Clinical Biotensegrity

Illustrating a Data-based Clinical Model of Compression-Tension Forces That Facilitate Orthopedic Medical Diagnosis, Treatment, and Postural Rehabilitation

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Disclaimers: None

Graphic Illustrations: Faith Gowan

"When we try to pick out anything by itself, we find that it is bound fast by a thousand invisible cords . . . to everything in the universe."

John Muir
Personal Journal
July 27,1869

In Memory of
Michael Wayne Seamans, DO

Dedicated to
James S. Miles, MD
Professor Emeritus
Chairman of Orthopedic Surgery
University of Colorado School of Medicine
Father of the "Five R's of Orthopedics"

Educational Goals

1. Introduce **a Brief Background History** of Clinical Biotensegrity

2. Introduce **the Scientific Model** Used to Illustrate Clinical Biotensegrity

3. Illustrate **Natural Compression-Tension Forces** in an Ideally Balanced State

4. Illustrate **Injurious Compression-Tension Forces** in an Naturally Imbalanced State

5. Illustrate **Mapping** of **Compression-Tension Forces**

Goal 1:

Brief Historical History

of

Clinical Biotensegrity

Biotensegrity
Historical Landmarks

- **Sir Isaac Newton** (1642-1727)**: Third Law of Motion**[1]
- **Sir Charles Scott Sherrington** (1857-1952)**: Law of Reciprocal Innervation**[2]
- **R. Buckminster Fuller** (1895-1983)**: Principal of Tensional Integrity ("Tensegrity")**[3]
- **Kenneth Snelson** (1927-)**: Principal of Floating Compression**[4]
- **Stevin M. Levin, MD:** Coined "**Biotensegrity**"; Pioneer in clinical study of Biotensegrity since 1980's[5]
- **Donald E. Ingbar, MD:** Pioneer in academic study of **Cellular and Tissue Biotensegrity** since 1990's[6,7]

Goal 2:

The Scientific Model

Used to Illustrate

Clinical Biotensegrity

Levels of Medical Evidence

- Single Case “unique” Casual Observation/ Expert Opinion
- Multiple Case Series Casual Observation/ Expert Opinion
- Case Series Study- Retro/prospective and Consecutive/nonconsecutive
- Case-Control Study
- Retrospective Cohort Study
- Prospective Randomized Controlled Study

Levels of Medical Evidence

- Single Case “unique” Casual Observation/ Expert Opinion
- Multiple Case Series Casual Observation/ Expert Opinion
- **Case Series Study--Prospective (rigorously pre-planned) and Consecutive (including all cases presenting over a specific period)**
- Case-Control Study
- Retrospective Cohort Study
- Prospective Randomized Controlled Study

SIJD Physical Characteristics[9,10]

Initial Observations Leading to Study

Most Reproducible Definitive Physical Signs					
	Dropped Inferior Sacral Angle	**Short-sided Limp**	**Vertebral Scoliosis**	**Functionally Short Leg**	**Weakened Leg aBduction**
LSIJD	Left	Left Step Down	Dextro Lumbar	Left	Left Decreased
RSIJD	Right	Right Step Down	Levo Lumbar	Right	Right Decreased

SIJD Physical Characteristics[9,10]

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Frequently Supportive Physical Signs				
	Dropped Shoulder	**Restricted Sacroiliac Joint with**	**Supinated Foot**	**Pronated Foot**
LSIJD	Right	Left Ileal Flexion	Left	Right
RSIJD	Left	Right Ileal Flexion	Right	Left

SIJD Physical Characteristics[9,10]

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LSIJD	Right	Left Ileal Flexion	Left	Right
RSIJD	Left	Right Ileal Flexion	Right	Left

Question:
Why are all these physical parameters --from plantar arch to nuchal line— seemingly linked in SIJD??

A Data-Based Clinical Example of Sacroiliac Joint Dysfunction (SIJD)

Clark G. *Journal of Prolotherapy.* 2011 [9,10]

A Scientifically Planned Prospective Case-Series Study of SIJD

Carried Out over Six Years

Sacroiliac Joint Dysfunction (SIJD)

Prevalence in Low Back Pain Patients[9,10]

Data-Based Study of SIJD					
n = 110	Total	Female	Male	Sacral Stabilization Requiring OMT	Sacral Stabilization Requiring Prolo
All SIJD	-------	63%	37%		
LSIJD					
RSIJD					

Sacroiliac Joint Dysfunction (SIJD)

Prevalence in Low Back Pain Patients[9,10]

Data-Based Study of SIJD					
n = 110	Total	Female	Male	Sacral Stabilization Requiring OMT	Sacral Stabilization Requiring Prolo
All SIJD	-------	63%	37%		
LSIJD	81%	82%	80%		
RSIJD	19%	18%	20%		

Sacroiliac Joint Dysfunction (SIJD)

Prevalence in Low Back Pain Patients[9,10]

Data-Based Study of SIJD					
n = 110	Total	Female	Male	Sacral Stabilization Requiring only OMT	Sacral Stabilization Requiring Prolo
All SIJD	-------	63%	37%	30%	70%
LSIJD	81%	82%	80%	29%	71%
RSIJD	19%	18%	20%	31%	69%

Sacroiliac Joint Dysfunction (SIJD)

Prevalence in Low Back Pain Patients[9,10]

Data-Based Study of SIJD					
n = 110	Total	Female	Male	Sacral Stabilization Requiring only OMT	Sacral Stabilization Requiring Prolo
All SIJD	-------	63%	37%	30%	70%
LSIJD	81%	82%	80%	30%	70%
RSIJD	19%	18%	20%	30%	70%

ALL the above-mentioned patients were Right-Handed!!

Only TWO Left-Handed patients have been encountered in 10 years of carefully documented Orthopedic Medical practice

Left Sacroiliac Joint Dysfunction (LSIJD)

Data-based Model Characterized by:

Primary Left Sacroiliac Ligament Laxity and Sacroiliac Joint Displacement

Compensatory Dextrolumbar Scoliosis

Compensatory Left Short Leg

Compensatory Right Long Leg

Goal 3:

Natural

Compression-Tension Forces

in an

Ideally Balanced

State

Biotensegrity

Models, Examples, Analogies

Newton Apple

Sherrington Agonist-Antagonist

Wright Flyer

Fuller Geodesic Dome

Snelson Bead Chain X Column

Levine Vertebrate Structures

Ingbar Cytoskeletal Structures

Biotensegrity
Models, Examples, Analogies

Newton Apple

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Levine Vertebrate Structures

Ingbar Cytoskeletal Structures

Cantieri Degenerative Postural Low Back Cascade[8]

Biotensegrity
Models, Examples, Analogies

Newton Apple

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Levine Vertebrate Structures

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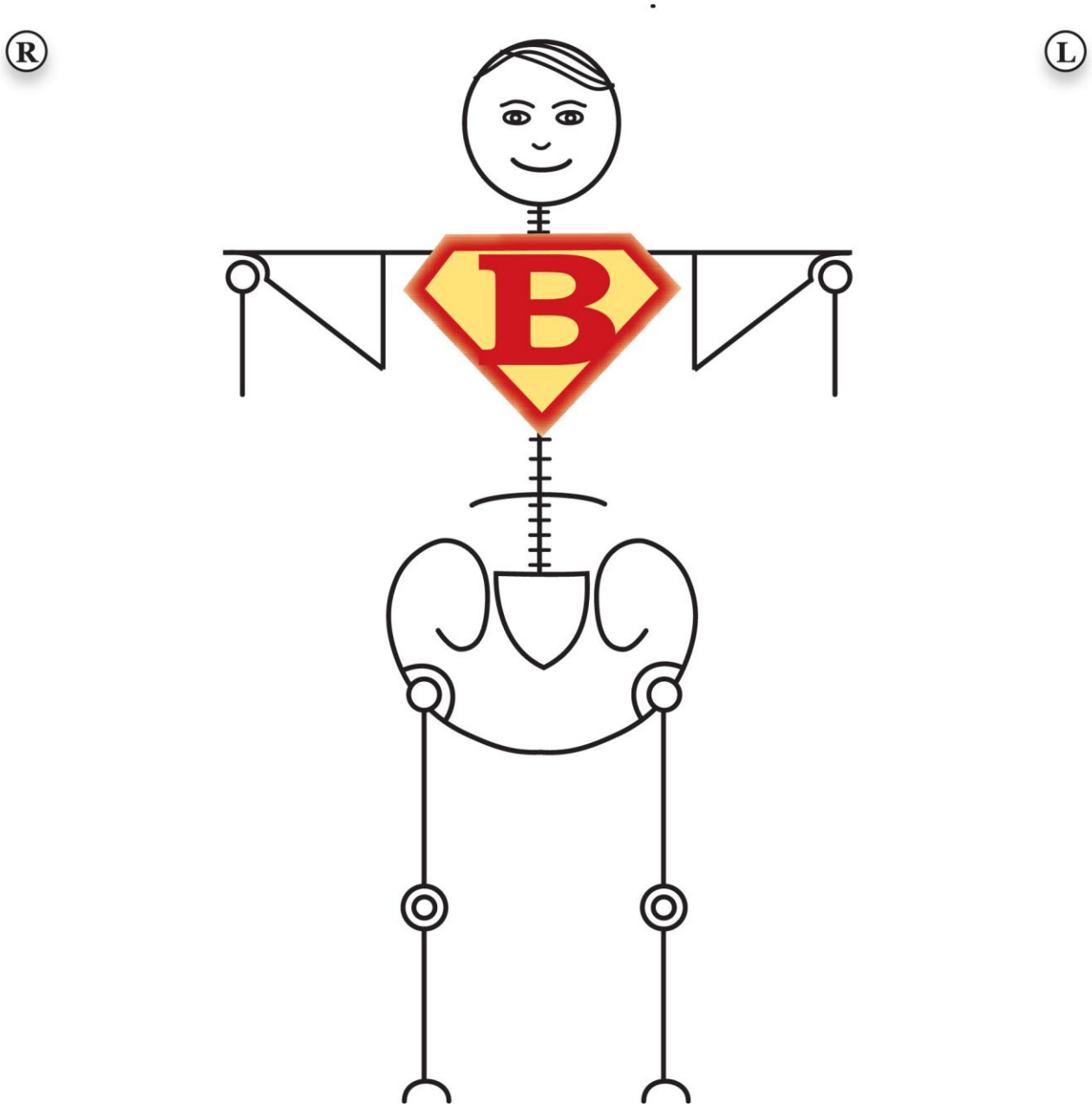
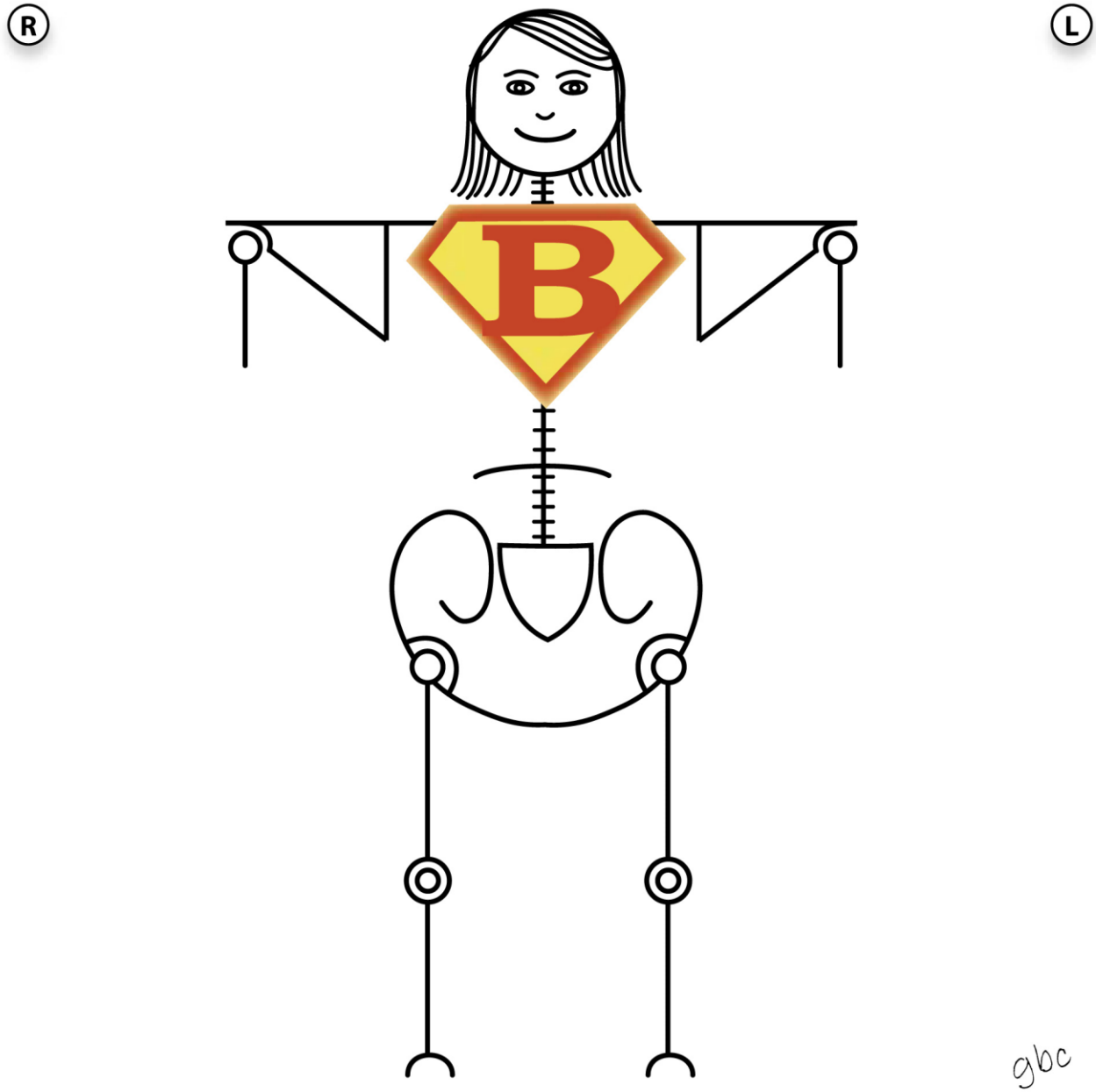
Cantieri Degenerative Postural Low Back Cascade[8]

Trister Umbrella

Biotensegrity Man!!



Biotensegrity Woman!!



