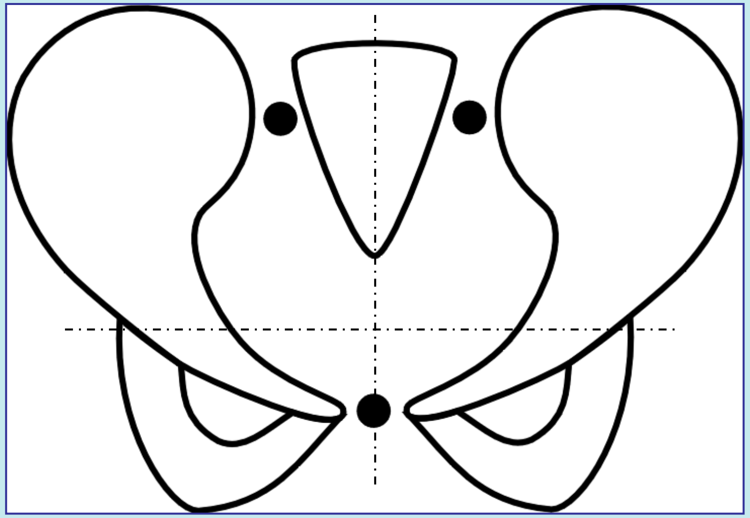
«Degree of freedom»
№ 1 - № 6

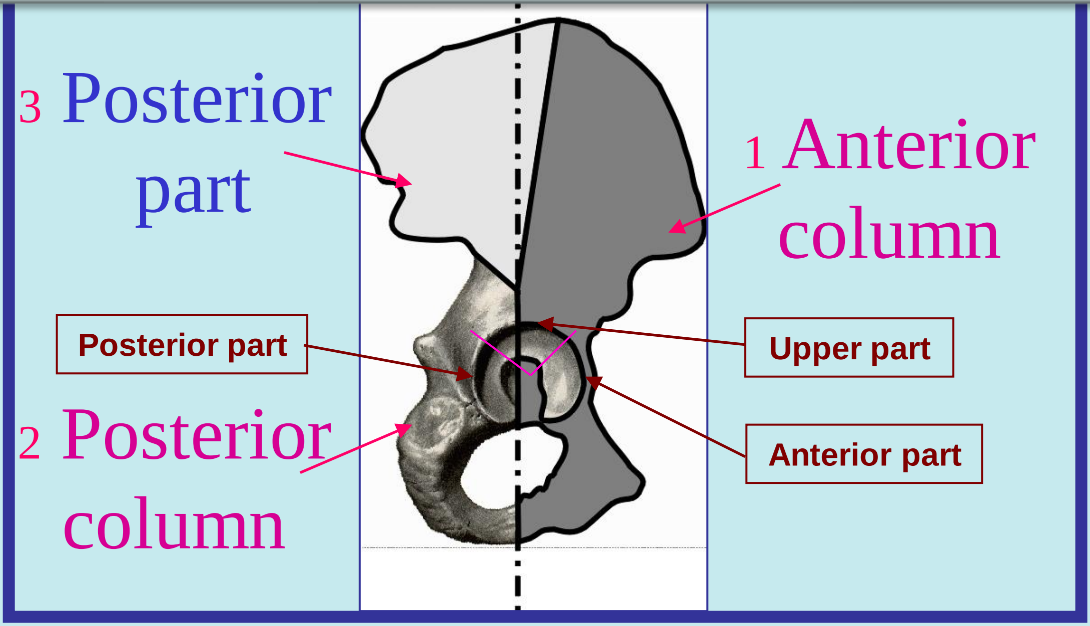
Degrees of freedom (directions of movement of bone fragments): ***N1***, ***N2***, ***N3***, ***N4***, ***N5***, ***N6***.

