Hip Biomechanics

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Aim:

- Understanding of Free Body Diagrams and their resolution

Scope:

- Newton Laws
- Basic and Derived Quantities
- Free Body Diagram
- Joint Reaction Force
- Reducing the Joint Reaction Force
- A Little trigonometry

Newtons Laws

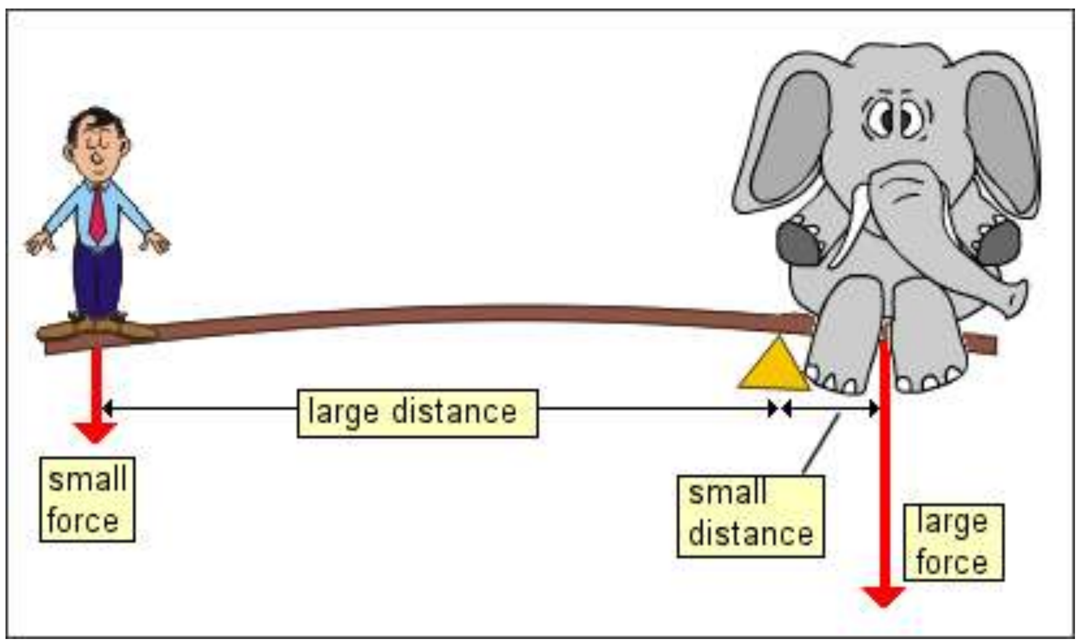
- First Law: Inertia- if zero net force acts on a body it will remain at rest of continue to move uniformally
- Second Law: Accelerations (F=ma)
  - Acceleration of an object is directly proportional to the forces acting on it
- Third Law: Reaction
  - To every action there is an equal and opposite reaction.
  - This allows you to work out Free Body Diagrams

Basic and Derived Quantities

- Scalar quantities- magnitude but no direction (Vol, Mass, Time)
- Vector quantities- (Force, acceleration, Velocity)
  - Magnitude
  - Direction
  - Point of Application
  - Line of Application

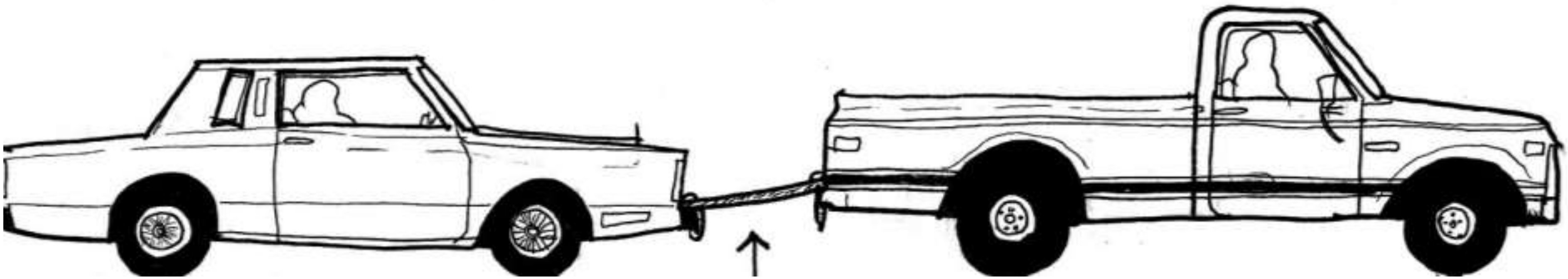
Moments

- Moment (Newton Meter)= Force x Distance and gives a rotational effect of a force on a body about a point.