The Usual Forces at Play

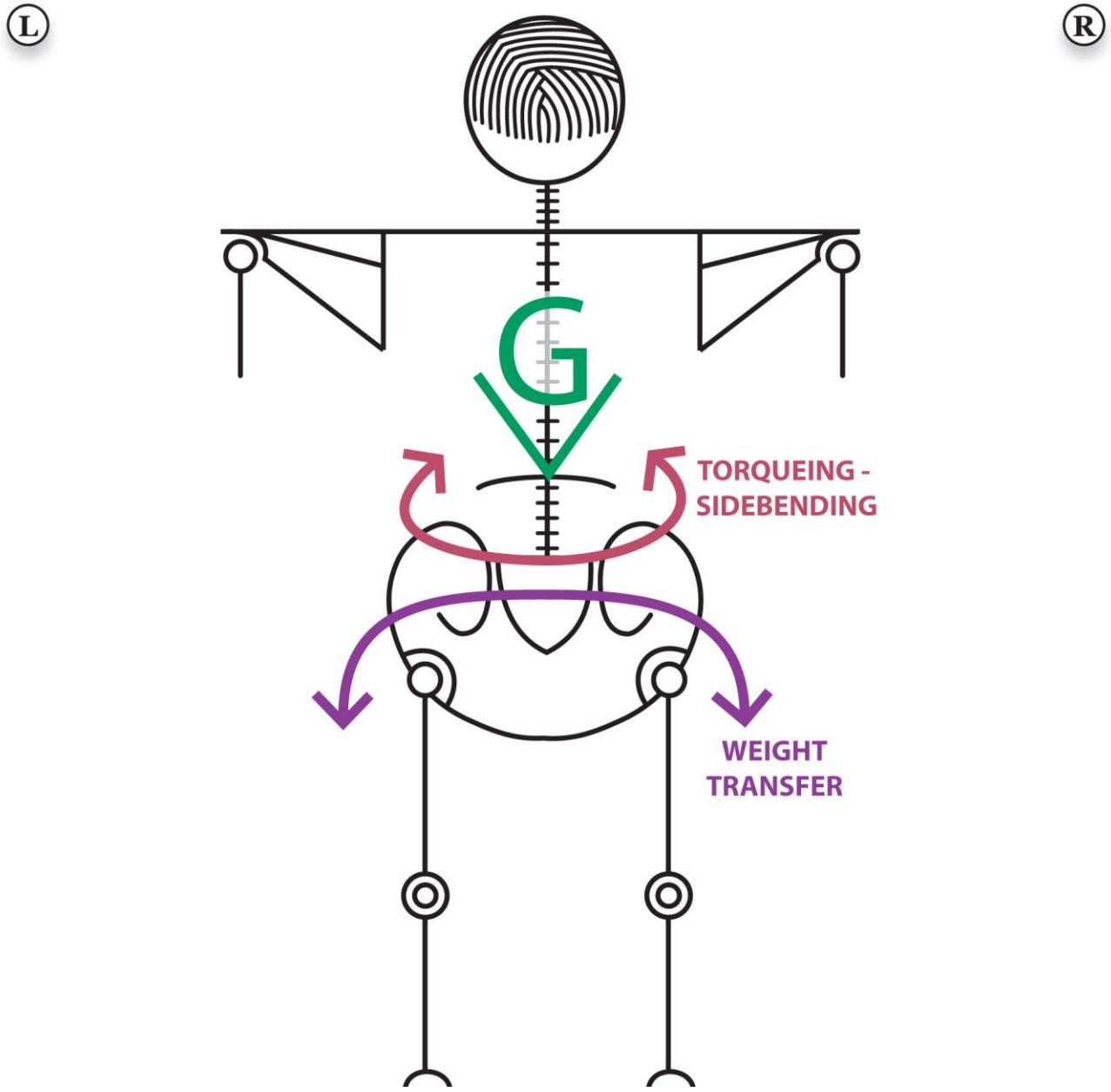
Forces Causing Compression

- Passive Compression: Directly Due to Gravitational Force (Weight) 
- Active Compression: Directly Due to Muscular Force 

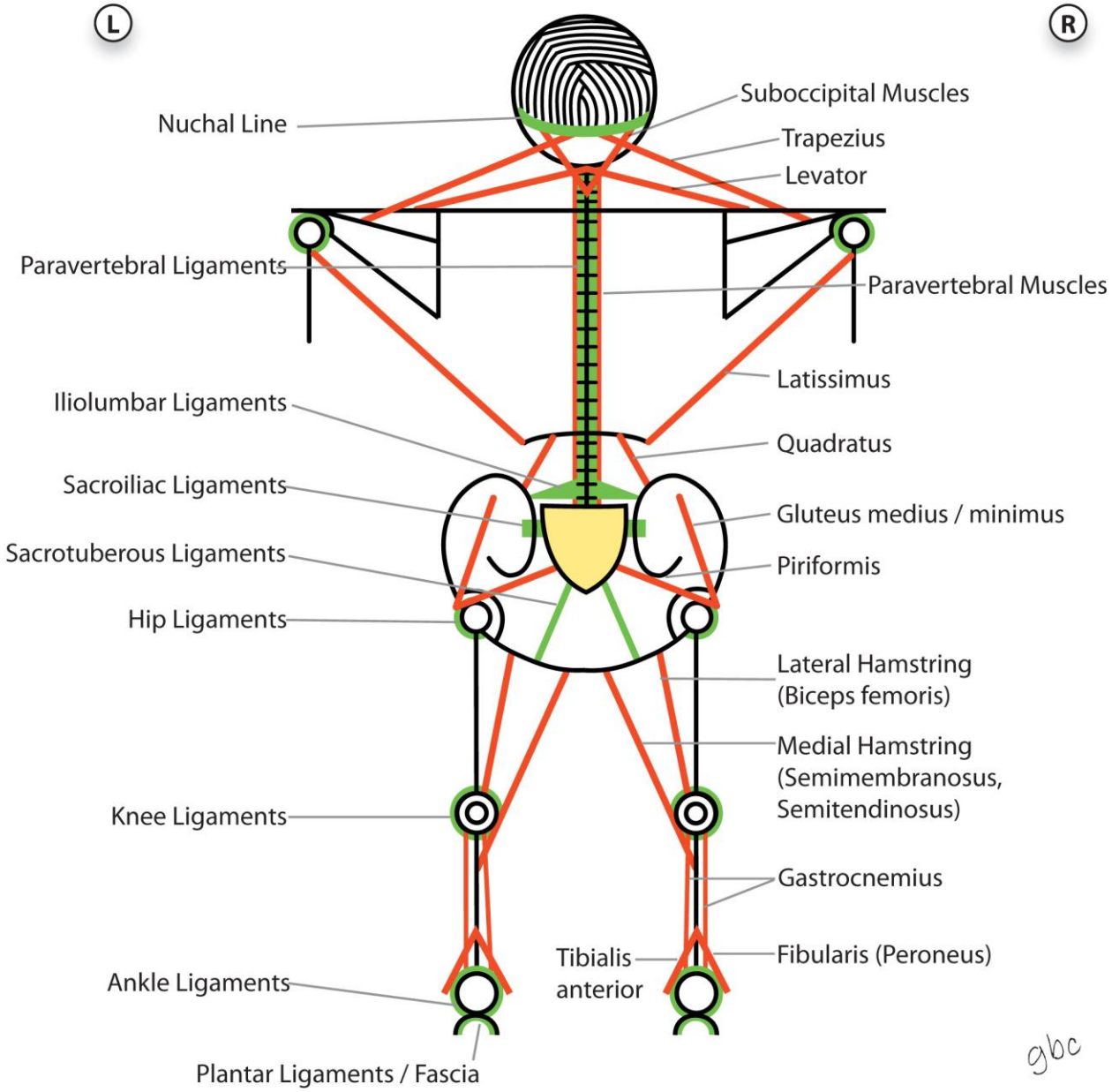
Forces Causing Tension

- Passive Tension: Directly Due to Gravitational or Indirect Muscular Force 
- Active Tension: Directly Due to Muscular Force 

The Usual Forces at Play



Ideal Skeletal-Ligament-Muscle Balance and Alignment



Goal 4:

Injurious

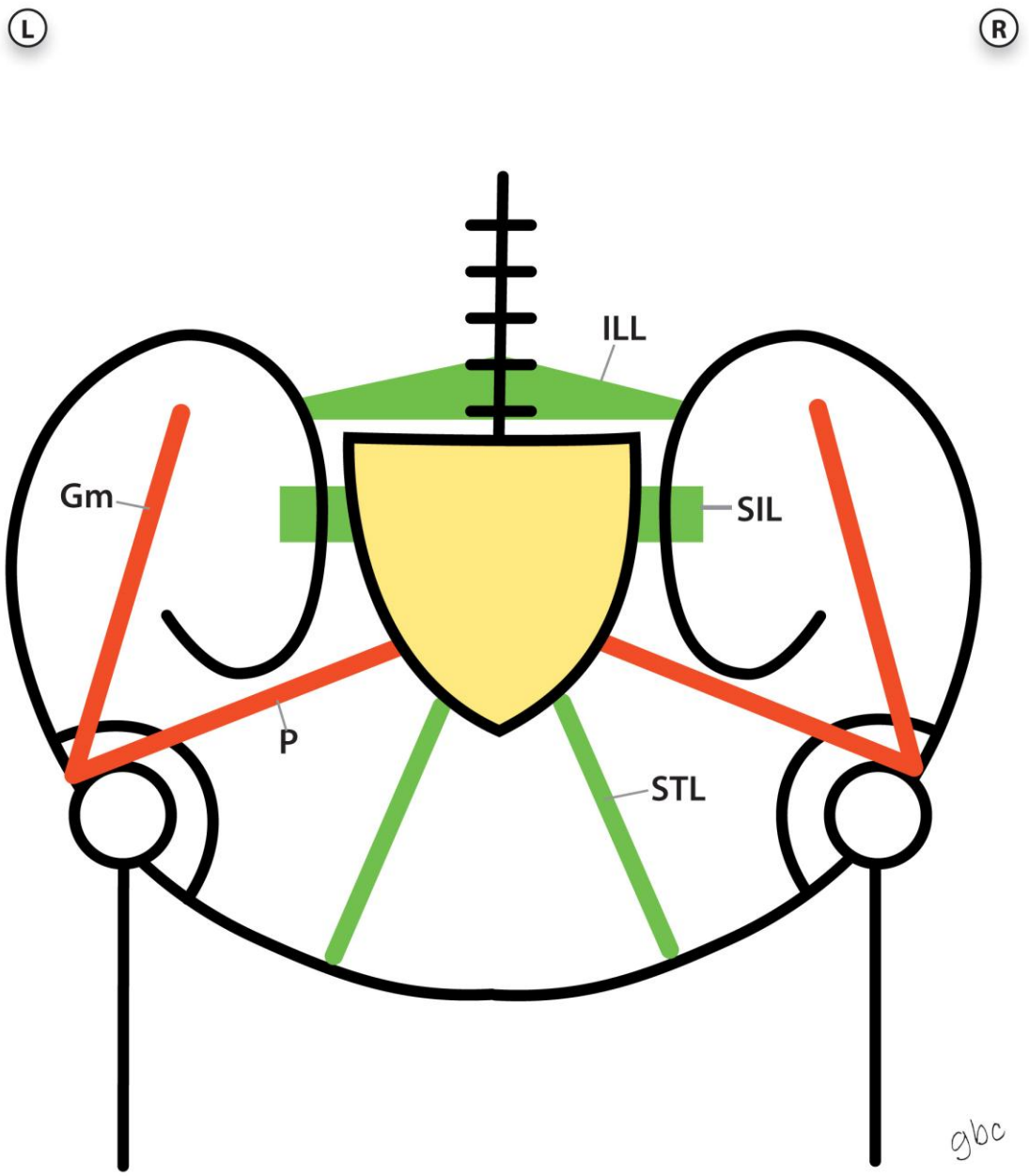
Compression-Tension Forces

in an

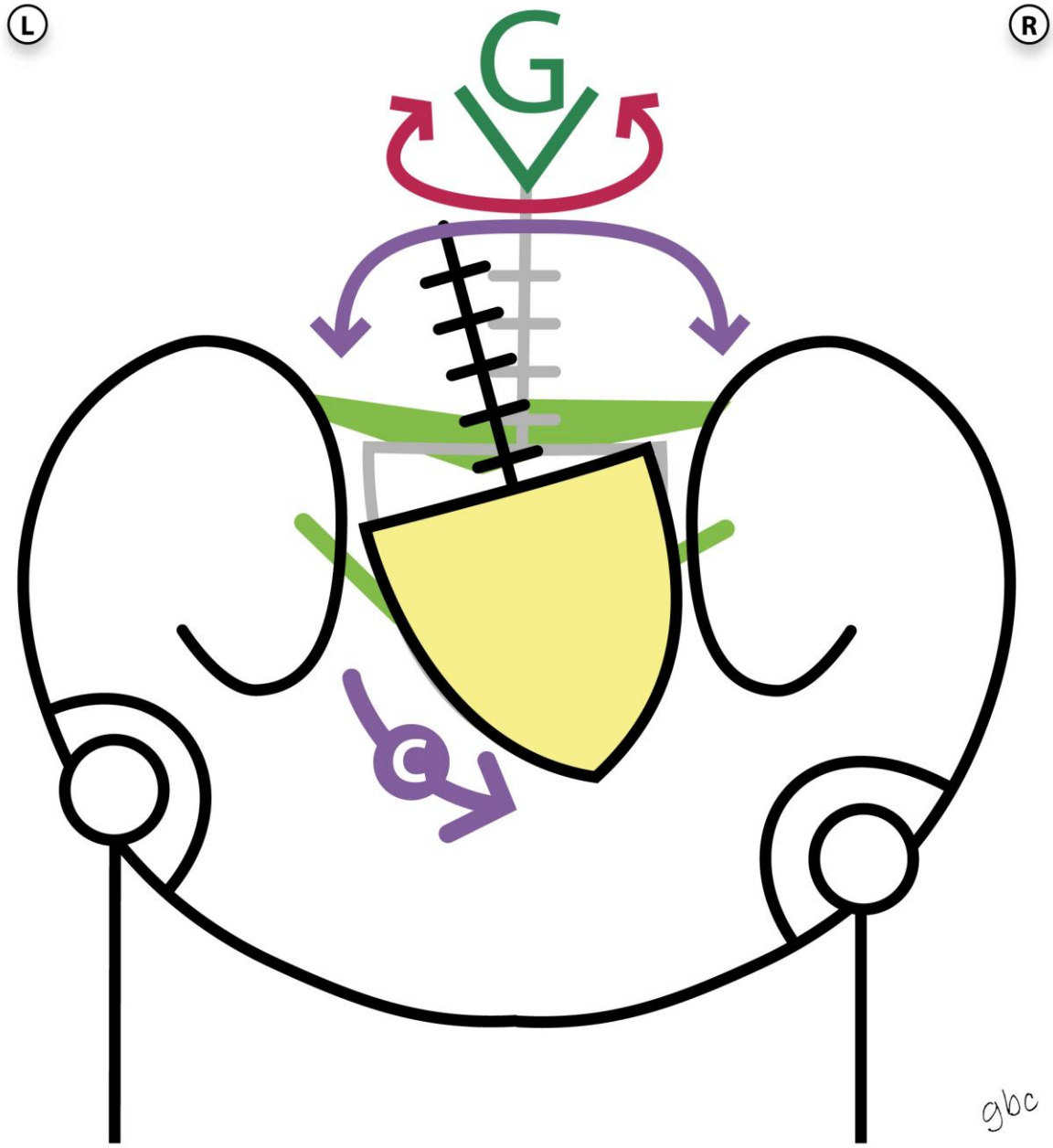
Imbalanced

State

Ideally Aligned and Balanced Sacrum-Pelvis



Primary Sacral Ligament Injury and Resultant Skeletal Displacement in LSIJD



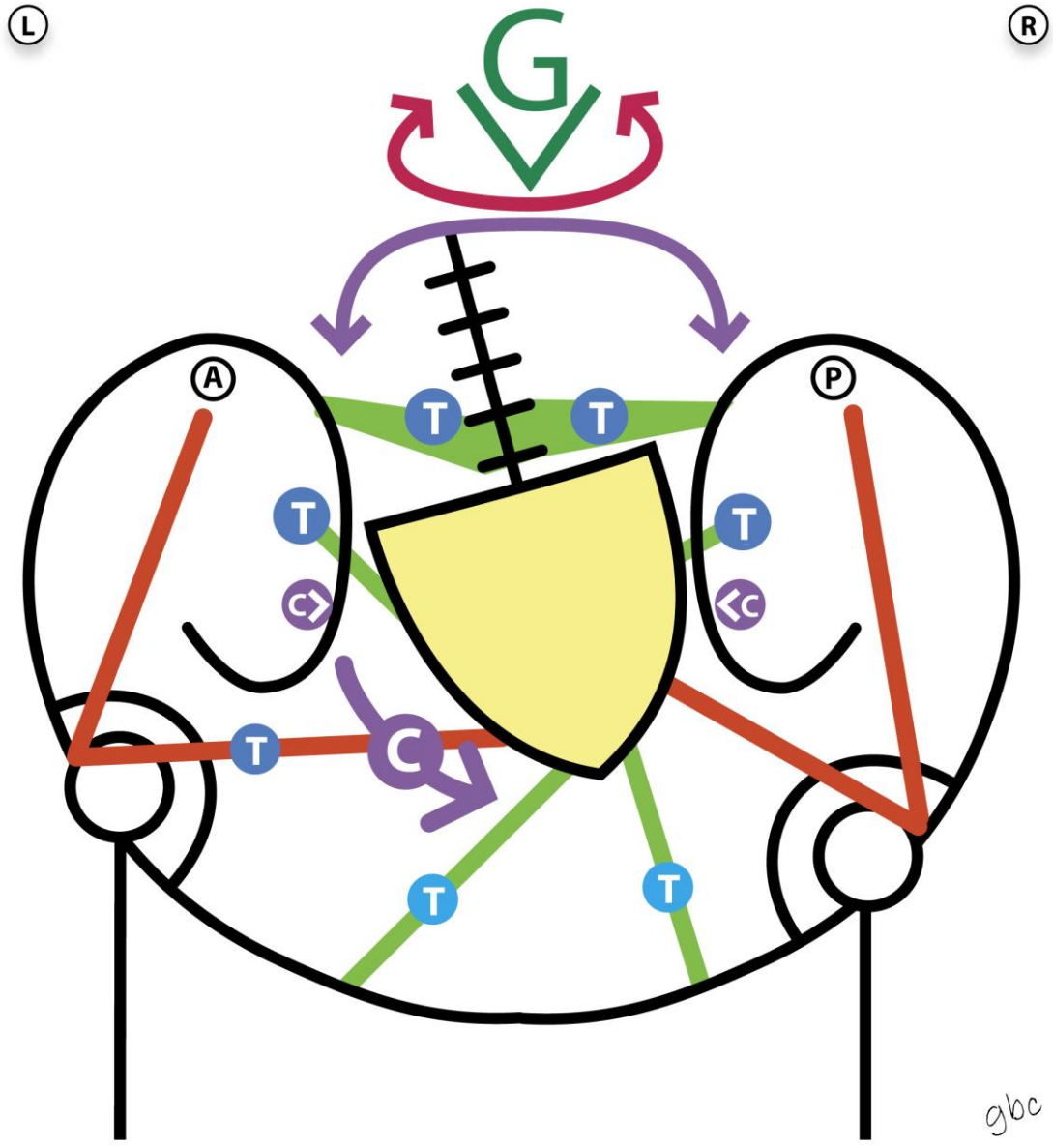
Goal 5:

Map

Compression-Tension Forces

Clinical Biotensegrity Force Map

Resultant Sacral-Pelvic Passive Compression-Tension Forces in LSIJD



A Spectrum of Potential Sacral-Pelvic Injuries in LSIJD

Chronic Active Tension—Produced During Normal Standing-Flexing-Extending-Side Bending-Rotating-and-Ambulating in a Right-handed World

- **Initially via Functionally Balanced Postural/Core Muscles**
- **These Postural/Core Muscles eventually decompensate and become functionally imbalanced**

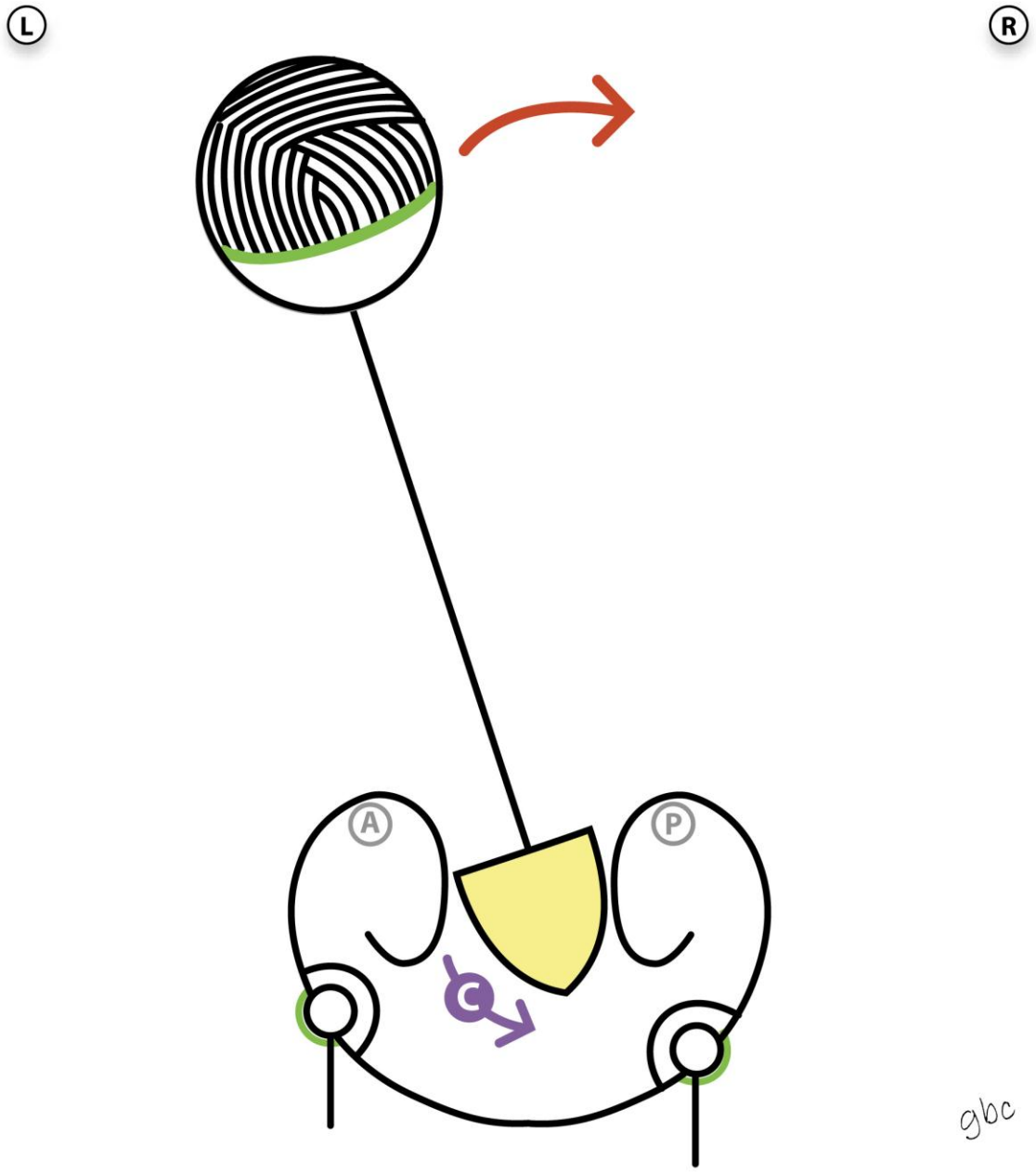
Chronic Passive Tension—Produced by Muscular/ Gravitational Forces

- **Bilateral Iliolumbar Ligament stress/strain/sprain/laxity**
- **Bilateral Superior-Inferior Posterior Sacroiliac Ligament stress/strain/sprain/laxity**
- **Bilateral Sacrotuberous Ligament stress/strain/sprain/laxity**

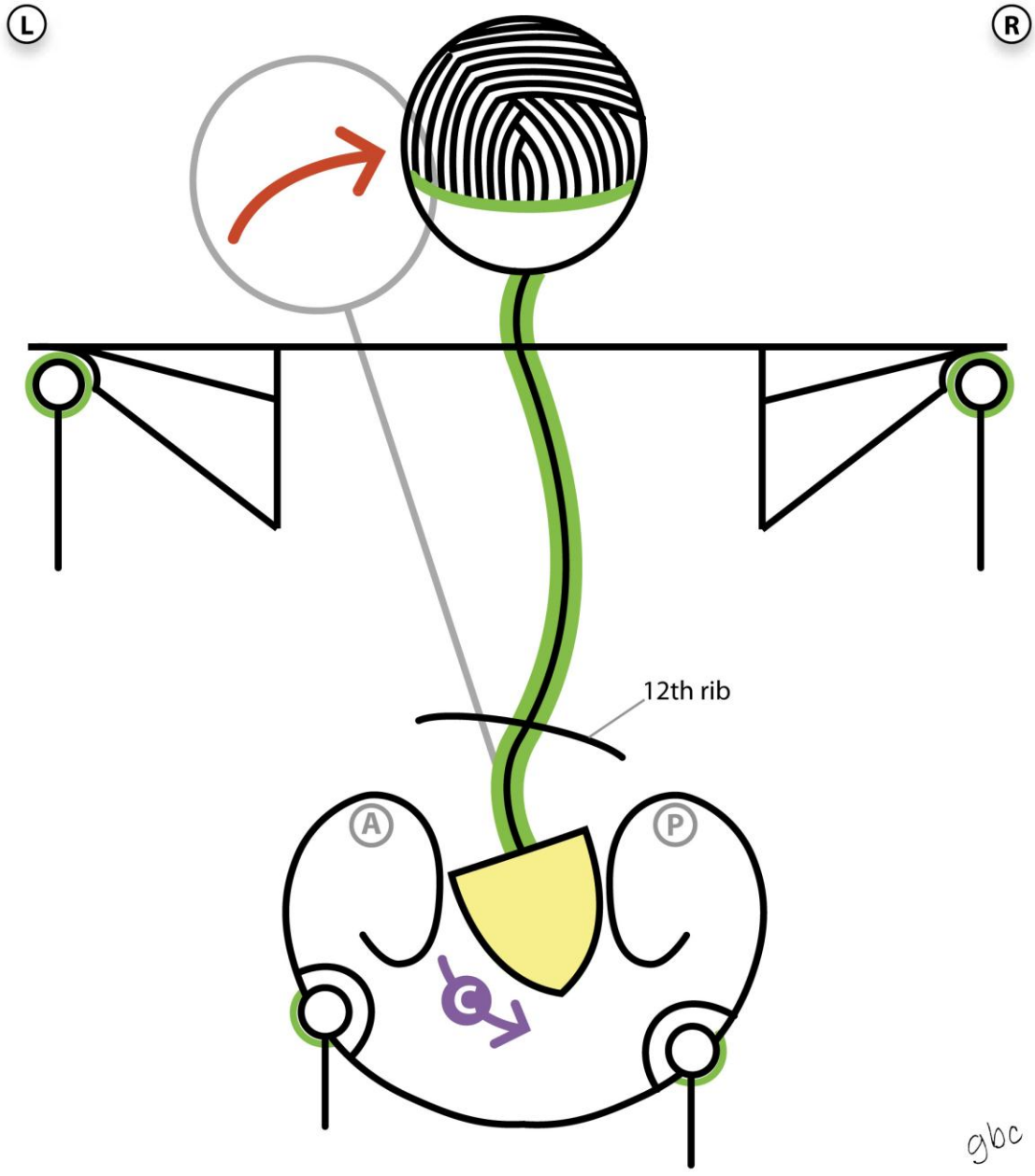
Chronic Passive Bilateral Sacroiliac Joint Compression —Produced by Gravitational Forces