CLINICAL & BIOMECHANICAL CLASSIFICATION OF THE PELVIS BONES FRACTURES by Pichkhadze

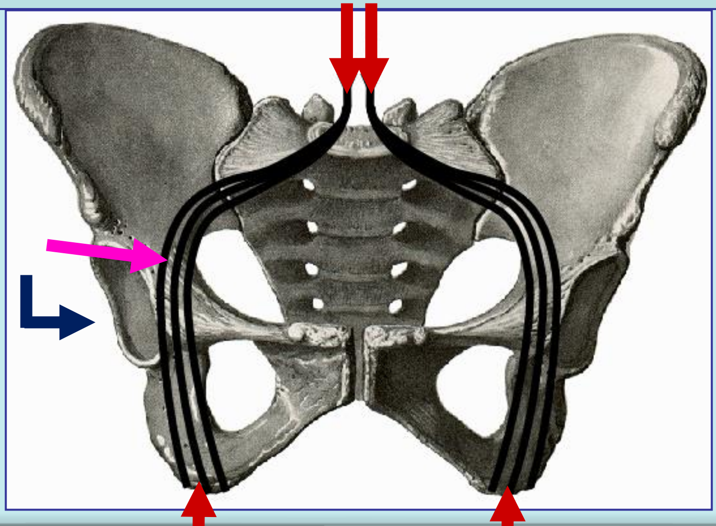


Scheme of three joint pelvic

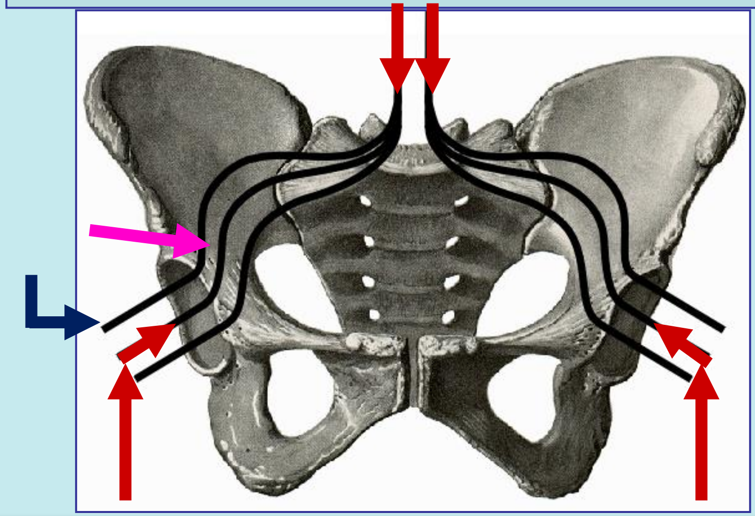


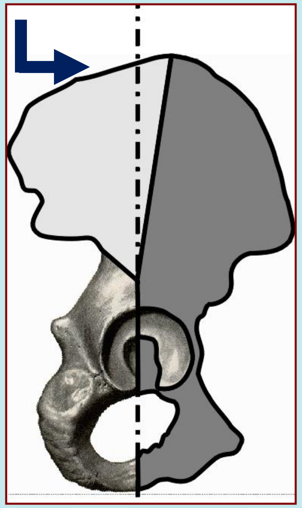


Spreading of forces at the sedentary position



Spreading of forces at the standing position





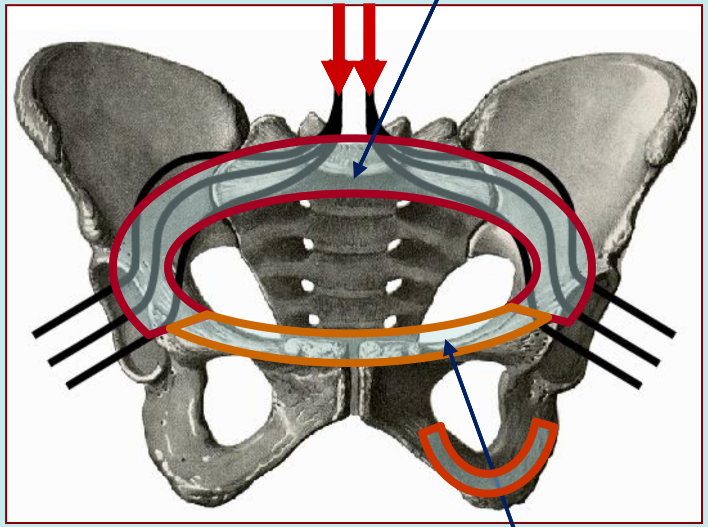
CLINICAL & BIOMECHANICAL CLASSIFICATION OF THE PELVIS BONES FRACTURES by Pichkhadze

a) **Extra-articular fractures:**

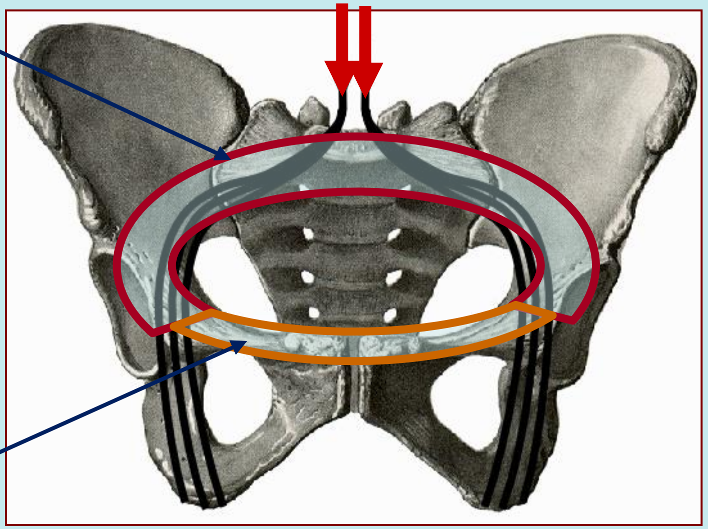
б) **Intra-articular fractures:**

Zones of fractures with discontinuity of the continuity of the posterior half-rings. → Is always (in all cases): → **Bileveral fractures**