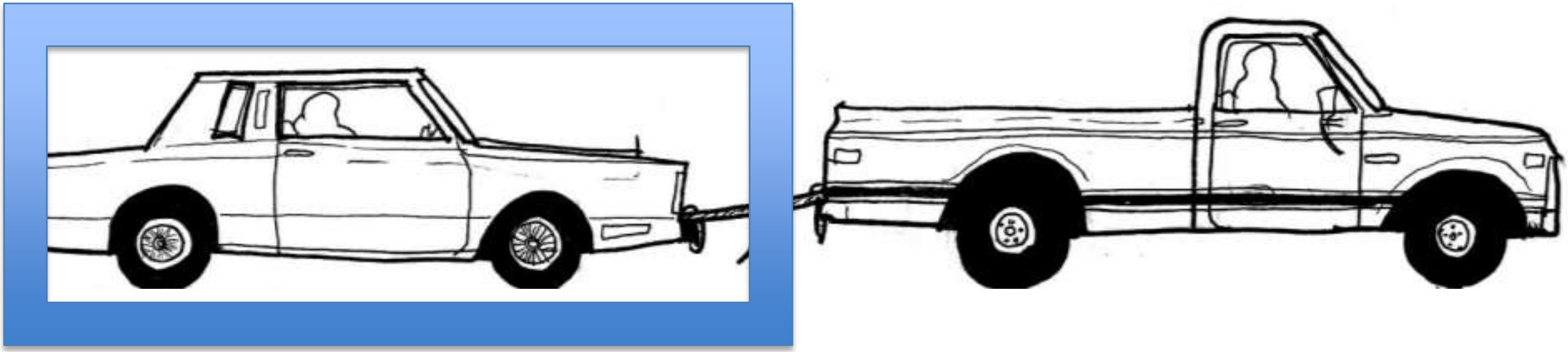
Free Body Diagrams

- Rules:
  - Draw a picture of the Environment



Free Body Diagrams

- Rules:
  - Identify the system being studied

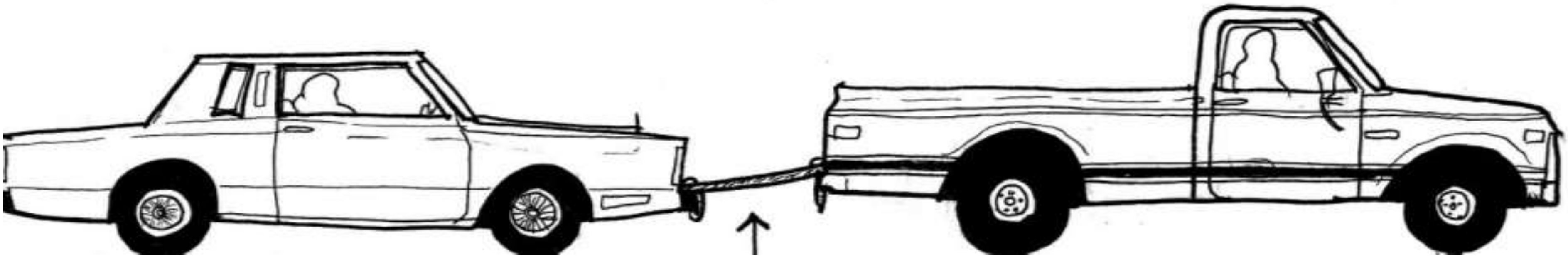


Free Body Diagram

- Draw System Alone

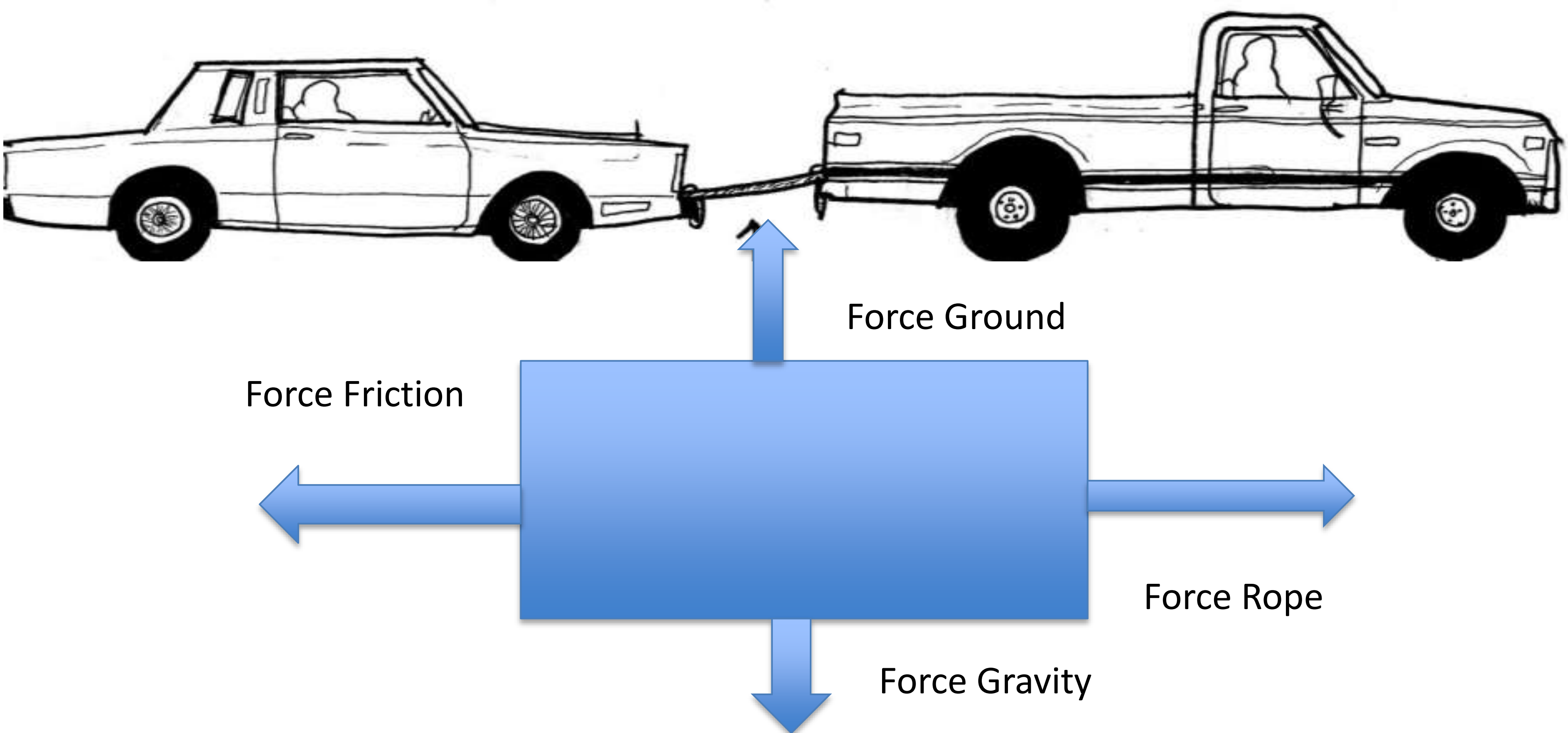
Free Body Diagram

- Draw Each Force From the Environment that acts onto the system