- **Left Sacroiliac Joint displacement**

Compensatory Scoliosis in LSIJD
Theoretical Head Displacement

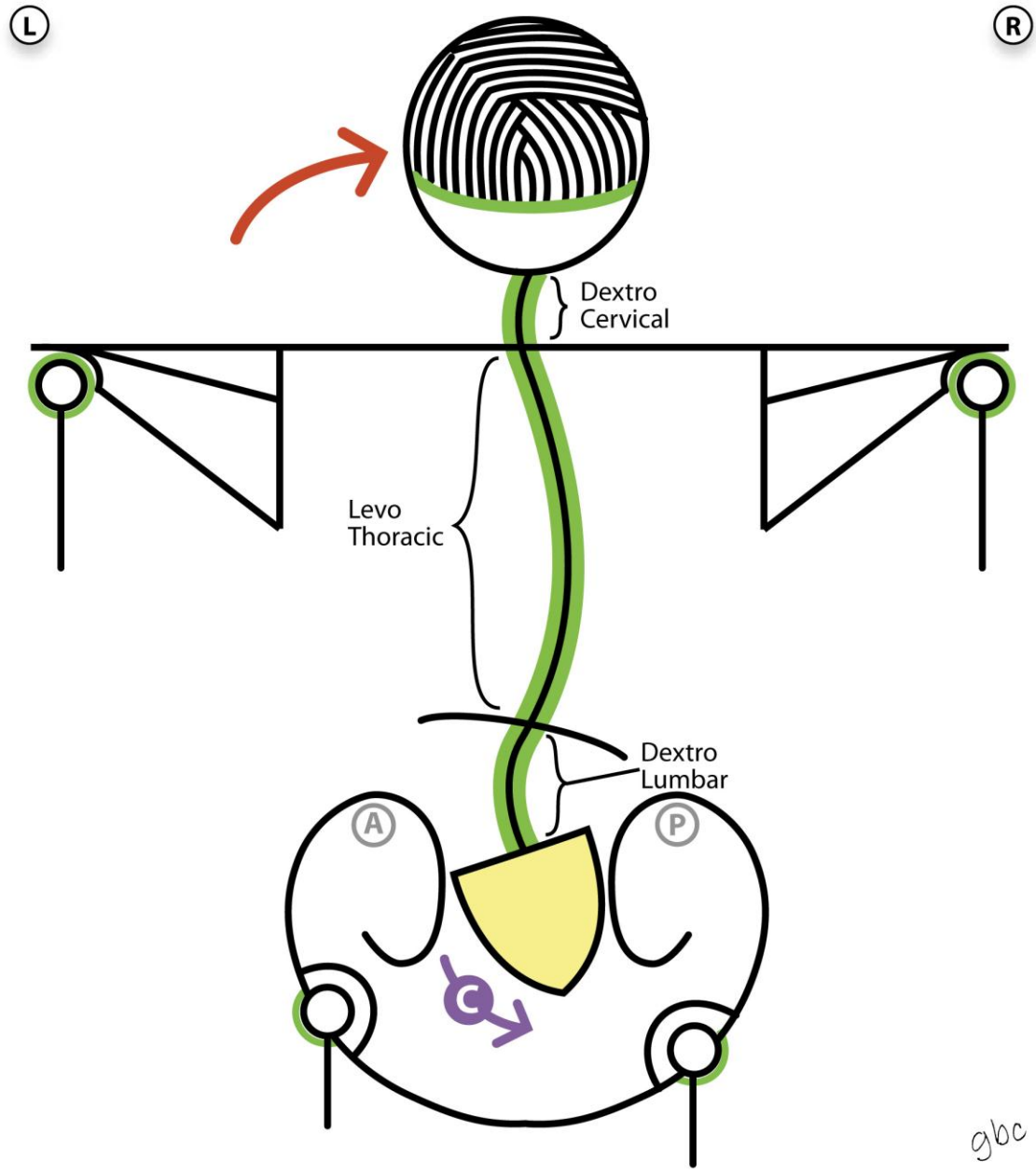


Compensatory Scoliosis in LSIJD
Head Maintained over Center of Gravity



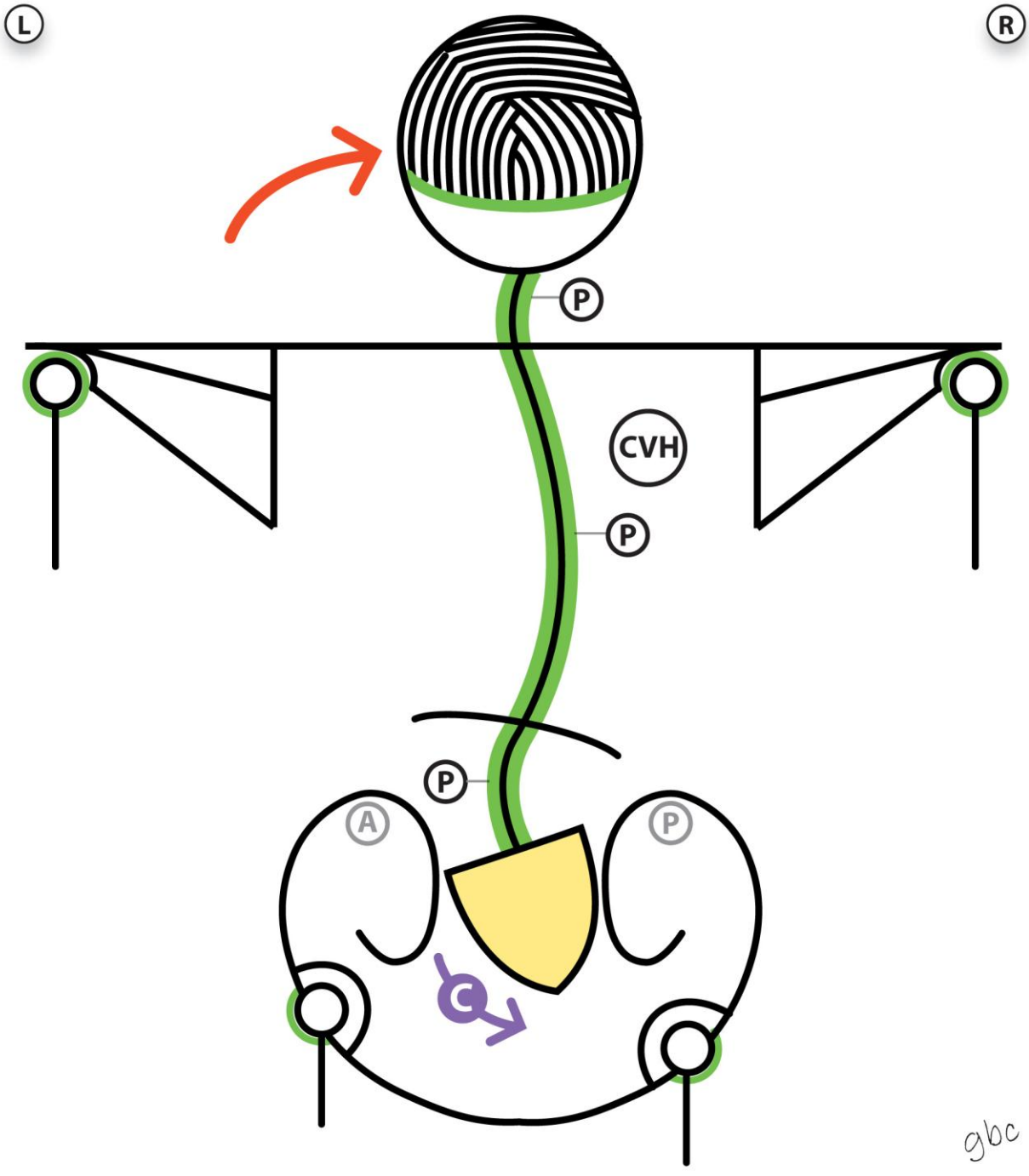
Compensatory Scoliosis in LSIJD

Resultant Regional Side-Bending



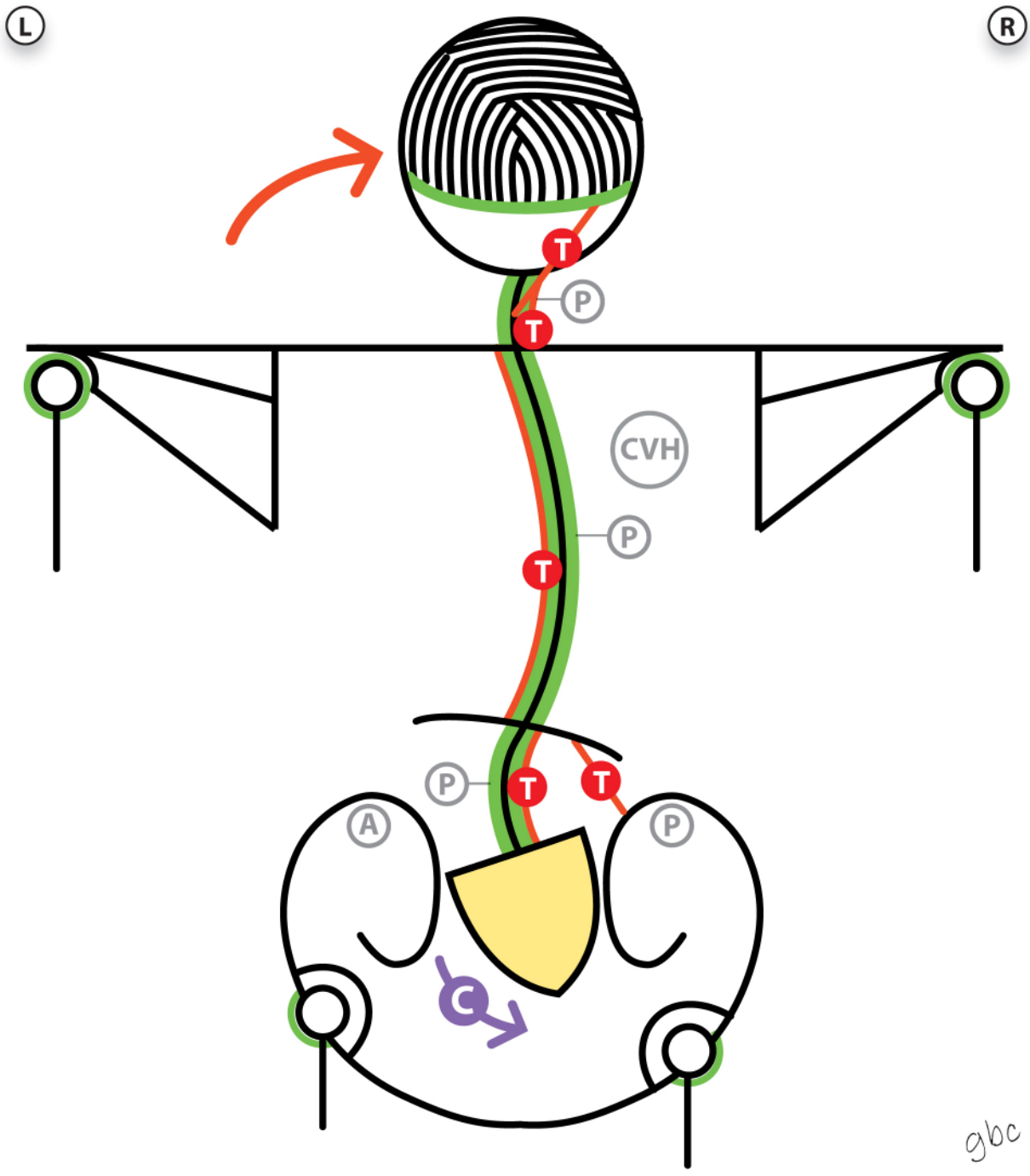
Compensatory Scoliosis in LSIJD

Resultant Vertebral Misalignment via Normal Spinal Mechanics

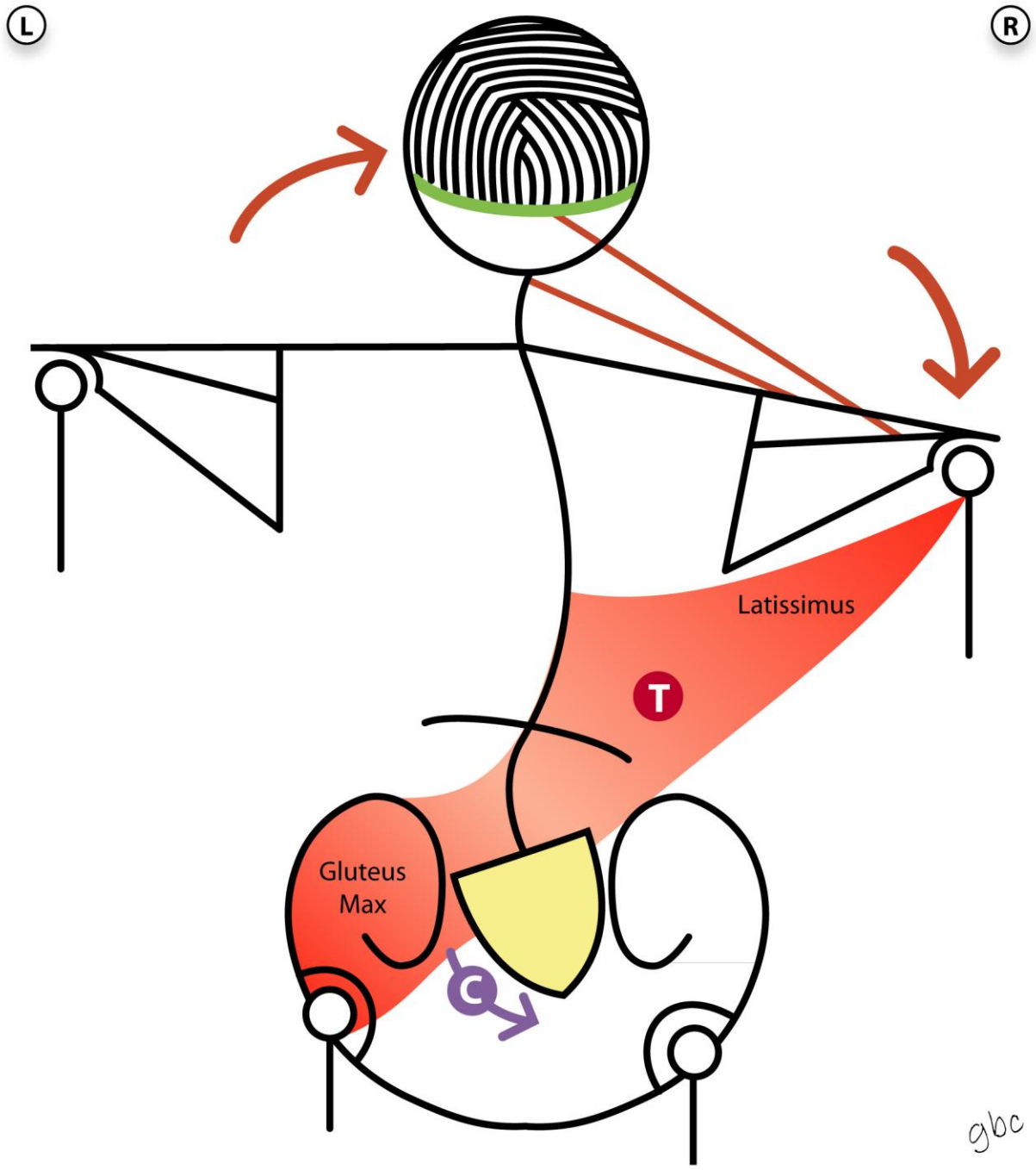


Compensatory Scoliosis in LSIJD

Causal Active Muscle Tension

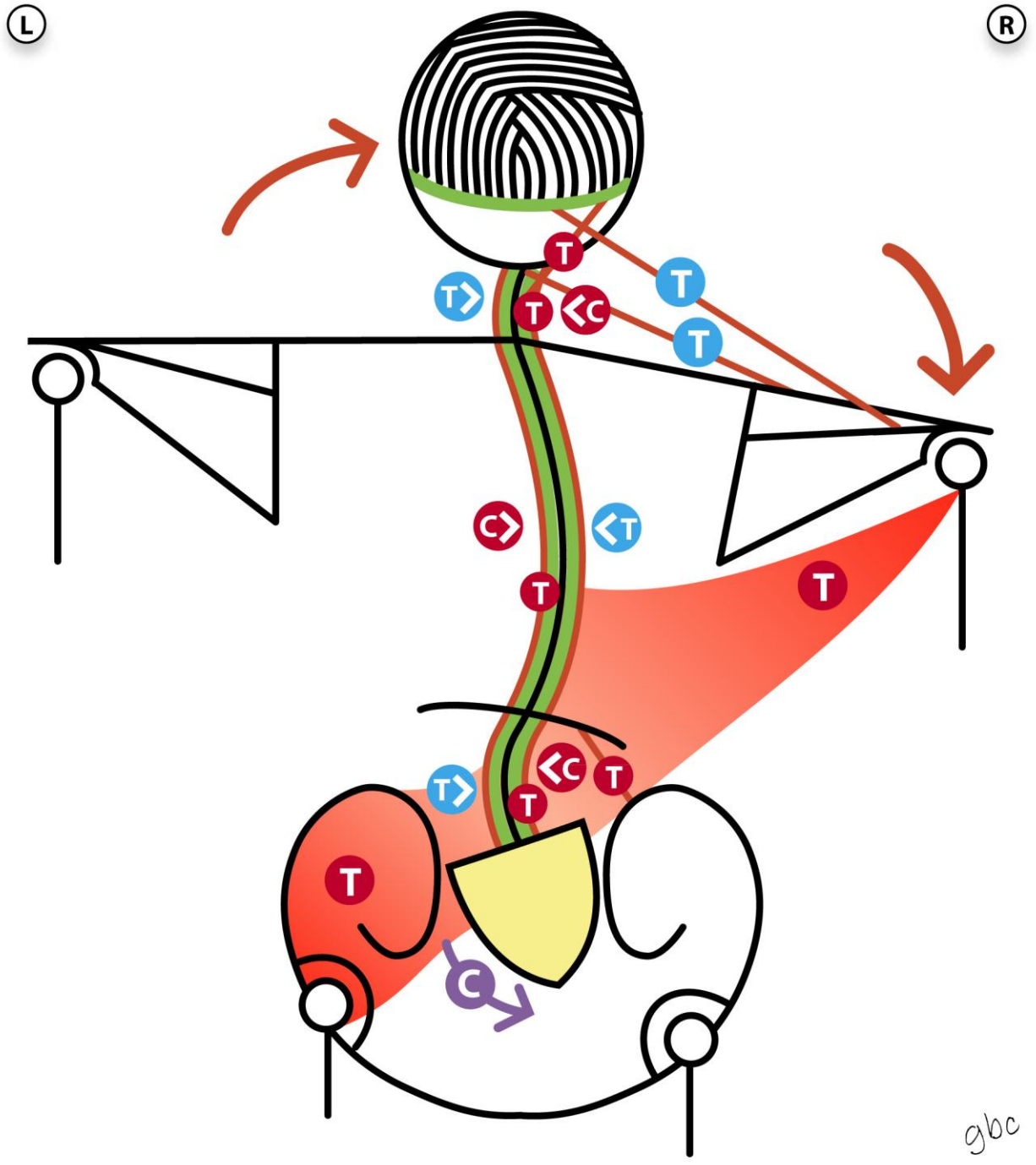


Additional Compensatory Right Posterior Sling Action in LSIJD



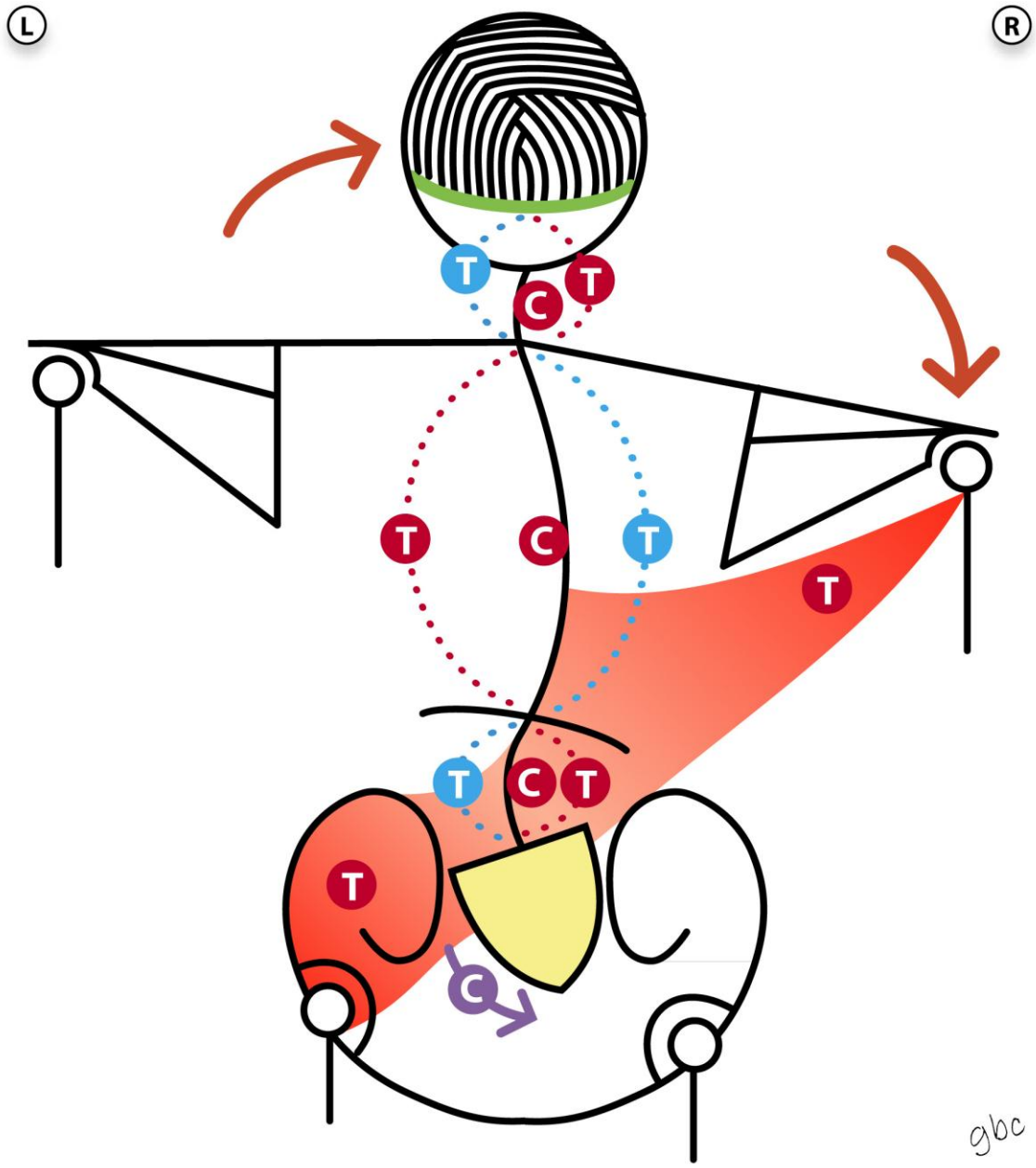
Clinical Biotensegrity Force Map

Resultant Compression-Tension Forces in Compensatory Scoliosis of LSIJD

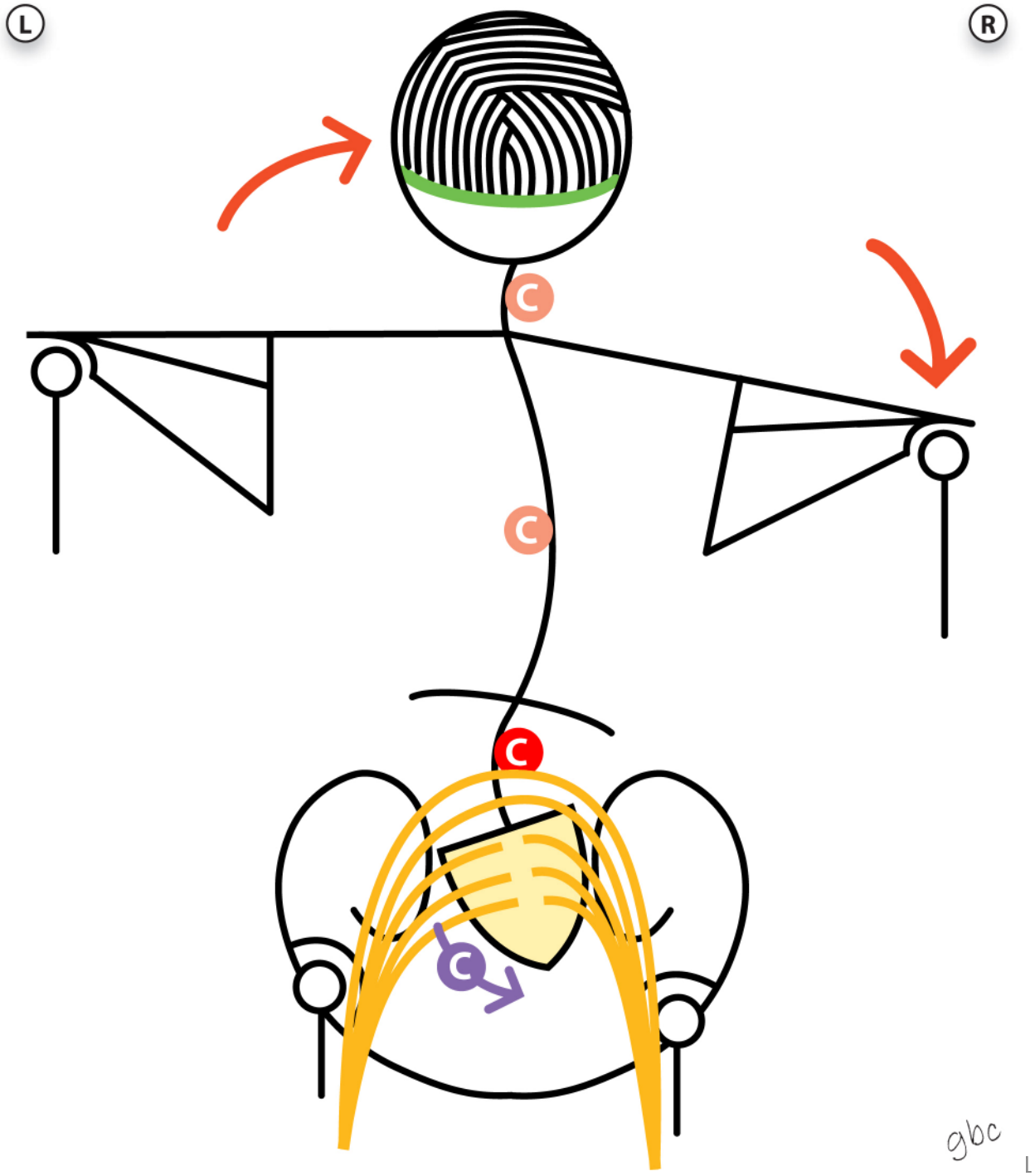


Clinical Biotensegrity Force Map

Resultant Arcs of Force in Compensatory Scoliosis of LSIJD



A “Perfect Storm”



A Spectrum of Potential Scoliotic Injuries in LSIJD

Chronic Active Tension—Compensatory along Concave Arcs

- Right Cervical Suboccipital/ Paraver-tebral Muscle activation/shortening/ strain/spasm/sprain/tendinosis
- Left Thoracic Paravertebral Muscle activation/shortening/strain/spasm/ sprain/tendinosis
- Right Lumbar Paravertebral Muscle activation/shortening/strain/spasm/ sprain/tendinosis
- Right Posterior Sling (Right Latissimus dorsi and Left Gluteus maximus) activation/shortening/strain/spasm/ sprain/tendinosis