At the standing position



At the sedentary position

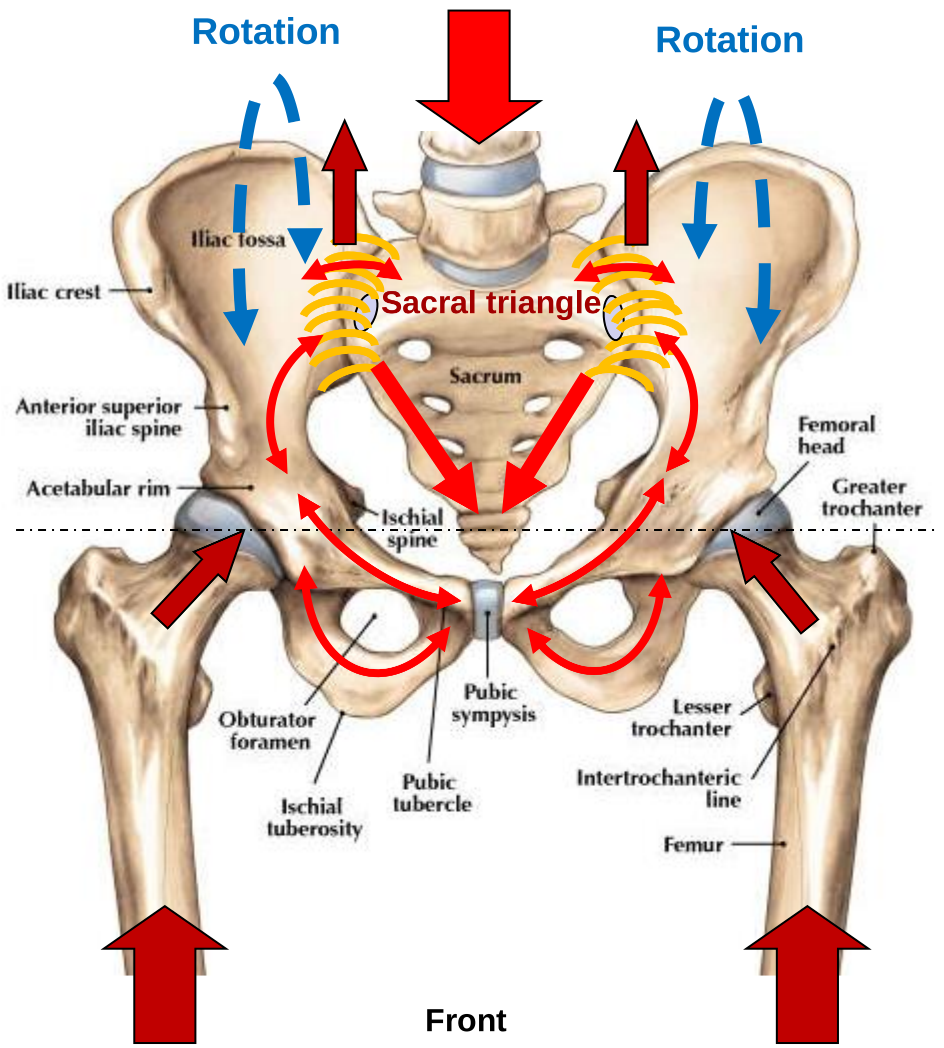


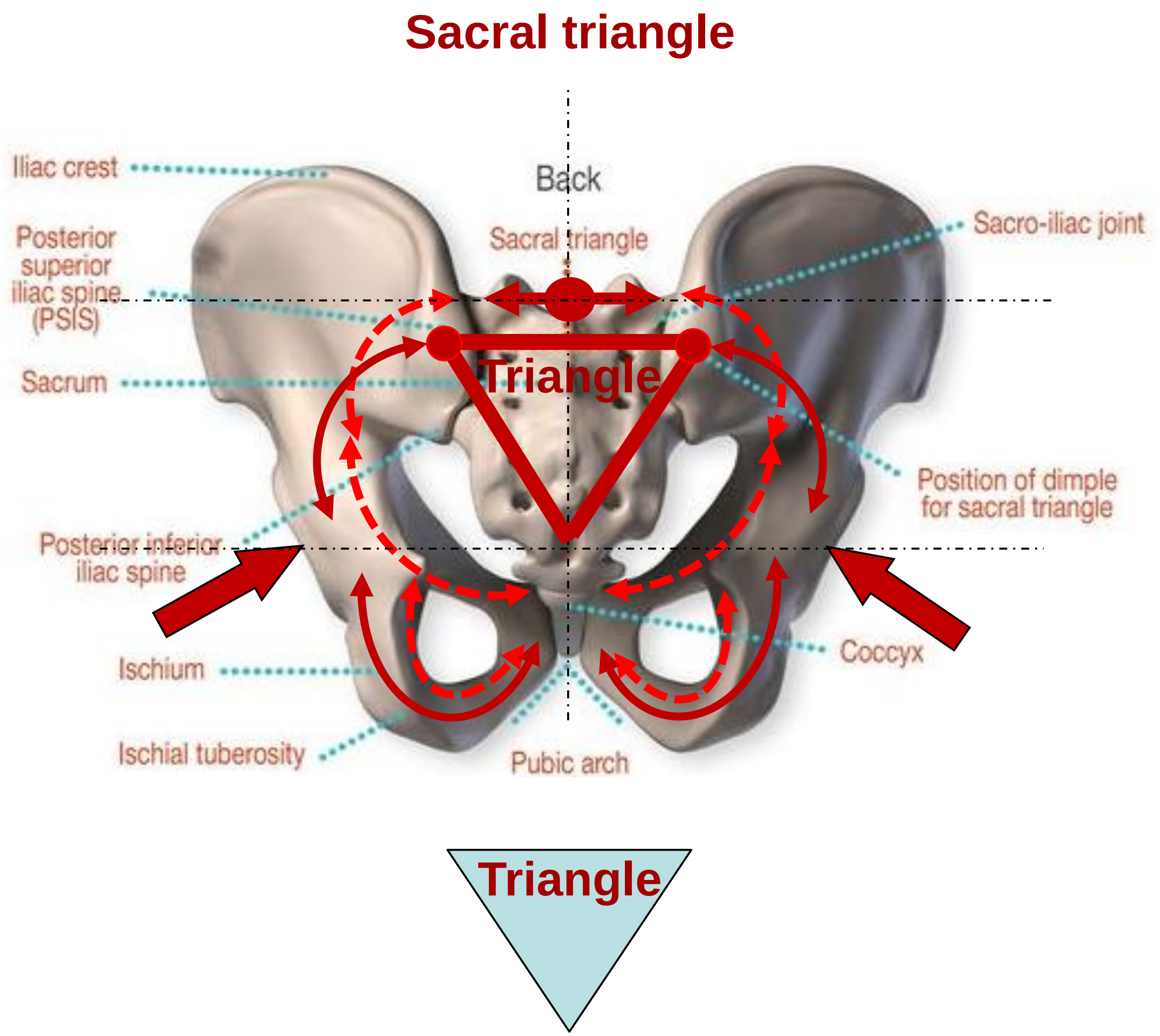
Zones of fractures with discontinuity of the continuity of the anterior half-rings. → Can be: → **Unileveral fractures** **or** **Nonleveral fractures**

With such fractures of the sciatic bone, in a sitting position, there is an effect of leverage.

Distribution of load forces along the pelvic ring and around the sacral triangle

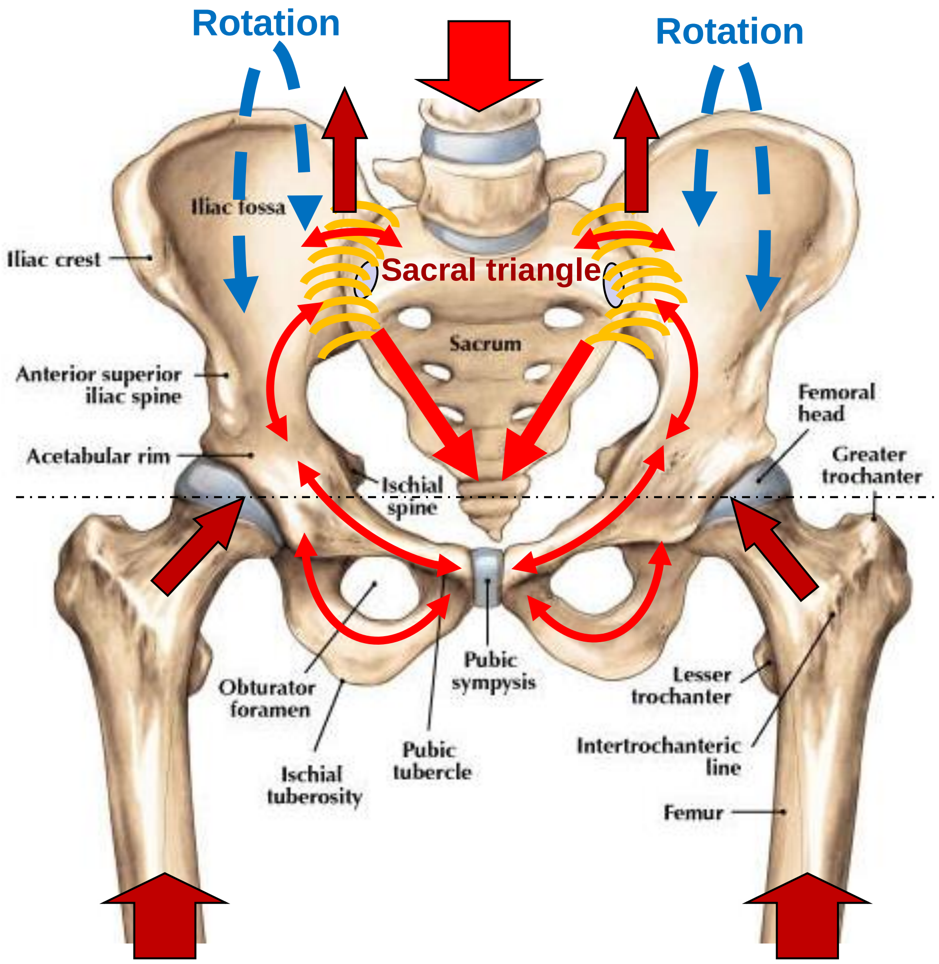
Rotational movements in the projection - B, when walking.