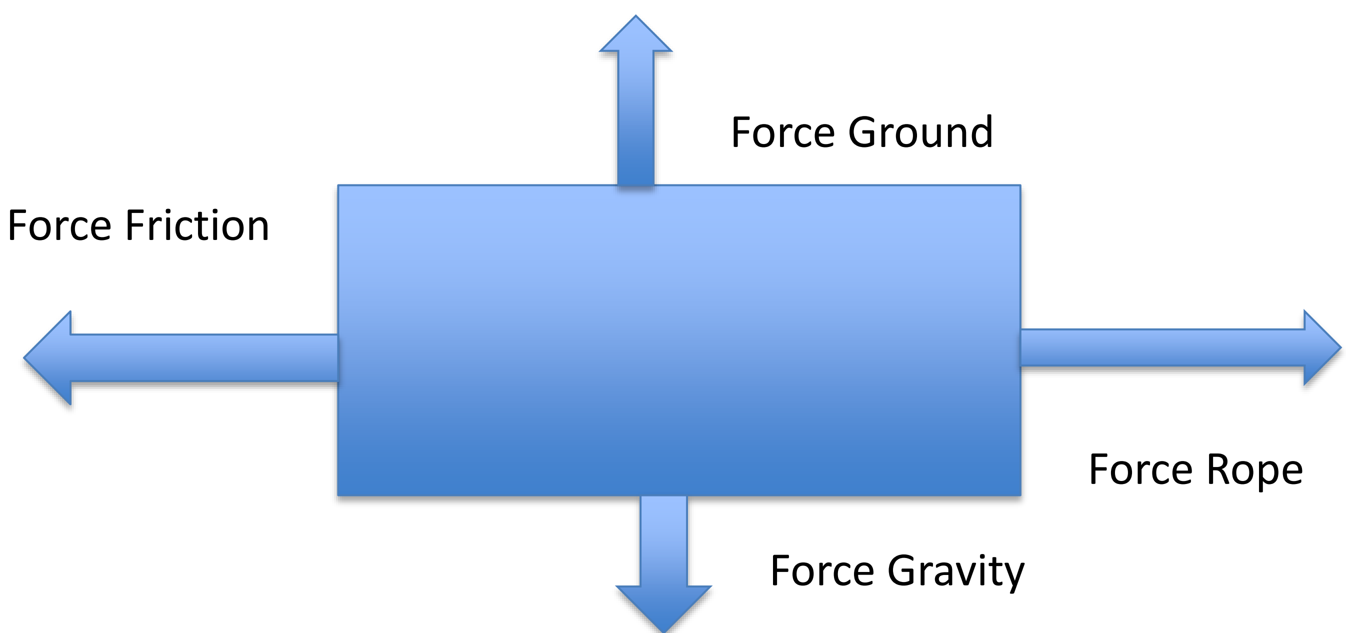
Free Body Diagram

- Repeat for each force until all accounted for

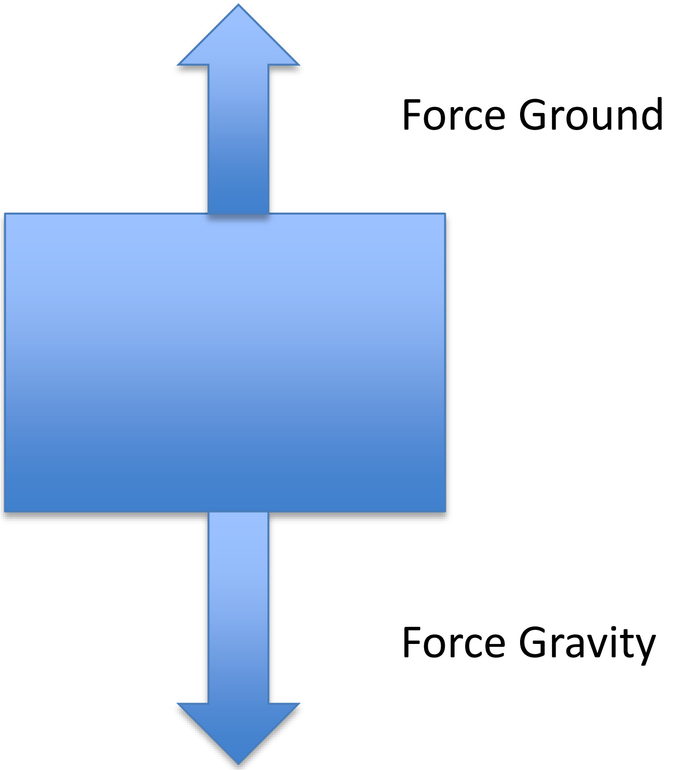


Free Body Diagram

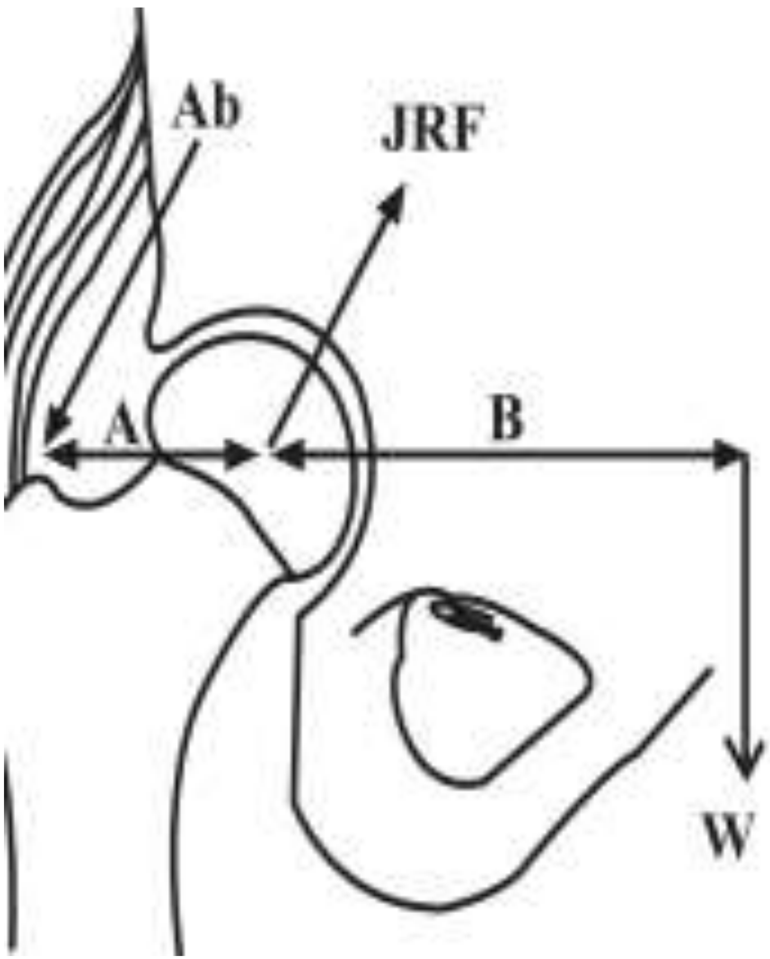
- Apply Newton's second so sum of all forces=ma
- So if Force Friction= Force Rope then remains same velocity. If FF>FR then slows down etc.