- Right Quadratus Lumborum Muscle activation/shortening/strain/spasm/ sprain/tendinosis
- Right Thoracic Costovertebral Joint dysfunction/Interscapular Muscle activation/shortening/strain/spasm/ sprain/laxity-tendinosis

Chronic Passive Tension—Along Convex Arcs

- Left Cervical Intervertebral Ligament and Muscle stress/strain/spasm/sprain/ laxity-tendinosis
- Right Thoracic Intervertebral Ligament and Muscle stress/strain/spasm/sprain/ laxity-tendinosis
- Bilateral T11-L 2 (crossover zone) Intervertebral Ligament and Paraspinal Muscle stress/strain/spasm/sprain/ laxity-tendinosis
- Left Lumbar Intervertebral Ligament and Muscle stress/strain/spasm/sprain/ laxity-tendinosis

Chronic Active Compression—Along Concave Arcs

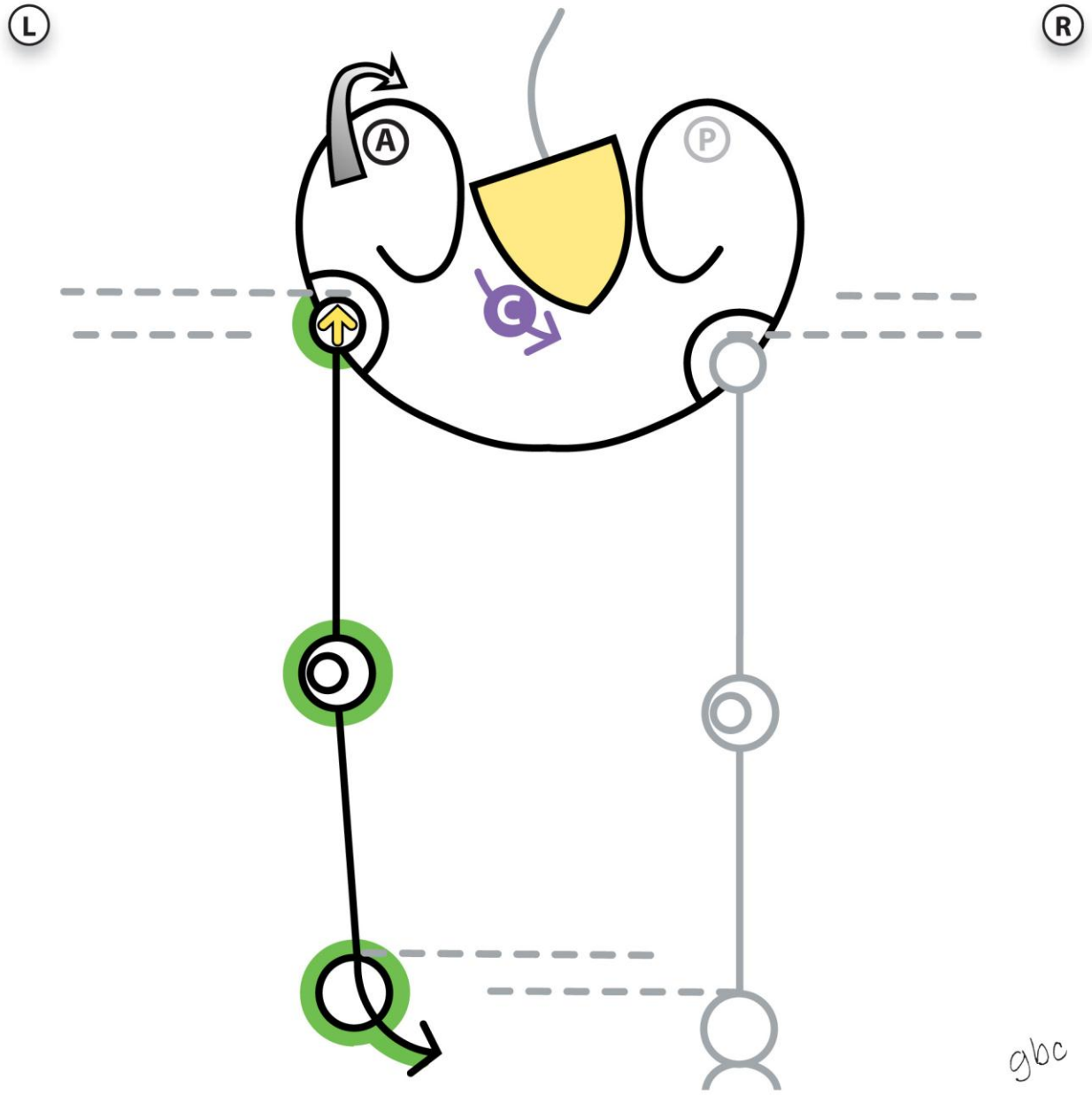
- Right C1-7 Vertebral Body wedging/ Facet Joint arthritis/Disc disease/Nerve impingement
- Left T1-12 Vertebral Body wedging/ Facet Joint arthritis/Disc disease/Nerve impingement
- Right L1-5 Vertebral Body wedging/ Facet Joint arthritis/Disc disease/Nerve impingement

Chronic Passive Tension—Other Compensatory along Convex Arcs

- Right Upper Trapezius Muscle stress/ strain/spasm/sprain/tendinosis
- Right Levator Scapulae Muscle stress/ strain/spasm/sprain/tendinosis
- Right Rotator Cuff impingement/stress/ strain/spasm/sprain/tendinosis
- Left Quadratus Lumborum Muscle stress/strain/spasm/sprain/tendinosis