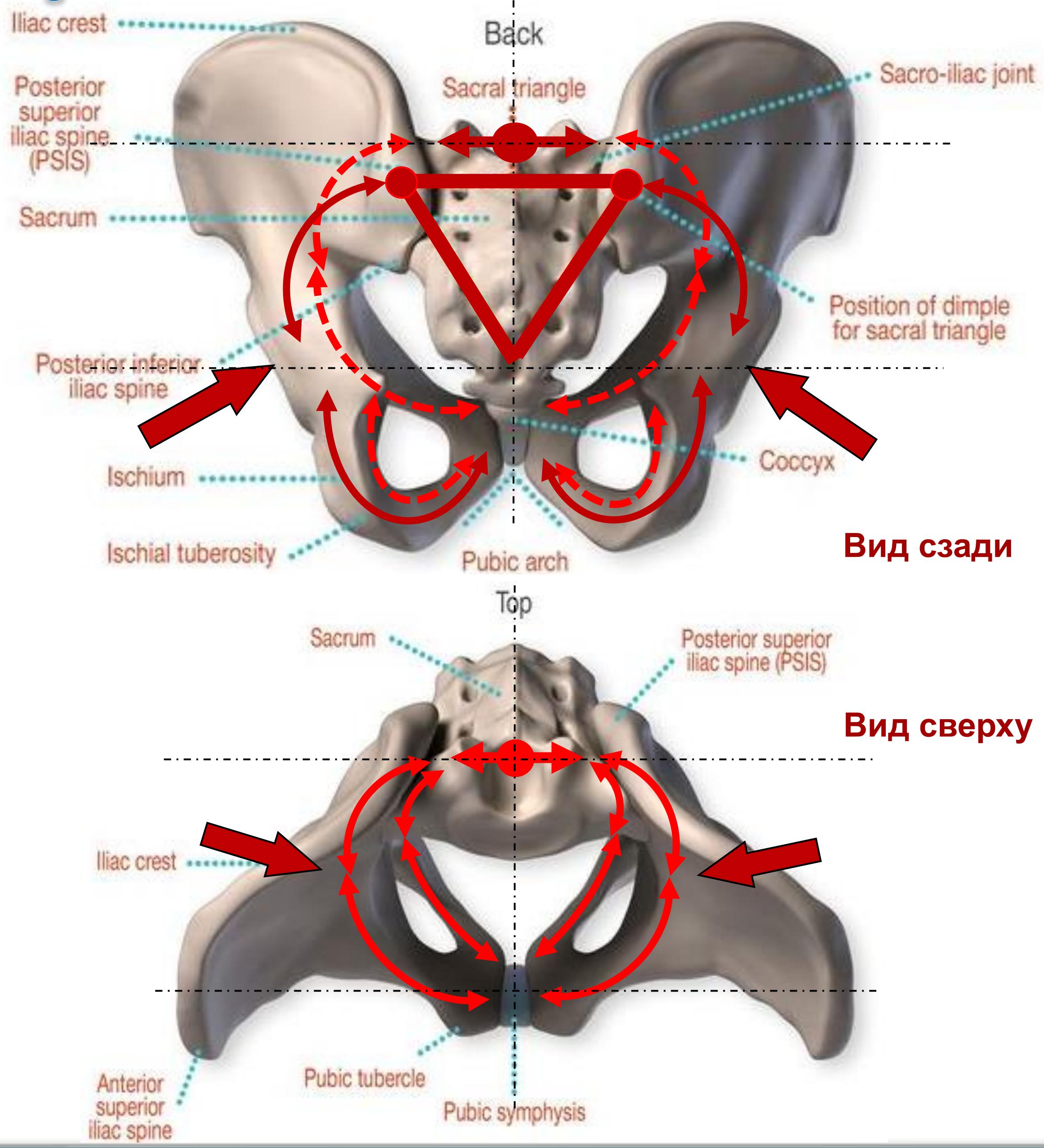


Distribution of load forces along the pelvic ring and around the sacral triangle

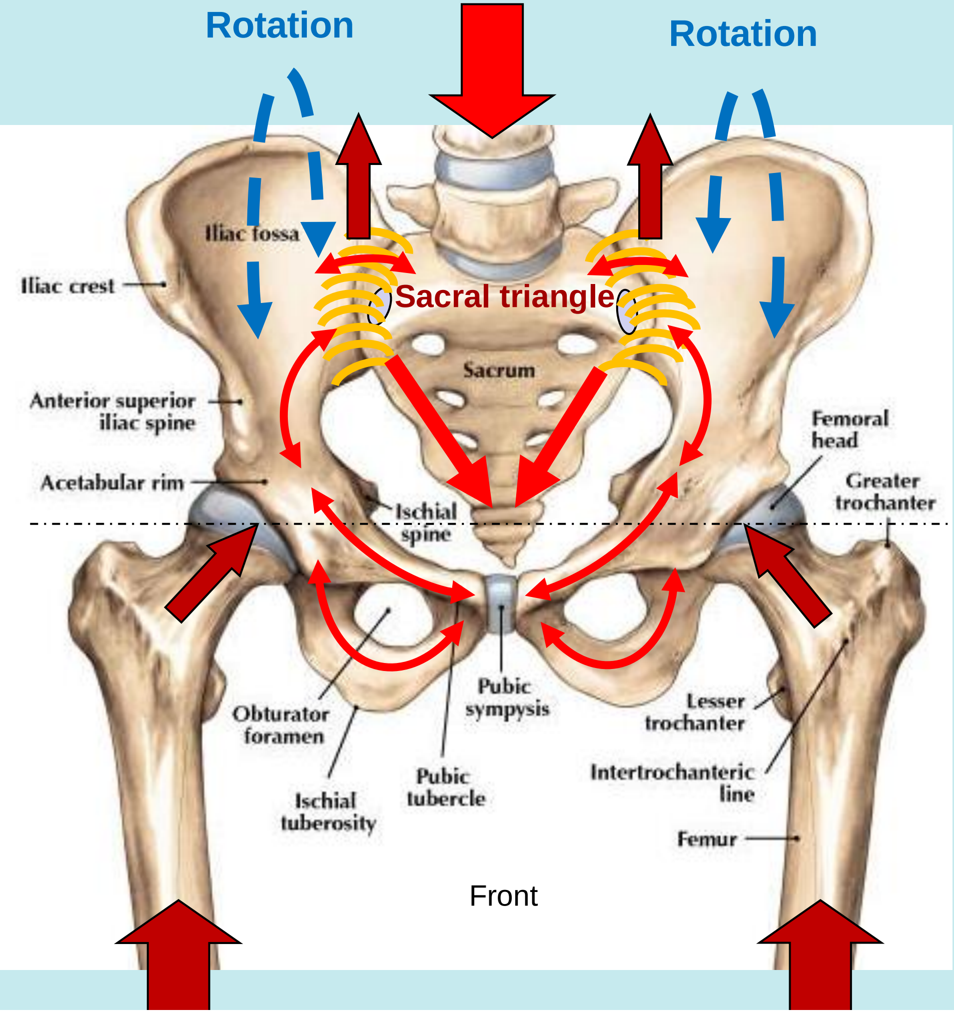
Rotational movements in the projection - B, when walking.