When Looking at Free Body Hip



Hip Free Body Diagram



Ab - Abductor force

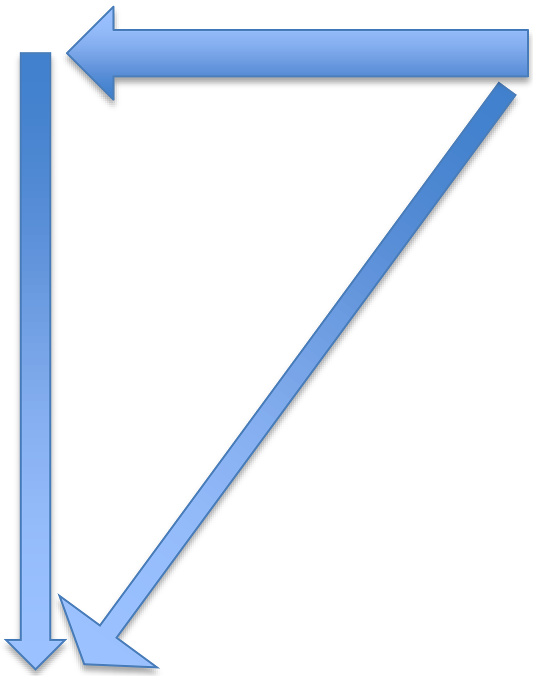
A - Abductor moment arm

B - Moment arm of body weig

JRF - Joint reaction force

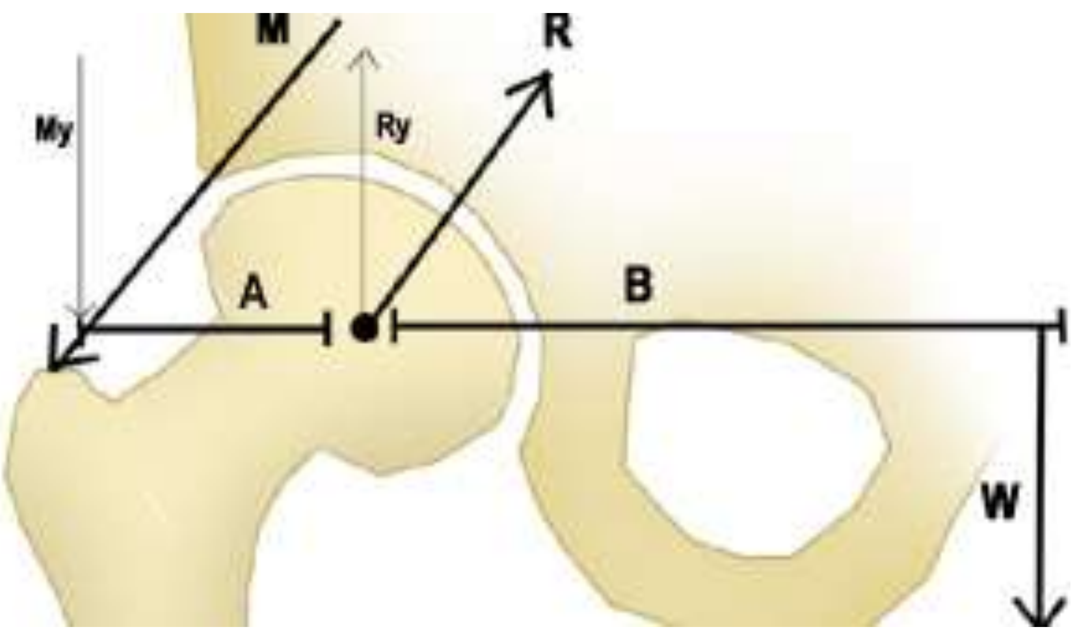
W - Body weight

Abductor Force Component of Two Forces



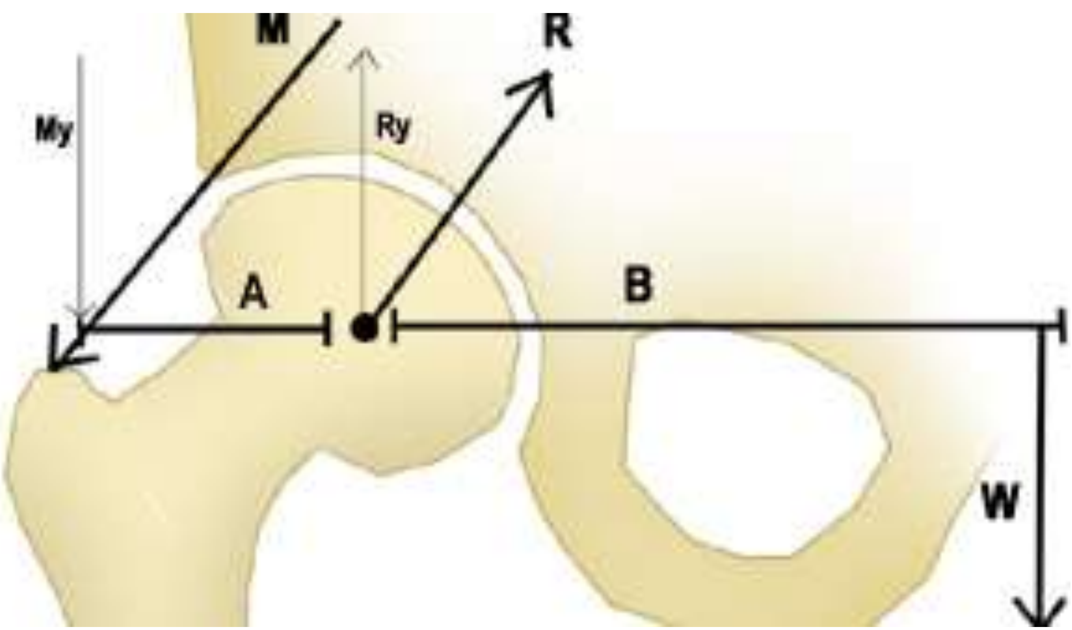
So Breaking it Down Torque