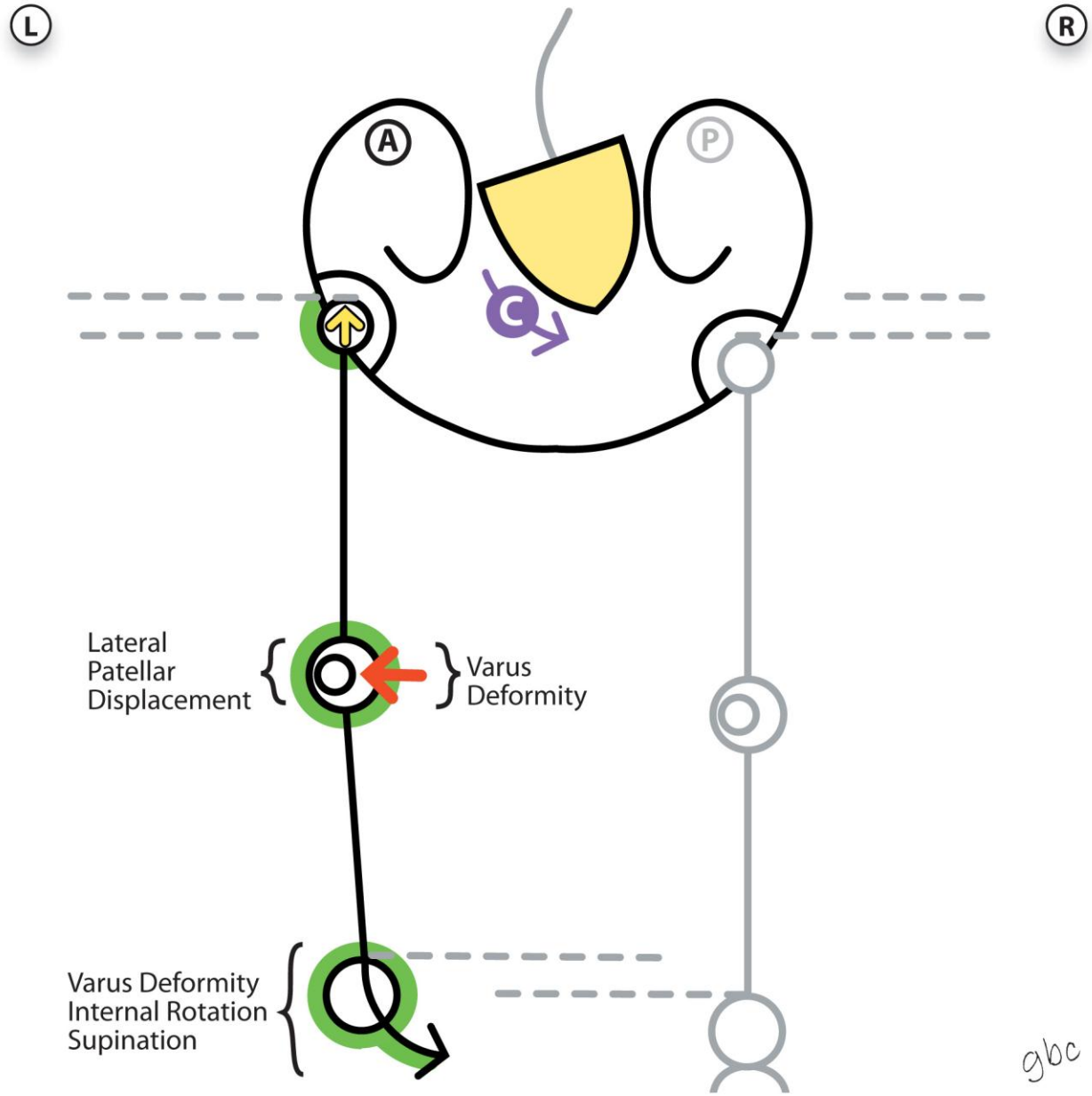
Compensatory Short Left Leg in LSIJD

Resultant Skeletal Displacement



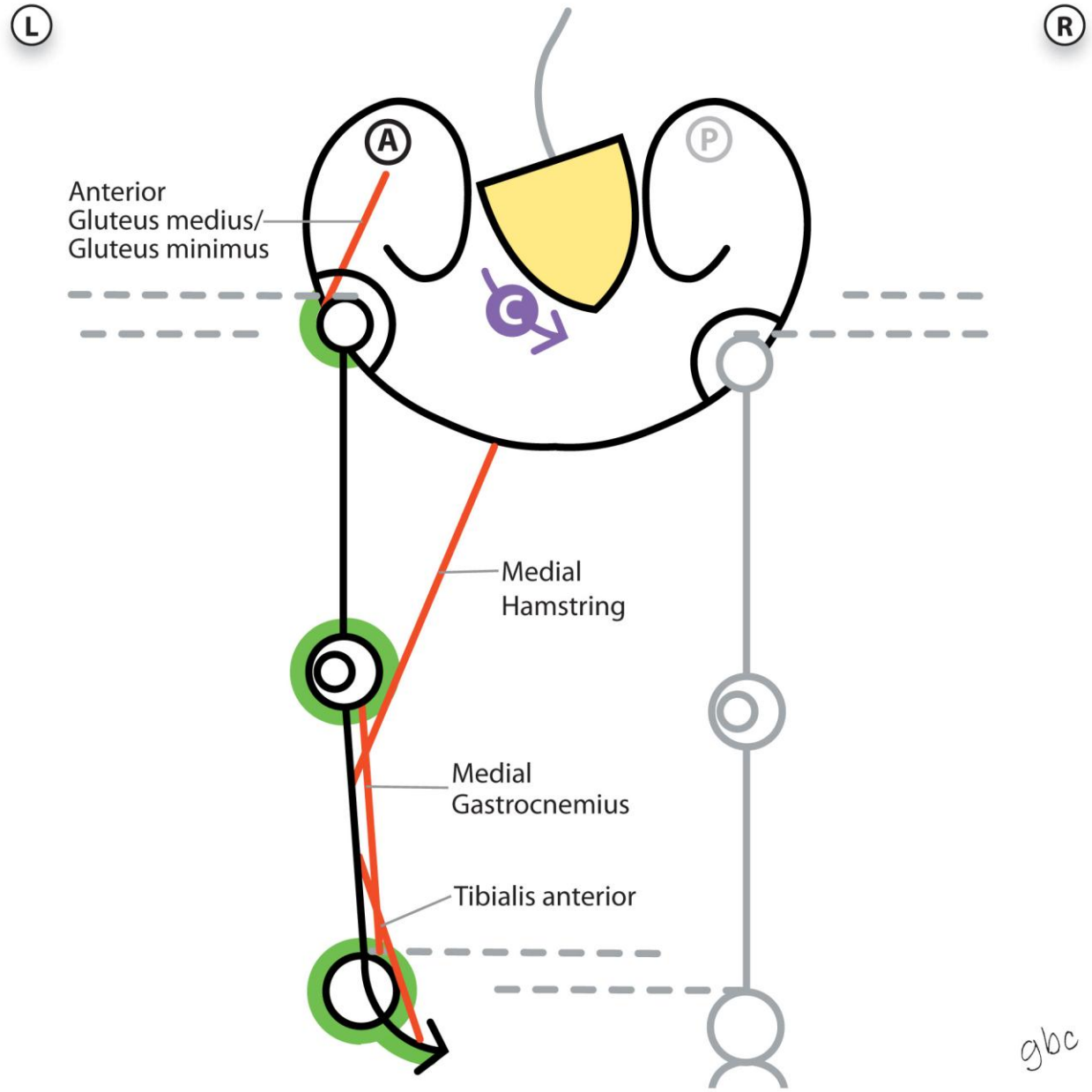
Compensatory Short Left Leg in LSIJD

Resultant Joint Deformities



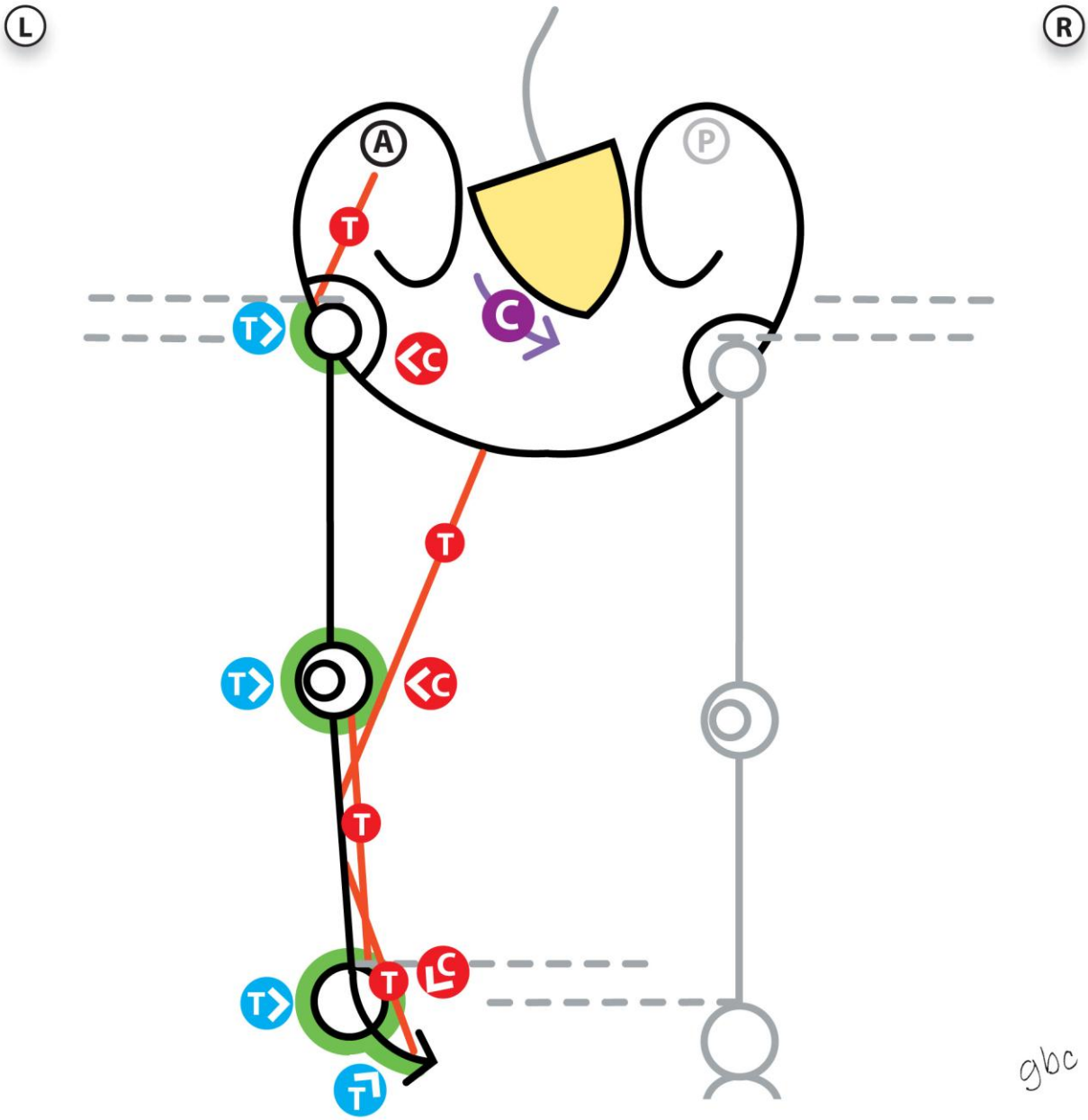
Compensatory Short Left Leg in LSIJD

Causal Active Muscle Tension



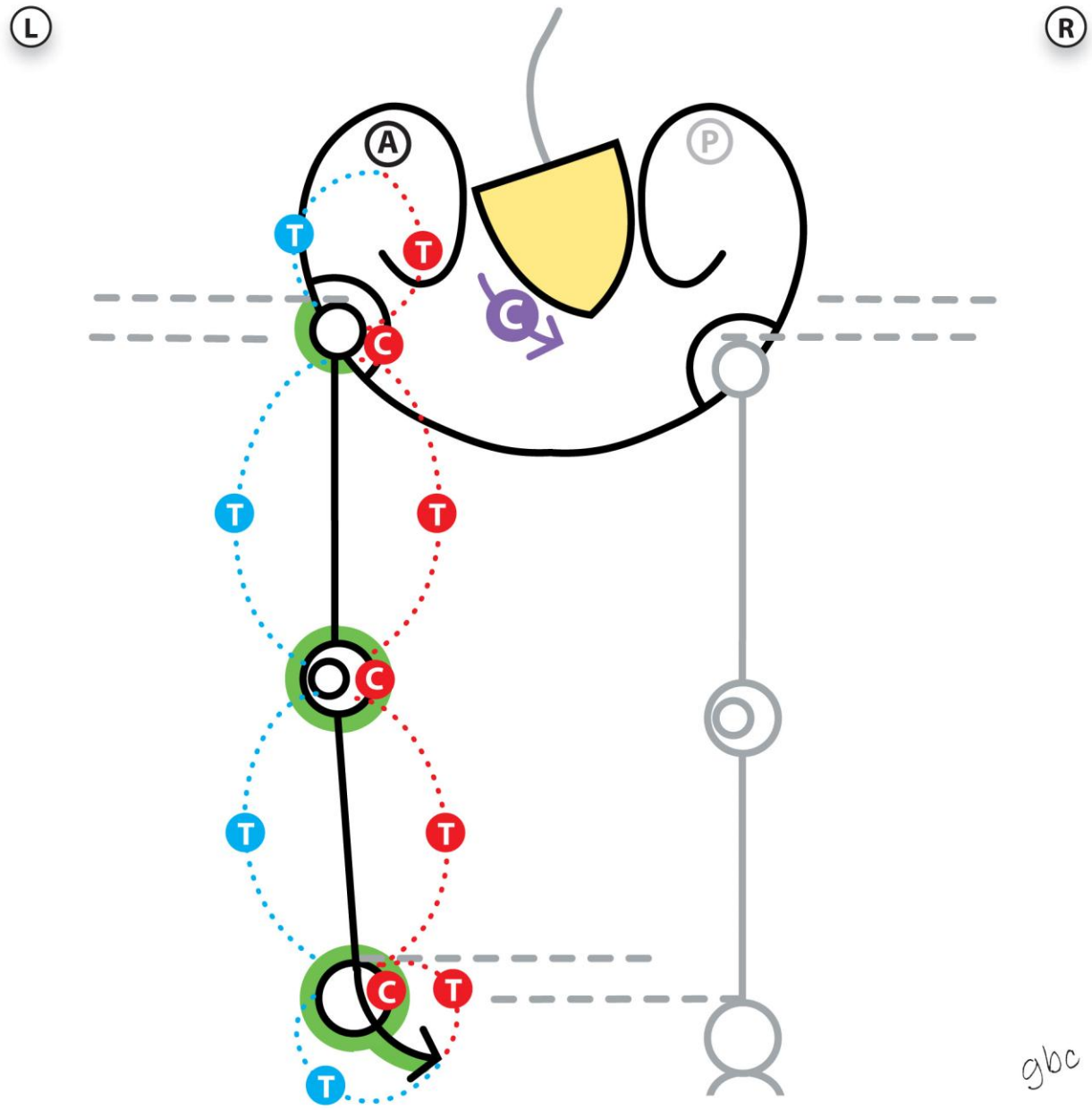
Clinical Biotensegrity Force Map

Resultant Compression-Tension Forces in Compensatory Left Short Leg of LSIJD



Clinical Biotensegrity Force Map

Resultant Arcs of Force
in Compensatory Left Short Leg of LSIJD



A Spectrum of Potential Short Left Leg Injuries in LSIJD

Left Hip and Upper Leg

--Step-down/varus gait hip joint compressive injury

--Hamstring chronic active shortening/ stress/ strain/sprain/tendinosis at left ischial tuberosity

--Internal Rotator and aDductor active shortening/stress/strain/sprain/tendinosis at ileum and/or Greater Trochanter

--Posterior Capsular Ligament passive stress/strain/sprain

--External Rotator passive stress/strain/ sprain/tendinosis at sacrum and/or Greater Trochanter

Left Knee and Lower Leg

--Varus joint deformity

--Medial Tibial-Femoral articular cartilage compressive erosion

--Lateral Retropatellar articular cartilage compressive erosion

--Medial Gastrocnemius active shortening/stress/sprain/tendinosis

--Pes anserinus Tendon active shortening/stress/strain/ sprain/tendinosis

--Lateral Collateral/Coronary Knee and Fibular Ligaments passive stress/strain/ sprain/laxity