Front



Distribution of load forces along the pelvic ring



The sacrum carries the main burden of body weight - the proximally located sections of the spinal column with adjacent tissues and, like a wedge, presses on the ilium in the sacroiliac joints, wedging adjacent pelvic bones. The ligamentous and capsular apparatus of the sacroiliac joints, while holding the load, absorbs and transfers it to the pubic and sciatic bones and to the disc in the area of the pubic joint, which serves as a protector and a shock absorber between the pubic bones.

The presence of a violation of the continuity of the pelvic ring during fractures leads to a violation of this system of elastic strength of the closed pelvic ring, which leads to pathological mobility, including rotational displacements of the right and left parts of the pelvis. When fixing pelvic fractures, it is extremely important and necessary to neutralize the gain in strength resulting from rotational displacements. Due to the significant moment of forces, they lead to loosening - destabilization plate fixators bone.

The sacrum carries the main burden of body weight - the proximally located sections of the spinal column with adjacent tissues and, like a wedge, presses on the ilium in the sacroiliac joints, wedging adjacent pelvic bones. The ligamentous and capsular apparatus of the sacroiliac joints, while holding the load, absorbs and transfers it to the pubic and sciatic bones and to the disc in the area of the pubic joint, which serves as a protector and a shock absorber between the pubic bones.