- The MyA Moment must equal the WB Force



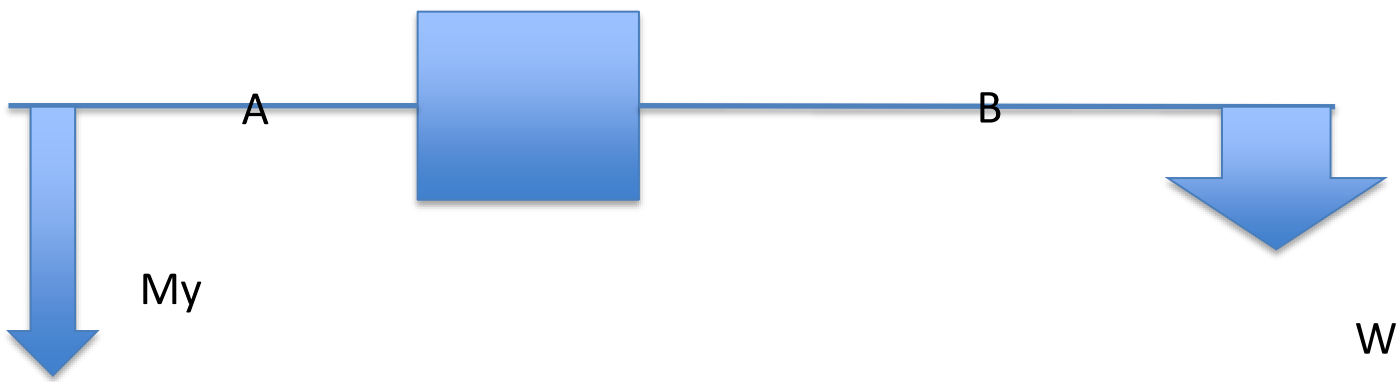
So Breaking it Down Free Body

- The Ry Force Must Equal the My+W



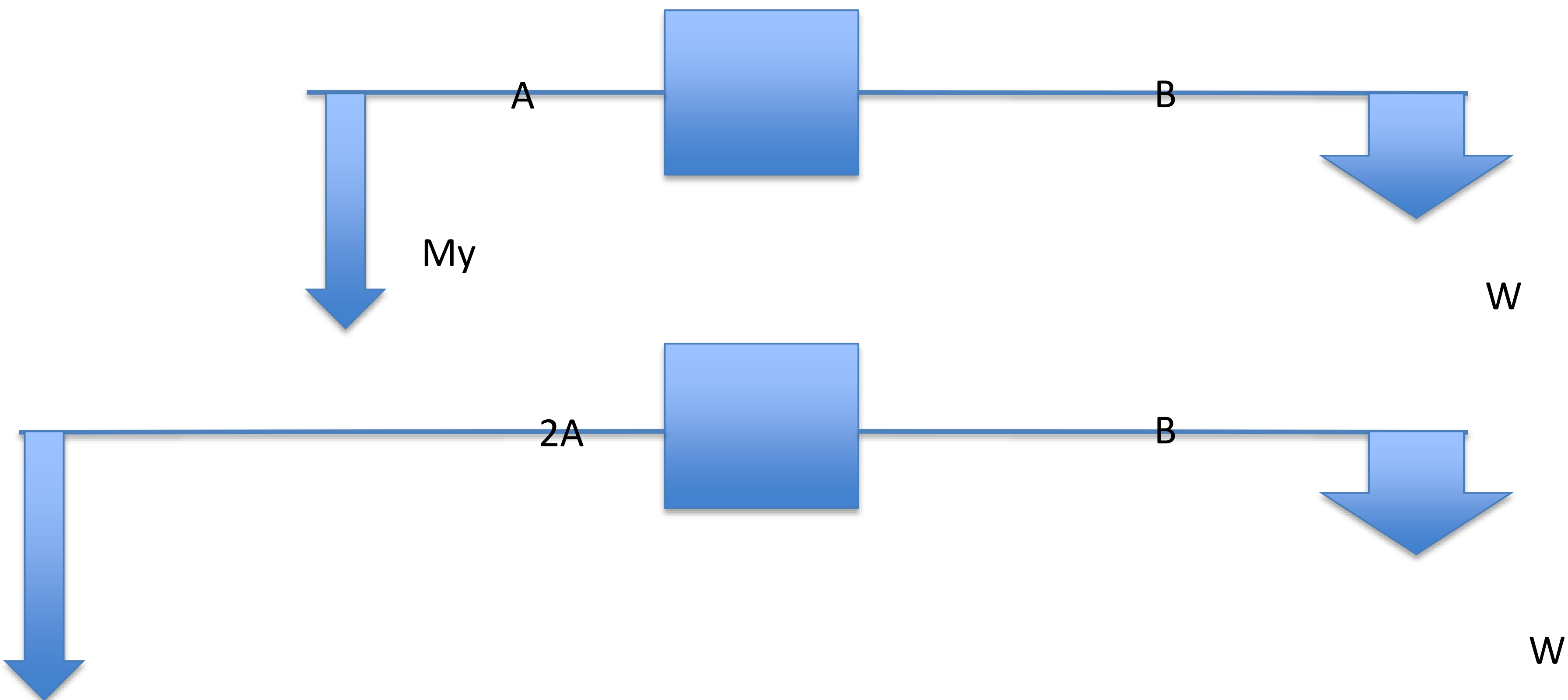
So Simple Extended Free Body

- Looking at Moments: MyA=WB



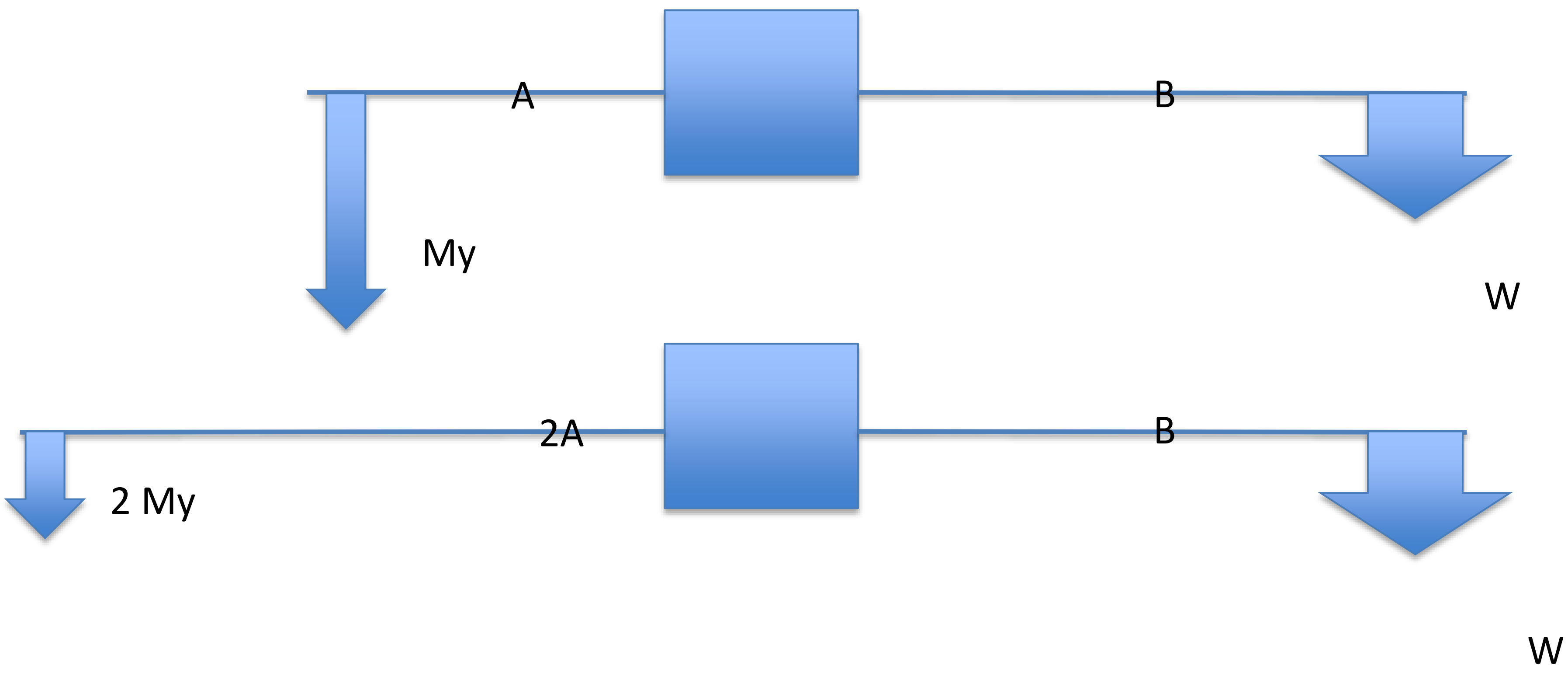
So Doubling Offset:

- A becomes 2A



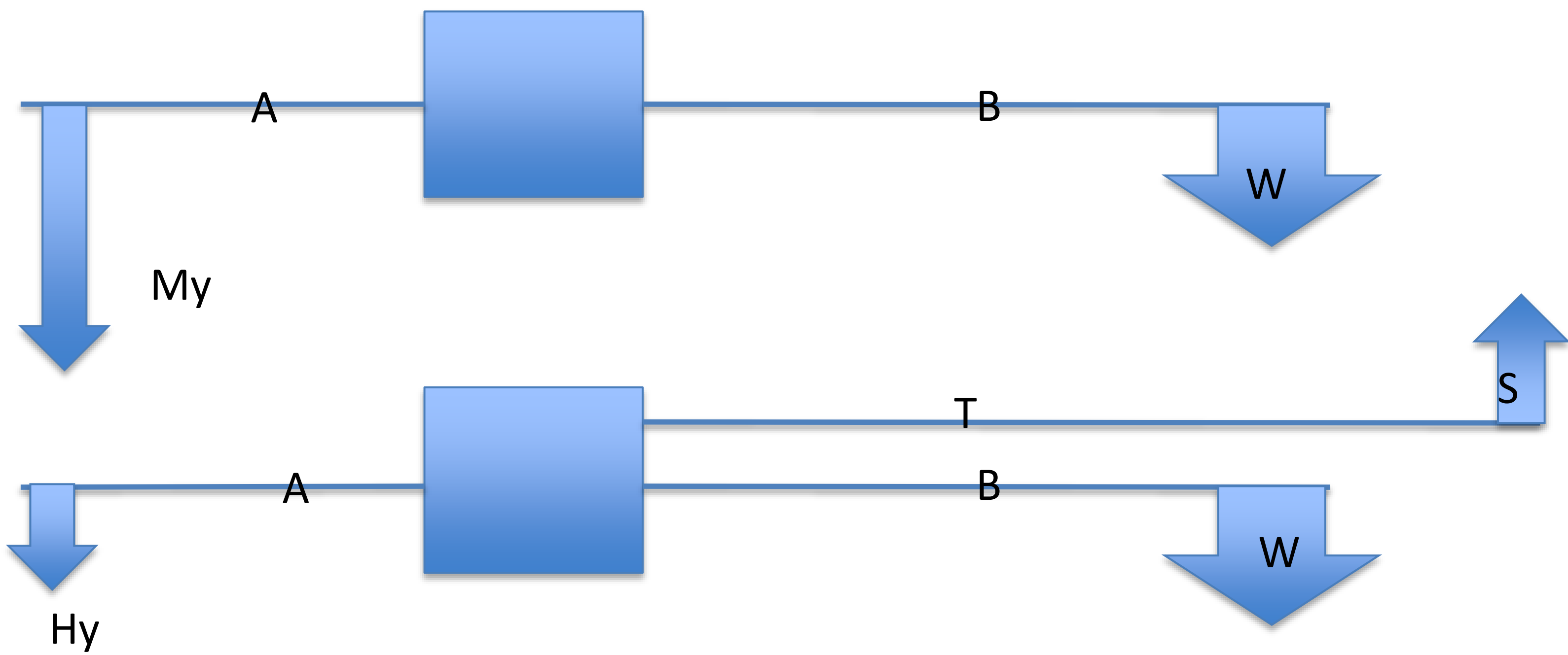
So Doubling Offset:

- A becomes 2A
- And My Becomes Half My



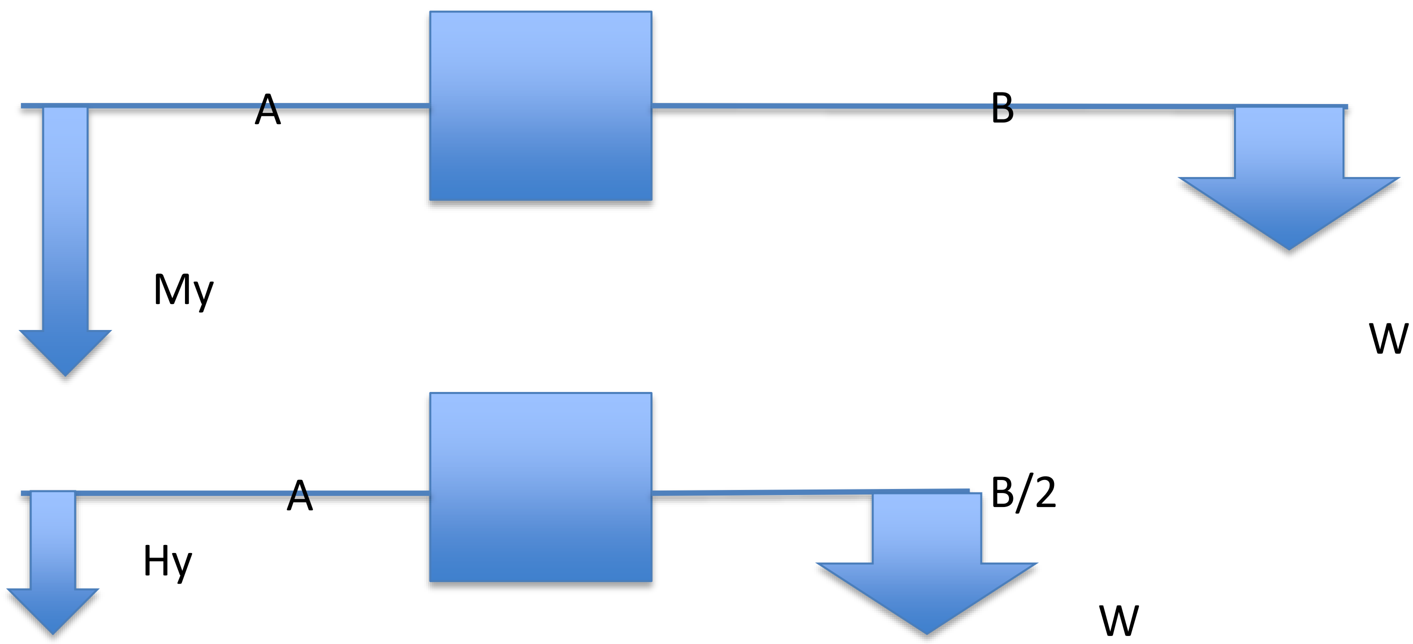
So Using A Stick In Other Hand

- So HyA+TS=BW
- So Hy is Less than My



Or Leaning Over a Bad Hip

- Decreases the WB distance
- So WB/2=HyA
- So Hy is less than My



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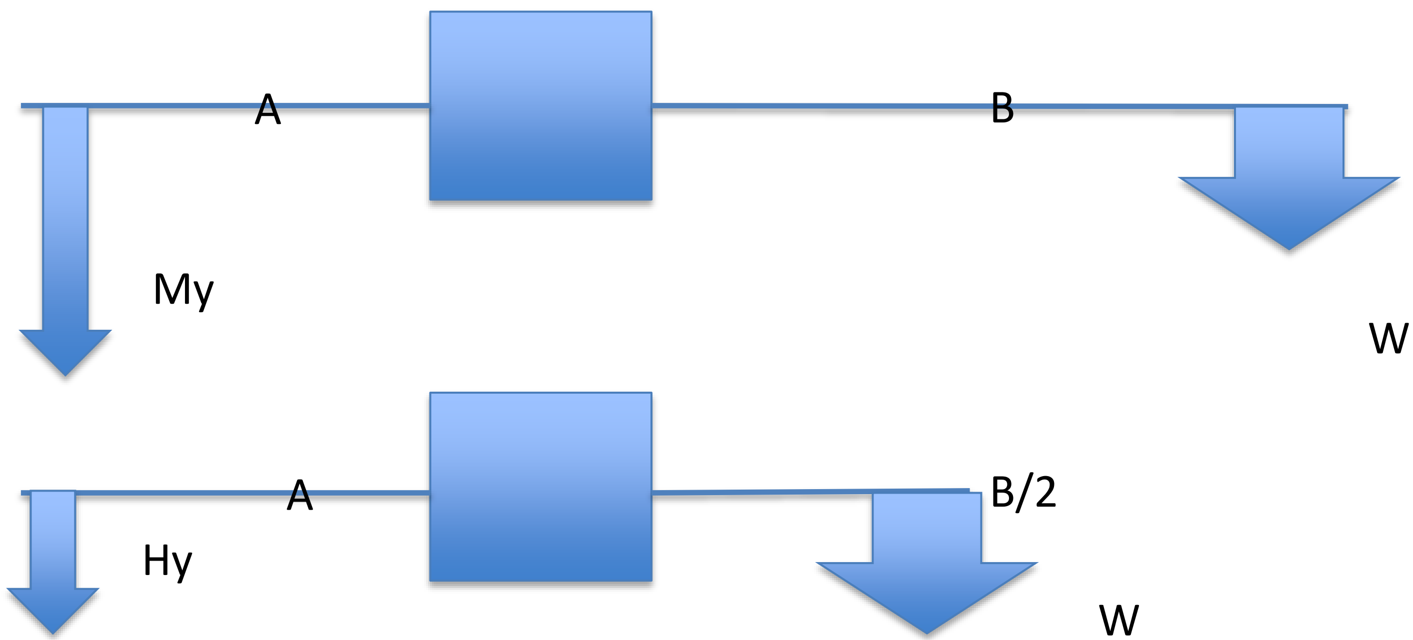

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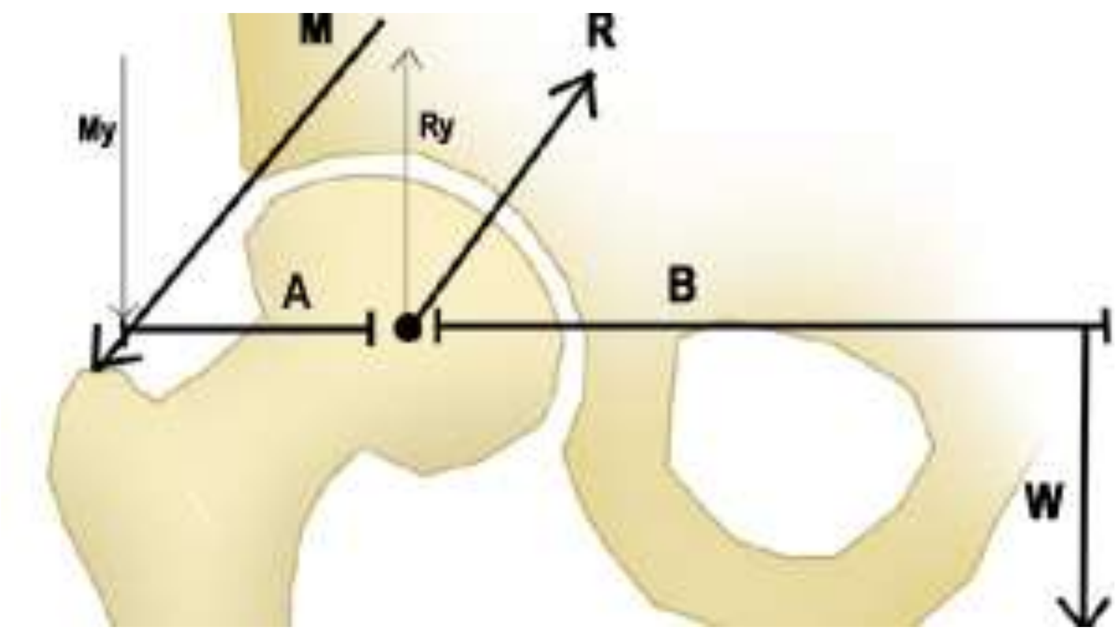