--Posterior Cruciate Ligament passive stress/ strain/sprain/laxity

Left Ankle

--Varus joint deformity prone to lateral sprain

--Medial articular cartilage compressive erosion

-- Achilles Tendon active shortening/ stress/strain/sprain/tendinosis

--Lateral Collateral Ligaments passive stress/strain/sprain/laxity

Left Foot

--Supination foot deformity

--Medial Tibialis posterior tendon active shortening/stress/strain/sprain/tendinosis

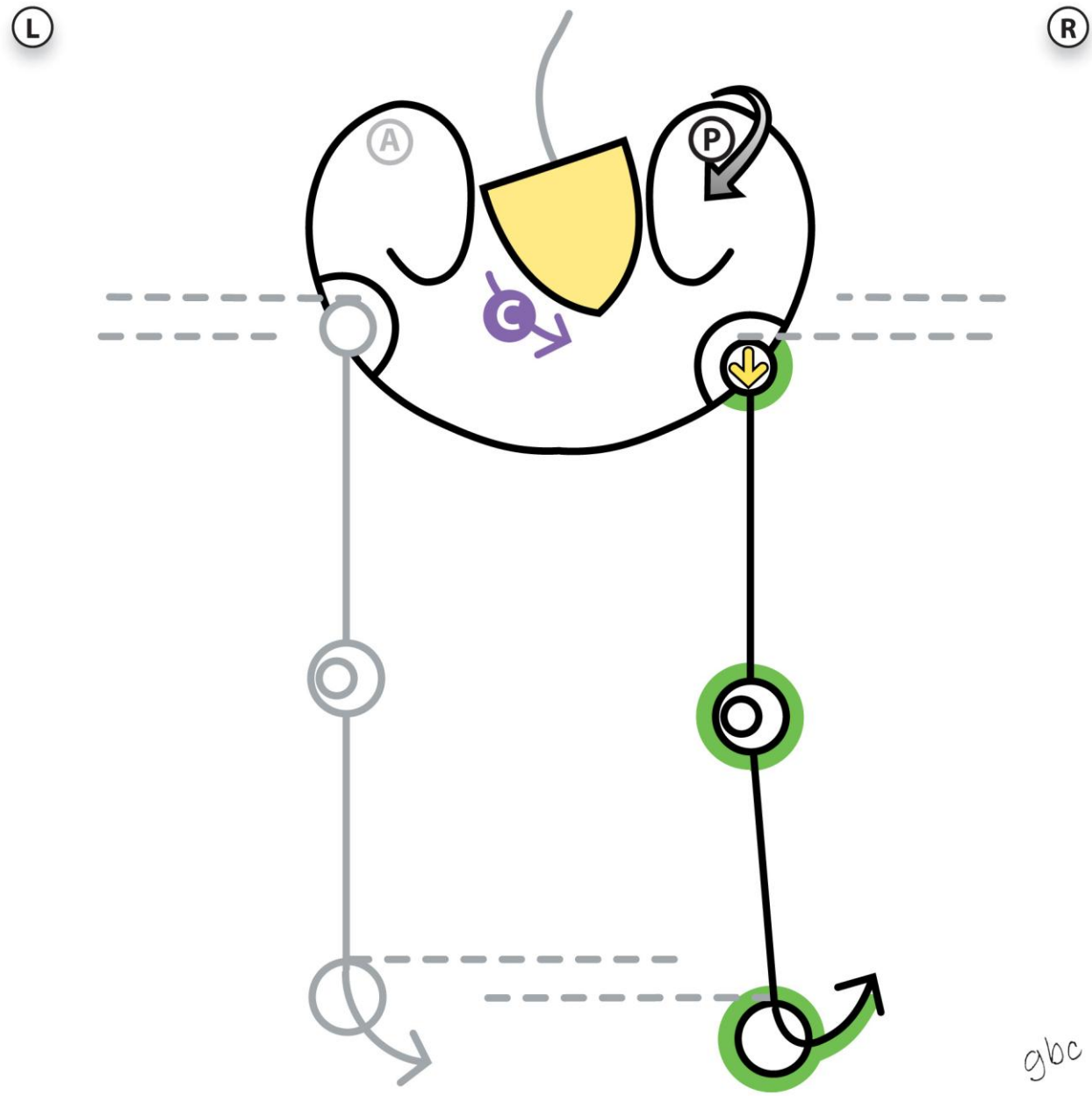
--Medial Plantar muscles active shortening/stress/ strain/sprain/fasciitis/tendinosis