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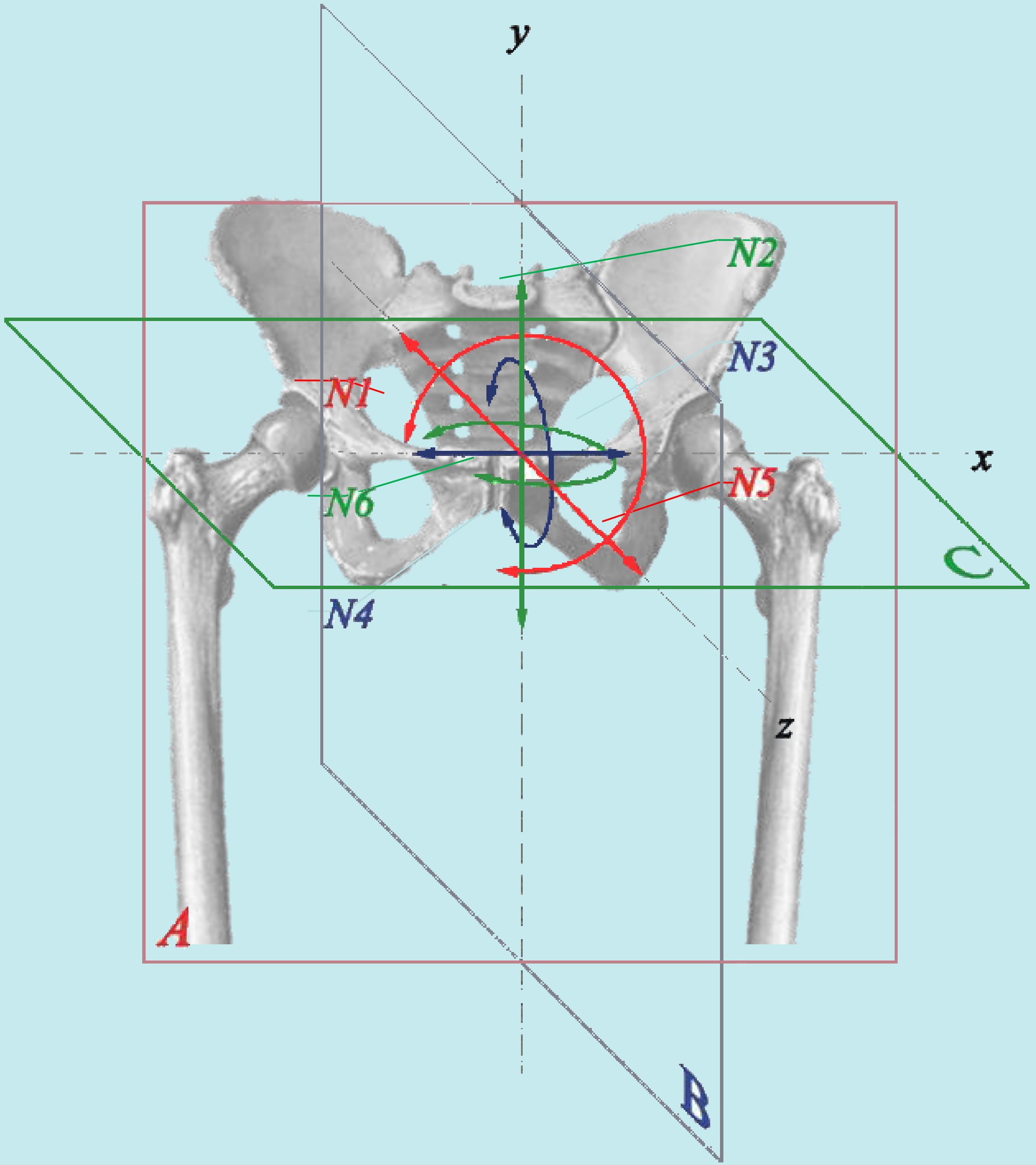
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A
B
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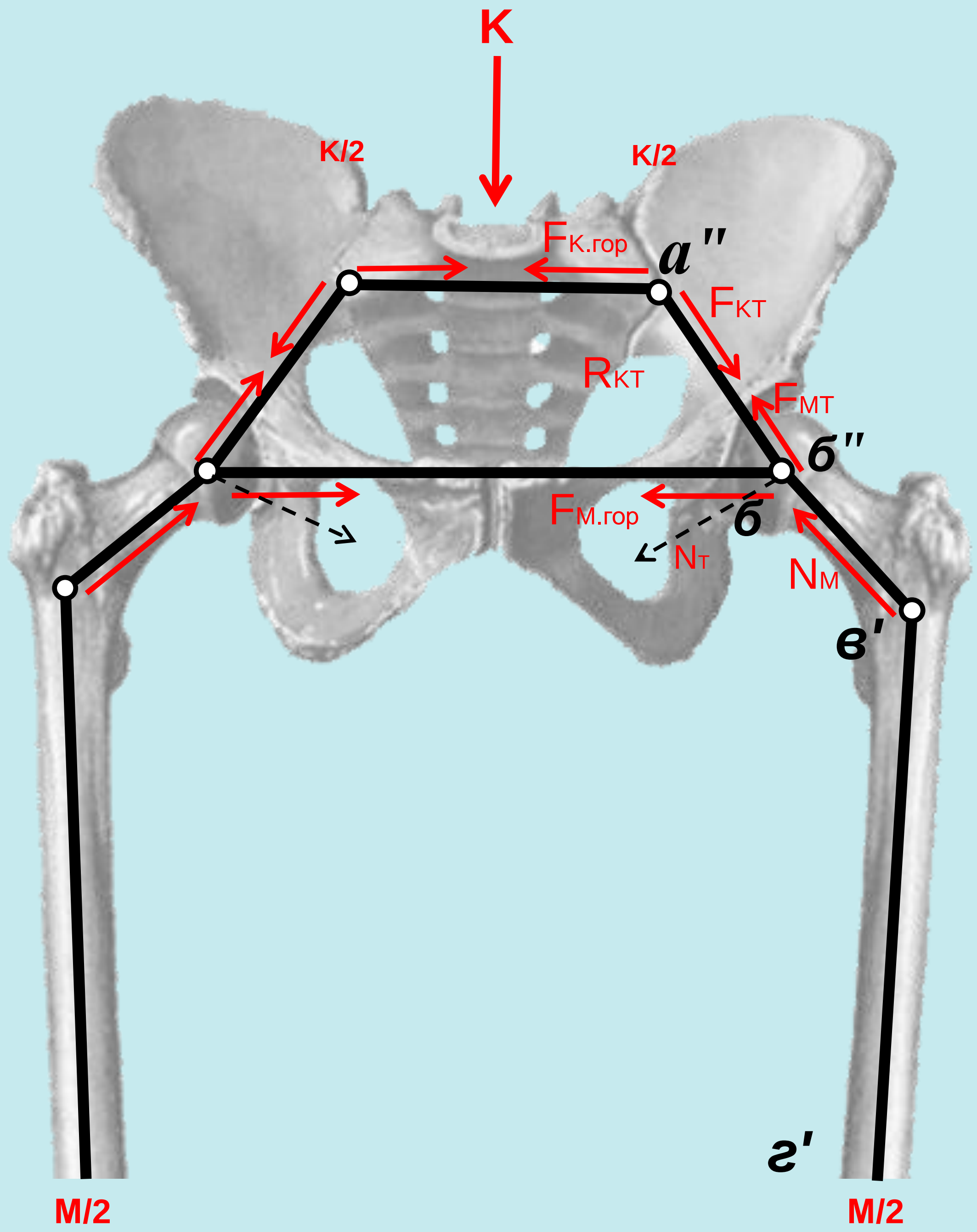
K
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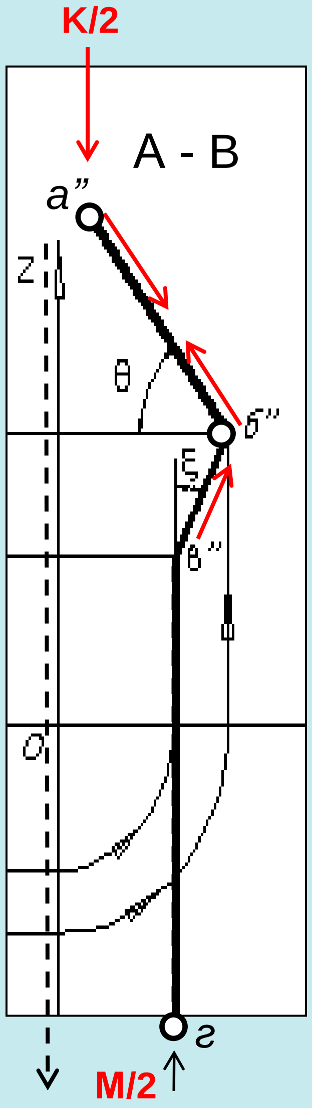
K/2
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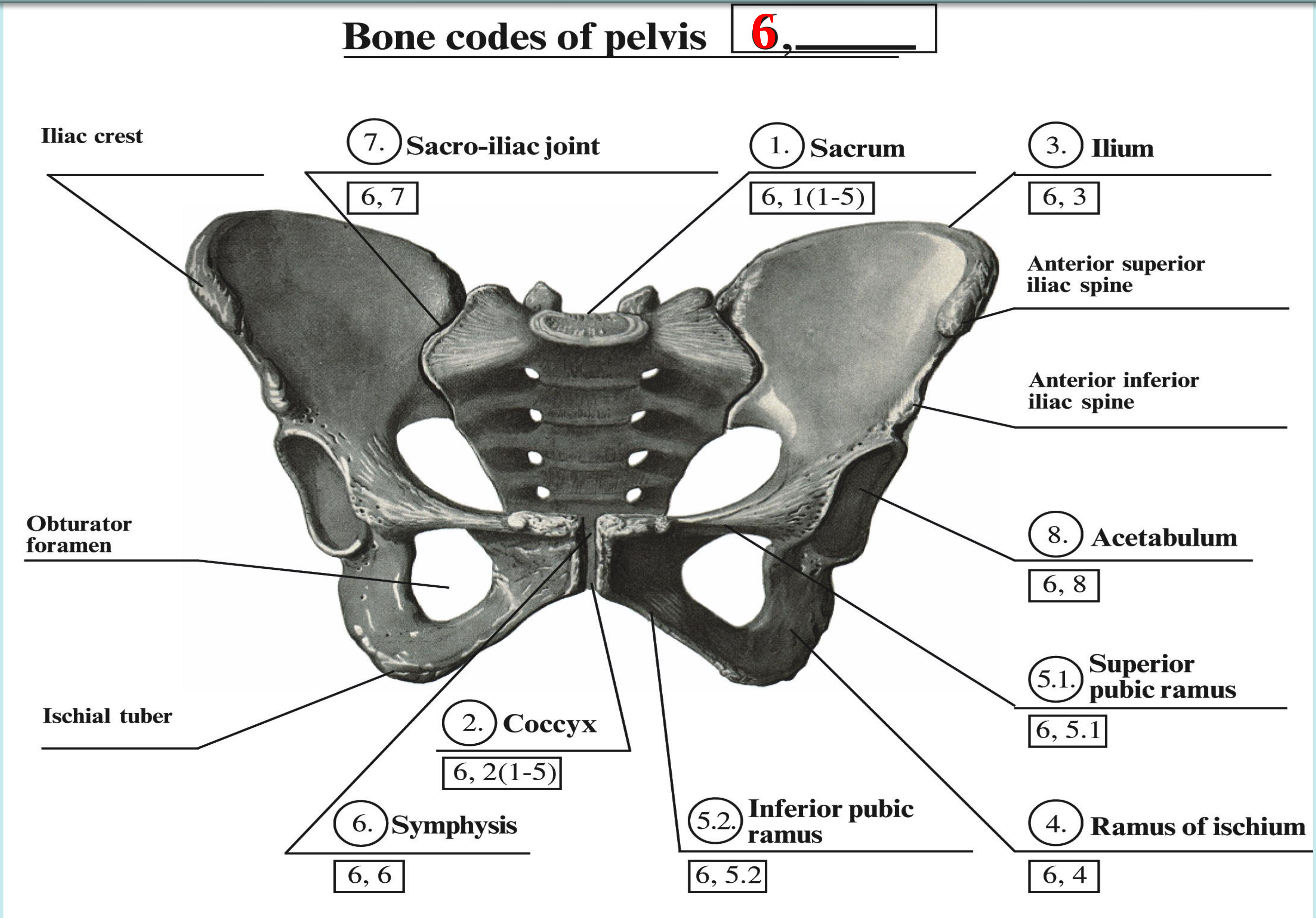
BONE CODES pelvis fractures (according to the classification)