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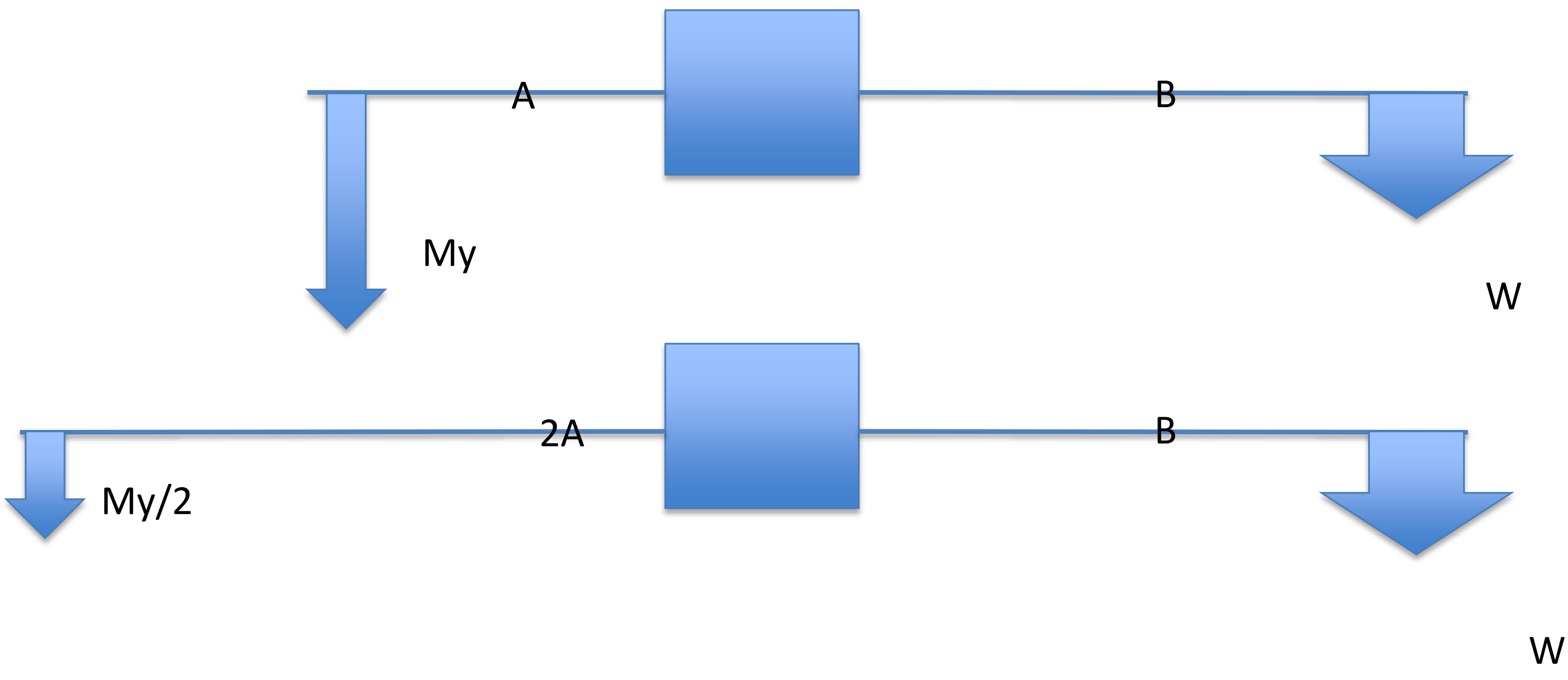
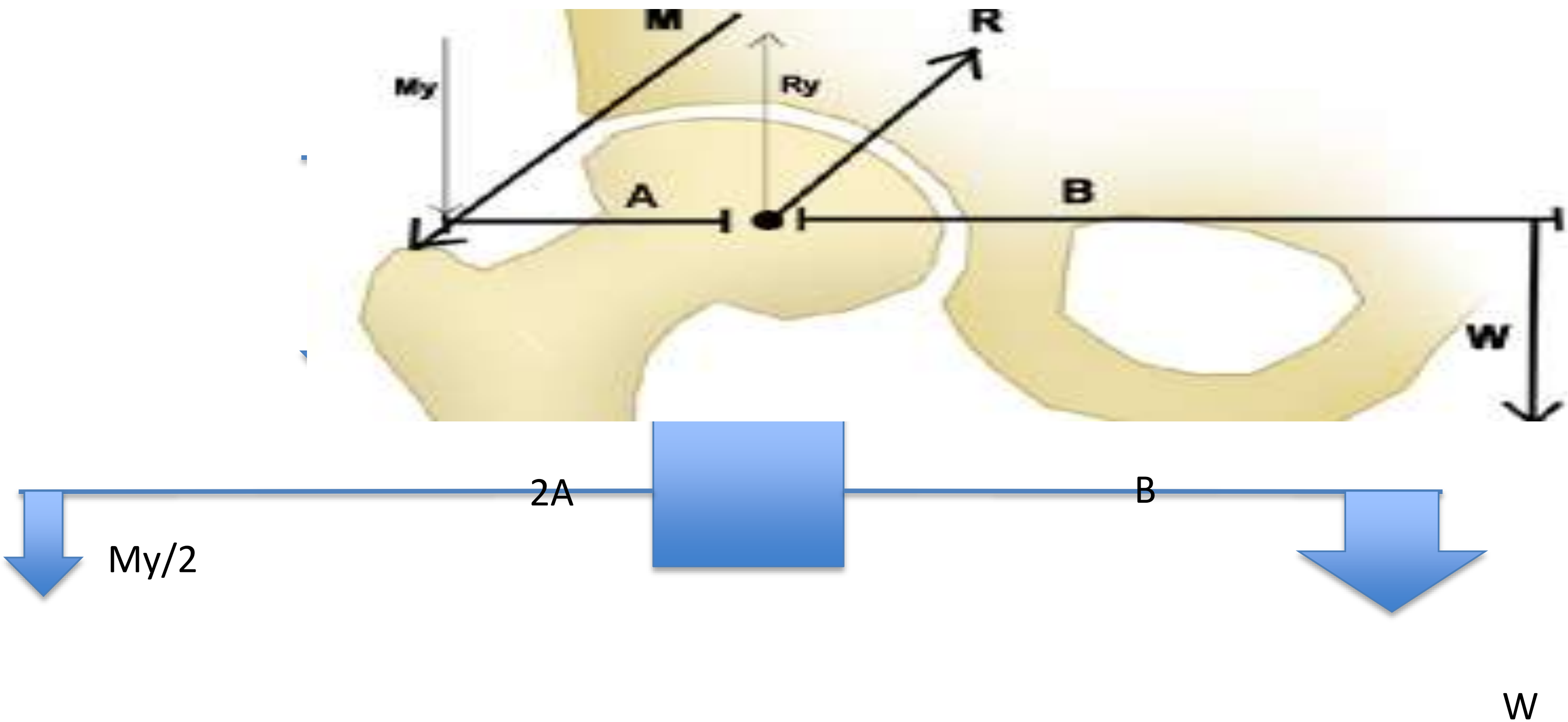