--Dorsilateral Ligaments passive stress/ strain/sprain/laxity

--Lateral Peroneus brevis/longus tendon passive stress /strain/sprain/tendinosis

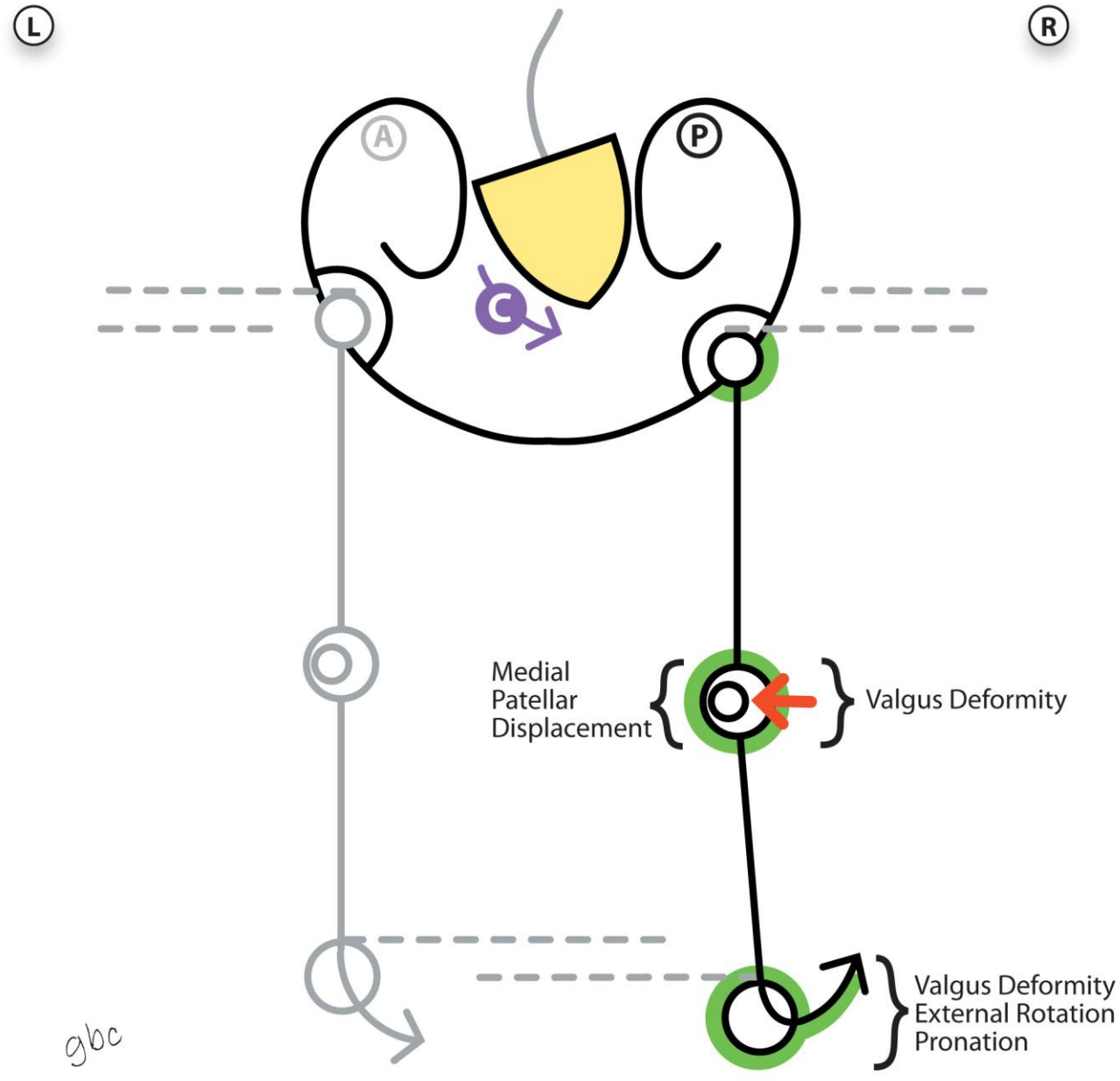
Compensatory Long Right Leg in LSIJD

Resultant Skeletal Displacement



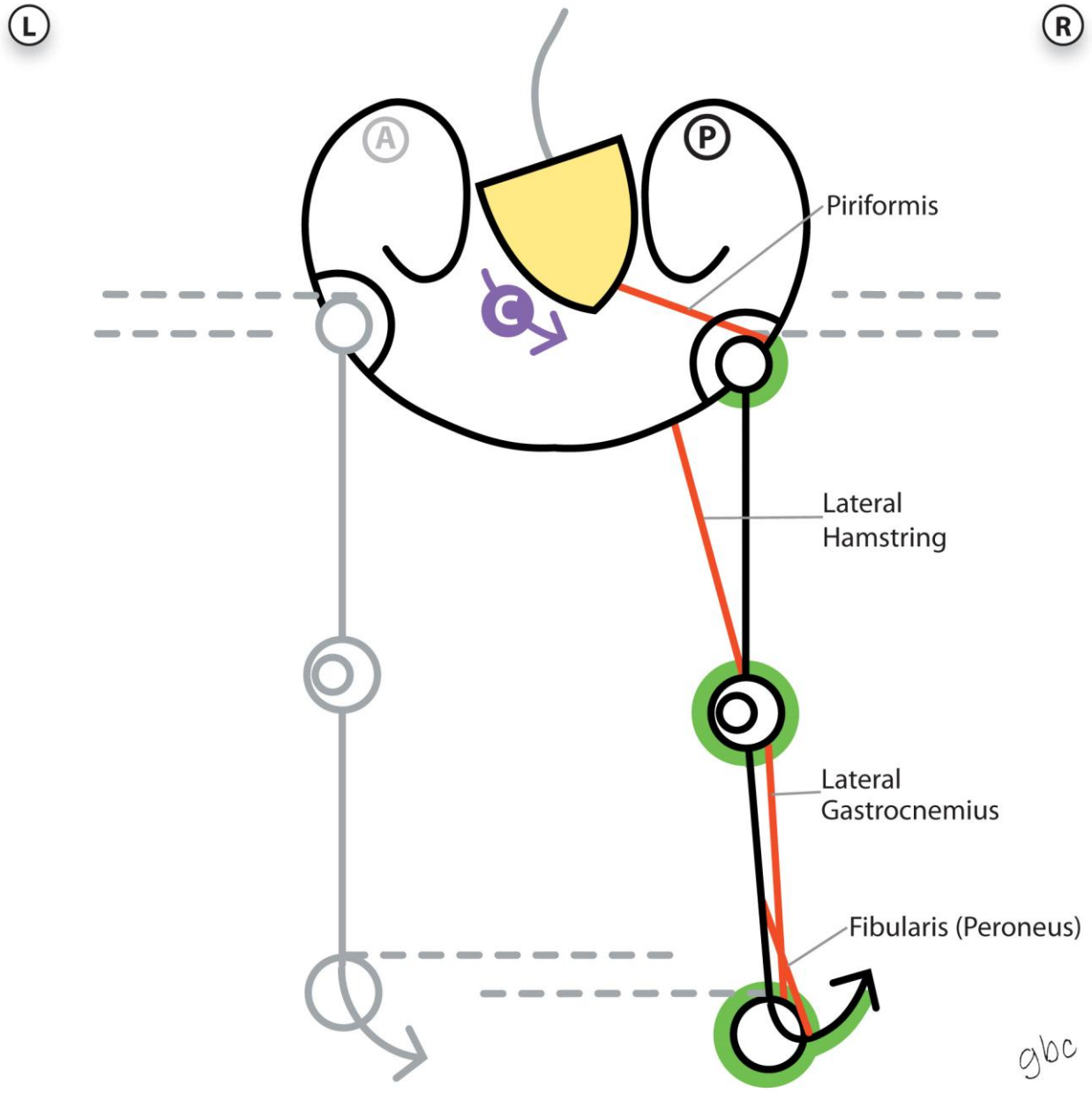
Compensatory Long Right Leg in LSIJD

Resultant Joint Deformities



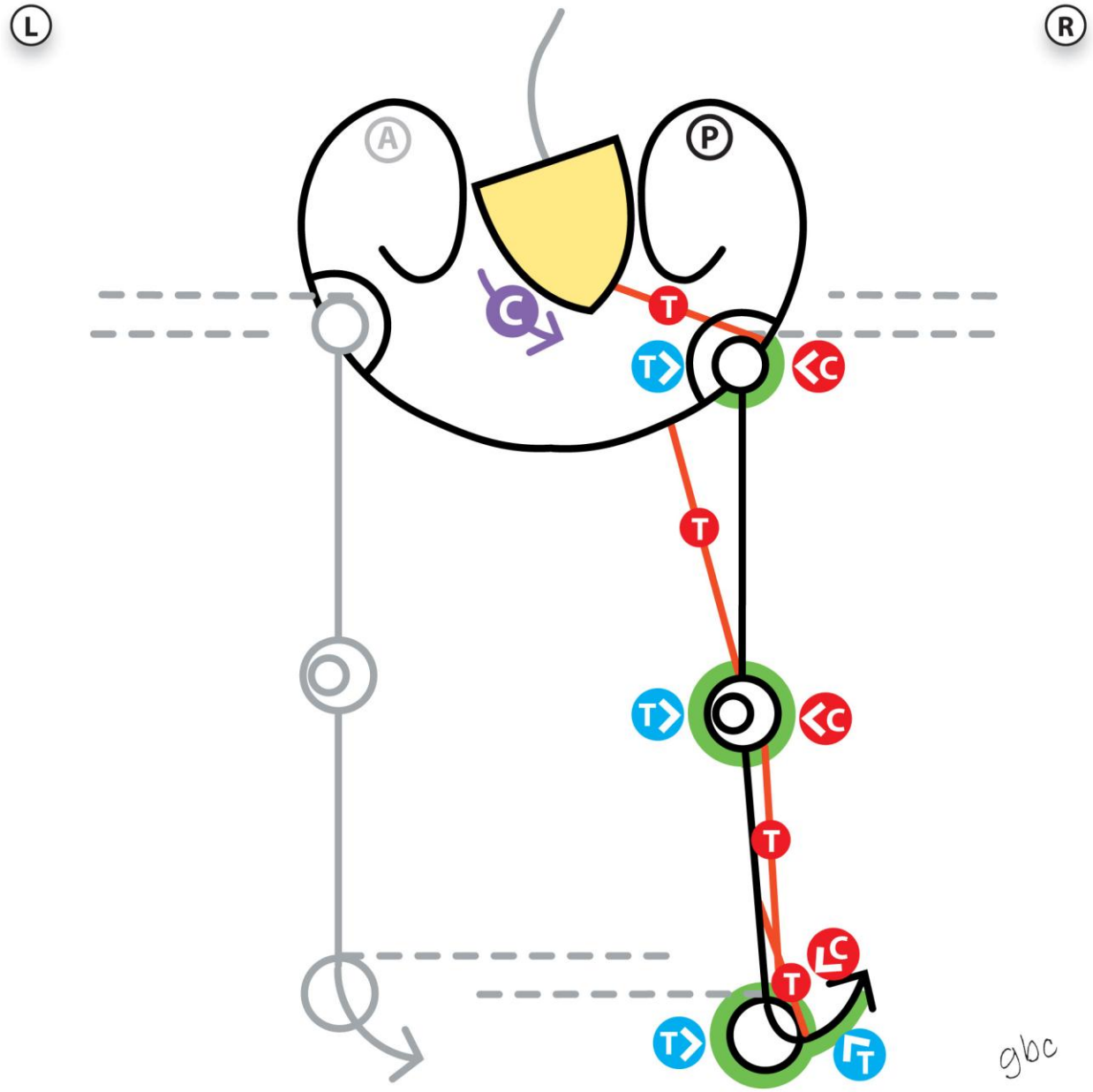
Compensatory Long Right Leg in LSIJD

Causal Active Muscle Tension



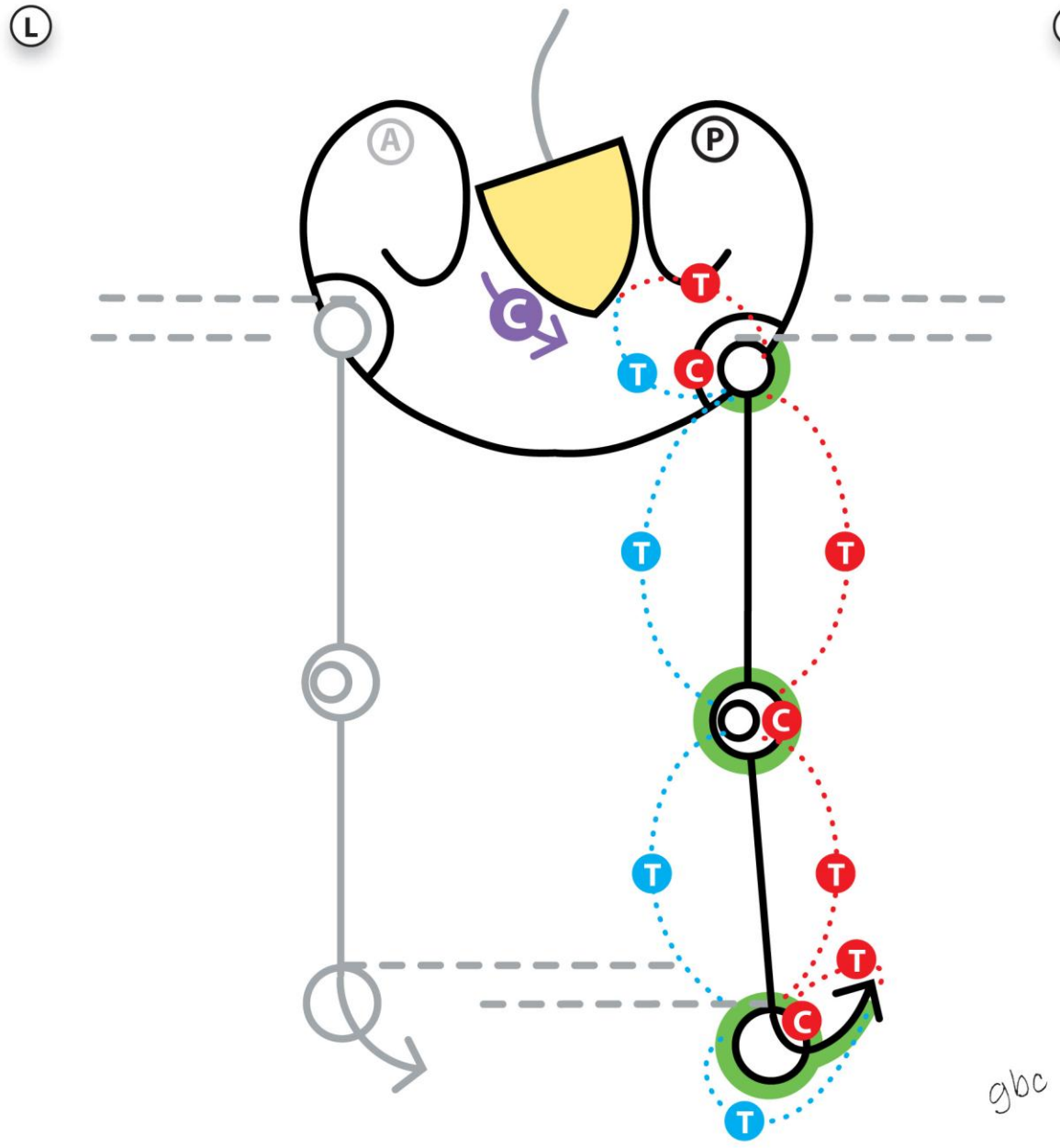
Clinical Biotensegrity Force Map

Resultant Compression-Tension Forces in Compensatory Short Left Leg of LSIJD



Clinical Biotensegrity Force Map

Resultant Arcs of Force
in Compensatory Short Left Leg of LSIJD



A Spectrum of Potential Long Right Leg Injuries in LSIJD

Right Hip and Upper Leg

-- Long leg vaulting/valgus gait compression joint injury

-- External rotator active stress/strain/sprain/tendinosis at sacrum and/or Greater Trochanter

-- Lateral Quadriceps and Patellar tendon active stress/strain/sprain/tendinosis

-- Anterior capsular passive stress/strain/sprain/laxity

-- Internal rotator passive shortening/stress/strain/sprain/tendinosis

Right Knee and Lower Leg

-- Valgus joint deformity

-- Lateral tibial-femoral articular cartilage compressive erosion

-- Medial retropatellar articular cartilage compressive erosion

-- Medial knee ligaments passive stress/strain/sprain/laxity

-- Anterior cruciate ligament passive stress/ strain/sprain/laxity

Right Lower Leg and Ankle

-- Valgus joint deformity prone to medial sprain/laxity

-- Lateral articular cartilage compressive erosion

-- Anteromedial Tibialis posterior passive stress/strain/sprain/tendinosis ("shin splints")

-- Medial collateral ligaments passive stress/strain/sprain/laxity

Right Foot

-- Accentuated Pronation foot deformity

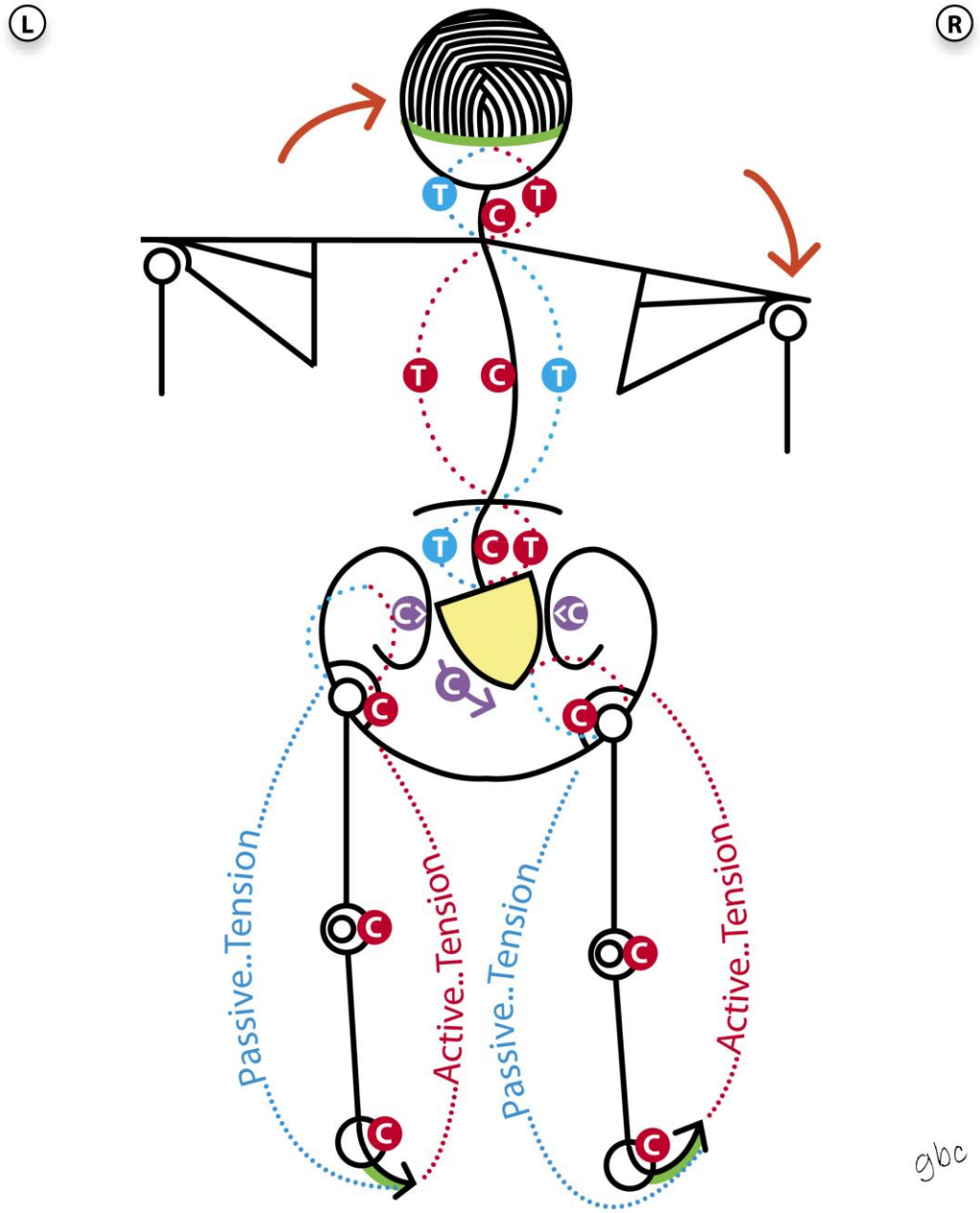
-- Lateral Peroneus brevis/longus tendon active stress/strain/sprain/tendinosis

-- Dorsilateral foot myofascial active stress/strain/sprain/"fasciitis"--tendinosis

-- Medial-plantar ligaments passive stress /strain/sprain/laxity

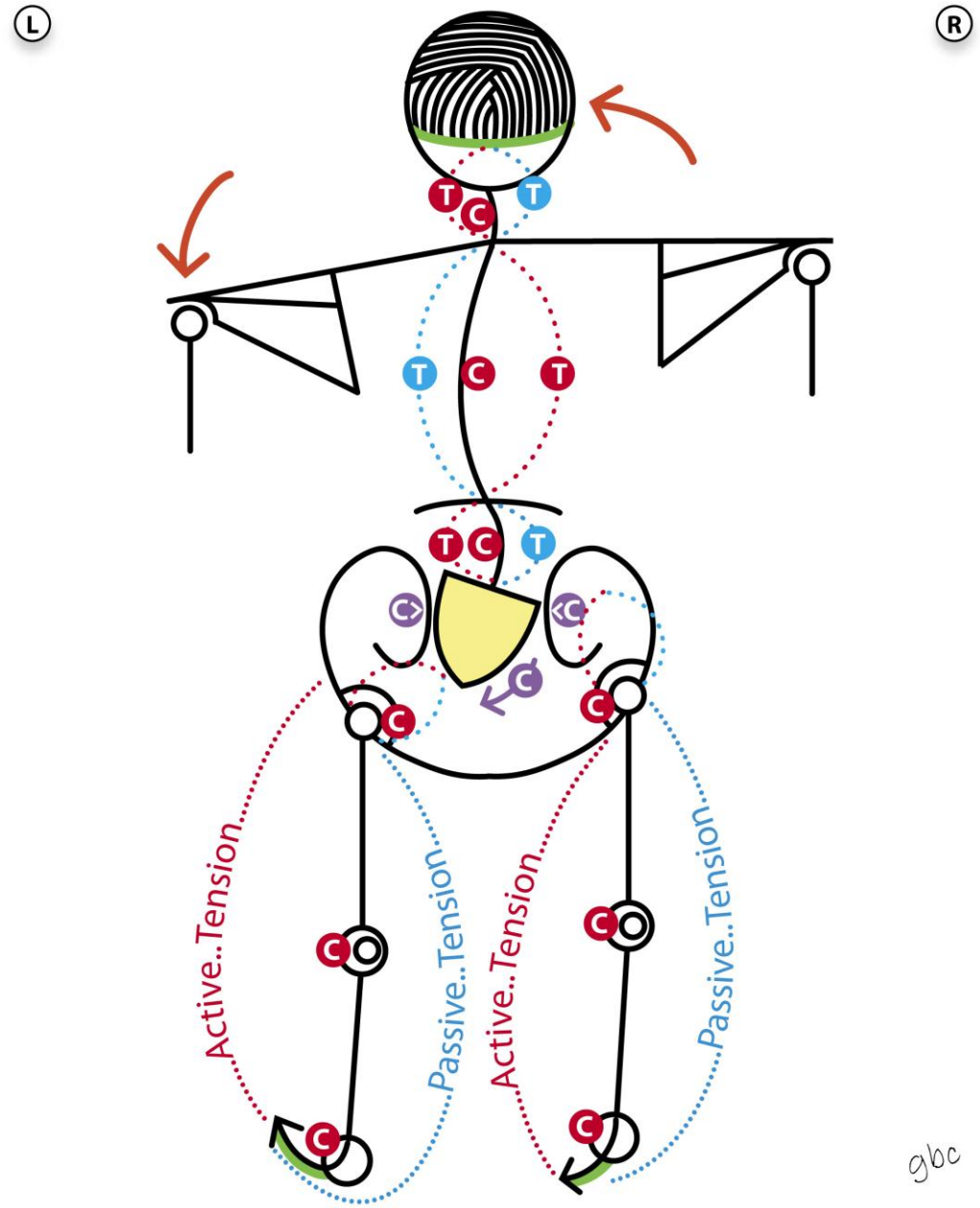
Whole-Body Compression-Tension Arcs and Spectrum of Potential Injuries in LSIJD

From the Plantar Arch to the Nuchal Line



Whole-Body Compression-Tension Arcs and Spectrum of Potential Injuries in RSIJD

From the Plantar Arch to the Nuchal Line



Sequence of Therapies for SIJD

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  - OMT: 30%
  - Prolotherapy: 70%

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- **WARNING: Avoid potential iatrogenic worsening of pre-existing scoliosis.**

Biotensegrity To Do List

Generate Other Data-Based Biotensegrity Models:

Improve the SIJD Model with its major clinical variants
Head-TMJ-Neck- Shoulder Injuries (e.g., whiplash)
Upper Extremity Injuries (e.g., epicondylosis)
Lower Extremity Injuries (e.g., Pes planus, Pes cavus)
Left/Right Sacroiliac–Right/Left Posterior Sling–Right/Left Shoulder Dysfunction

Determine mechanism
of leg aBductor (Gluteus medius) inhibition in SIJD

(perhaps due to Sherrington-oid "reciprocal innervation"
between anterior and posterior fibers)

Determine on a Biotensegrity Basis <u>when NOT</u> to stabilize the sacrum to preclude iatrogenic worsening of pre-existing scoliosis

Determine physiological and therapeutic differences between
Passive Musculo-Tendinous Injuries
versus
Active Musculo-Tendinous Injuries

Explore the most appropriate
OMT, Injection Therapy, Orthotic Therapy, and
Rolfing, Pilates, Physical Therapy, and
Other therapeutic and postural rehabilitative
sequential approaches for various Biotensegritous injuries

. . . . . and more

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