BCPBF



Clinical & Biomechanical Classification of the Pelvis Bones Fractures by Pichkhadze

BCPBF

Orthopedic - traumatologists have long developed and recognized many classifications for pelvis bone fractures. They gave emphasis on anatomy, mechanism of trauma, displacement of fragments, etc.

The Clinical and Biomechanical Classification of Long & Pelvis Bones fractures (BCLB&PF) is worked out to be easy to use, understand the severity of the fracture, provide management guide lines, and prognosis. The criteria of classification are 1. Leveral properties of fragments, 2. Stability of fragments, 3. Damage to articular cartilage, 4. Involvement of articular surface, 5. Comminution of fragments.

The **BCPBF** consist of Monolocal fractures, and Polylocal fractures.

Monolocal and Polylocal fractures are further classified into,

- of Extra-articular and - Intra-articular fractures.

Each group have sub-groups Nonleveral, - Unileveral and - Bileveral fractures, etc.

The classification is easy to understand, allows consistent interpretation, management guide to surgeons, standardizes treatment methods, is of medico-legal importance, and for prognosis of treatment.

The distribution of the forces acting upon pelvis bones in sitting and standing position.

1-2

Clinical and Biomechanical classification for bone fractures of such localization is based on this distribution.

If the fracture line crosses those pelvis bones that cause disconnection of the shown force lines, such a fracture is classified as bileveral.
The fractures with disconnection of posterior semiring (4) as well as unilateral anterior and posterior semirings on the or on the left (5) and bilateral (6) can be related to bileveral fractions.

When the fractured bones of anterior and posterior semiring are located outside the forse lines zone such cases can be defined as unileveral fraction.
These include fractures of pelvis bones without disconnection (2) and with disconnection of only anterior semiring (3).

All marginal (1) fractures of pelvis bones of anterior and posterior semiring are defined as nonleveral fractures.
They include fractures of pelvis bones without disconnection.

The distribution of the forces acting upon pelvis bones in sitting and standing position.

Clinical and Biomechanical classification for bone fractures of such localization is based on this distribution.

Bileveral:

If the fracture line crosses those pelvis bones that cause disconnection of the shown force lines, such a fracture is classified as **bileveral**.

The fractures with disconnection of posterior semiring (4) as well as unilateral anterior and posterior semirings on the or on the left (5) and bilateral (6) can be related to **bileveral** fractures.

The distribution of the forces acting upon pelvis bones in sitting and standing position.

Unileveral:

When the fractured bones of anterior and posterior semiring are located outside the forse lines zone such cases can be defined as **unileveral** fraction.

These include fractures of pelvis bones without disconnection (2) and with disconnection of only anterior semiring (3).

Nonleveral:

All marginal (1) fractures of pelvis bones of anterior and posterior semiring are defined as **nonleveral** fractures.

They include fractures of pelvis bones without disconnection.

CLINICAL & BIOMECHANICAL CLASSIFICATION OF THE PELVIS BONES FRACTURES by Pichkhadze

A - Monolocal fractures. B – Polylocal fractures.

(BCPBF)

a) Extra-articular fractures: **1. Nonleveral fractures.**

1. Marginal.
2. Fractures without disruption of the pelvic ring.

2. Unileveral fractures.

2. Fractures without disruption of the pelvic ring.
3. Fractures with discontinuity of the anterior semiring.
   Unilateral (U). Bilateral (B).

3. Bileveral fractures.

4. With discontinuity of the continuity of the rear nalf-ring.
5. With discontinuity of the continuity of the anterior and posterior half-rings on one side.
   Full (+) and incomplete (-) ruptures of the rear half-ring.
6. With discontinuity of the continuity of the anterior and posterior half-rings on both sides.
   Full (+) and incomplete (-) ruptures of the rear half-ring.

b) Intra-articular fractures: **1. Nonleveral fractures** (the damaged sector is less than 90°).

1. Fracture of the edges of the acetabulum.
2. Fracture of the bottom of the acetabulum.

2. Unileveral fractures (the damaged sector is from 90° to 179°).

3. Fracture of the articular surface.

3. Bileveral fractures (the damaged sector is more than 179°).

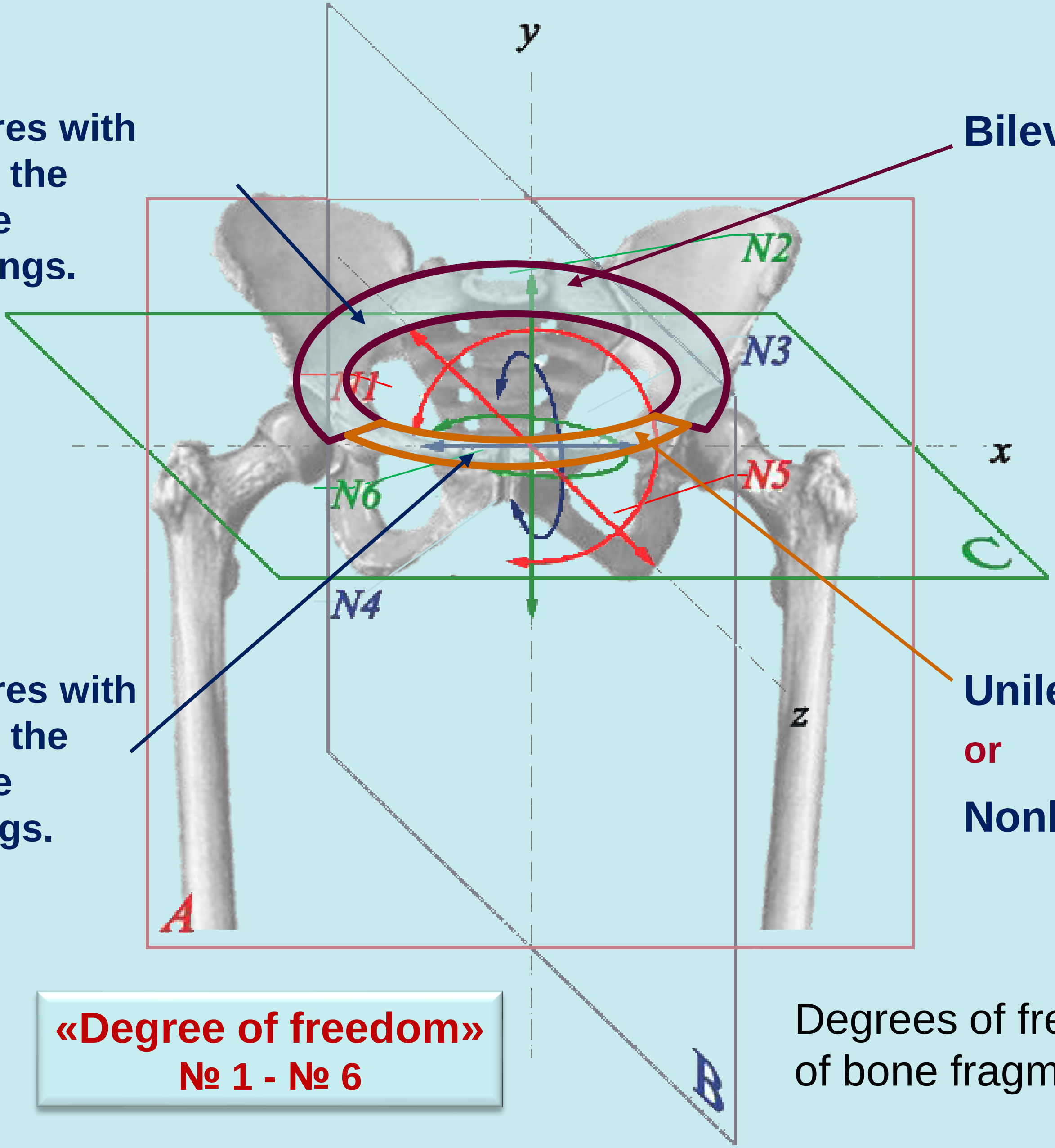
4. Fracture of the posterior column.
5. Fracture of the anterior column.
6. Transverse fracture of the acetabulum.
7. Fracture of the both column.

Zones of fractures of disruption of the pelvic ring.

(BCPBF)

Zones of fractures with discontinuity of the continuity of the <u>posterior</u> half-rings.

Bileveral fractures



<u>Biomechanical principles of reposition and fixation of the pelvic bones.</u>
Each fracture localization in case of a multilocal fracture of the pelvic bones should be fixed, as in each individual case of a monolocal fracture, but if possible, it is more reliable to create a common fixation base for all fracture localization.

Zones of fractures with discontinuity of the continuity of the <u>anterior</u> half-rings.

Unileveral fractures

or

Nonleveral fractures

«Degree of freedom»
№ 1 - № 6

Degrees of freedom (directions of movement of bone fragments): ***N1***, ***N2***, ***N3***, ***N4***, ***N5***, ***N6***.

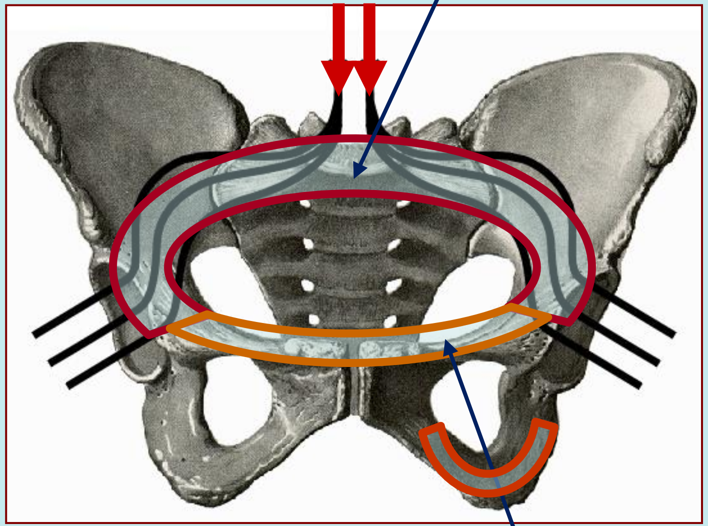
CLINICAL & BIOMECHANICAL CLASSIFICATION OF THE PELVIS BONES FRACTURES by Pichkhadze

a) **Extra-articular fractures:**

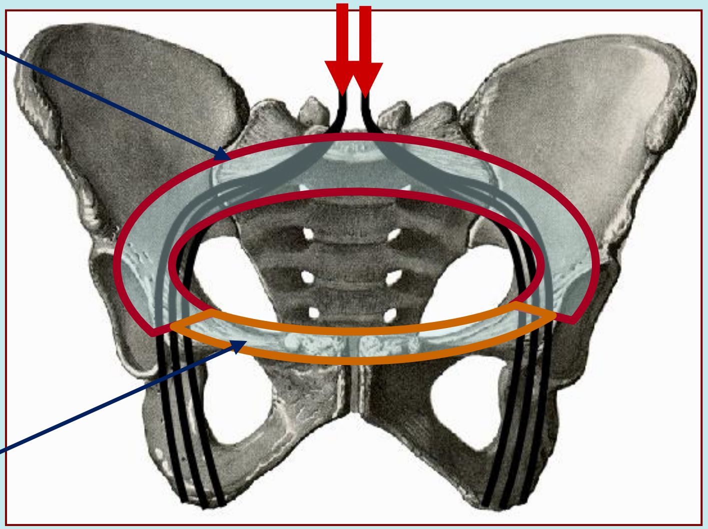
б) **Intra-articular fractures:**

Zones of fractures with discontinuity of the continuity of the <u>posterior</u> half-rings. → Is always (in all cases): → **Bileveral fractures**

At the standing position



At the sedentary position



Zones of fractures with discontinuity of the continuity of the <u>anterior</u> half-rings. → Can be: → **Unileveral fractures** **or** **Nonleveral fractures**

With such fractures of the sciatic bone, in a <u>sitting position</u>, there is an effect of leverage.

If diagnosis is made correctly according to the biomechanical classification it is possible to make out how each fragment should be fixed.