So Doubling Offset:

- As we have halved My we have reduced Ry



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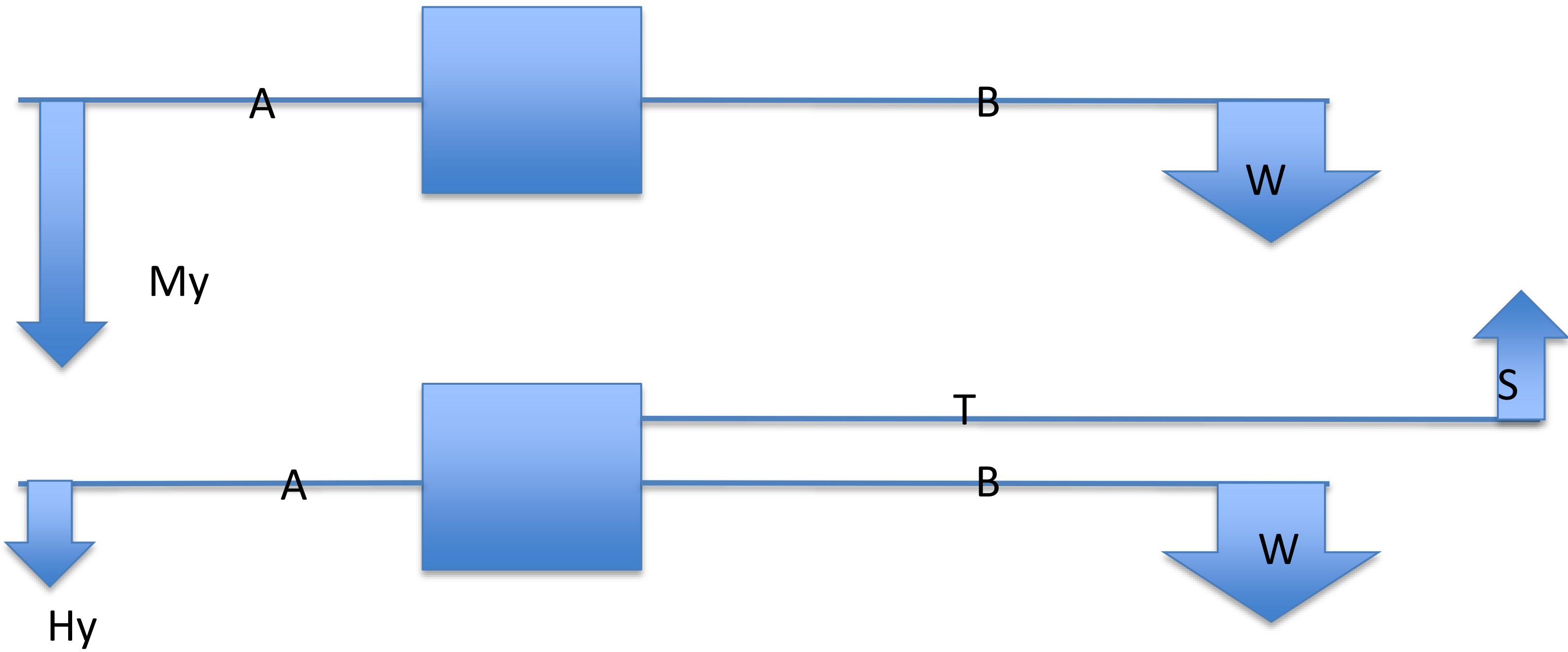
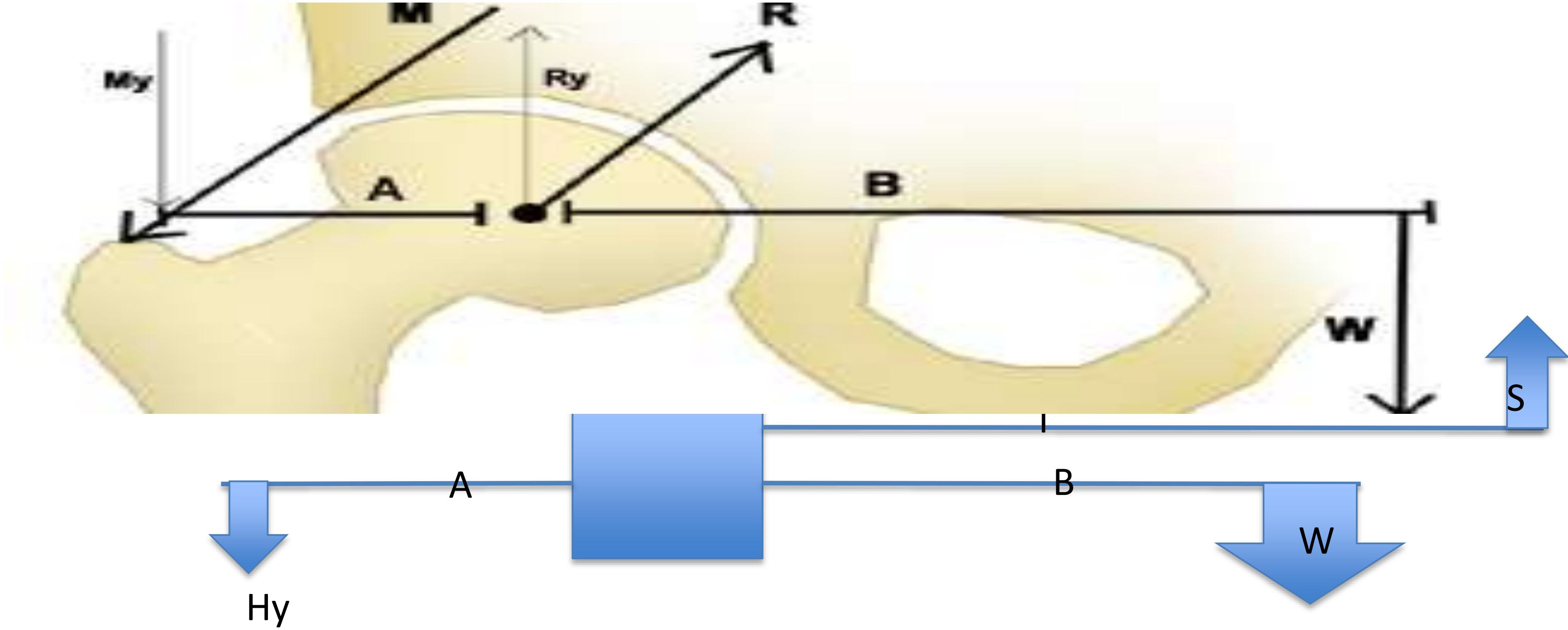


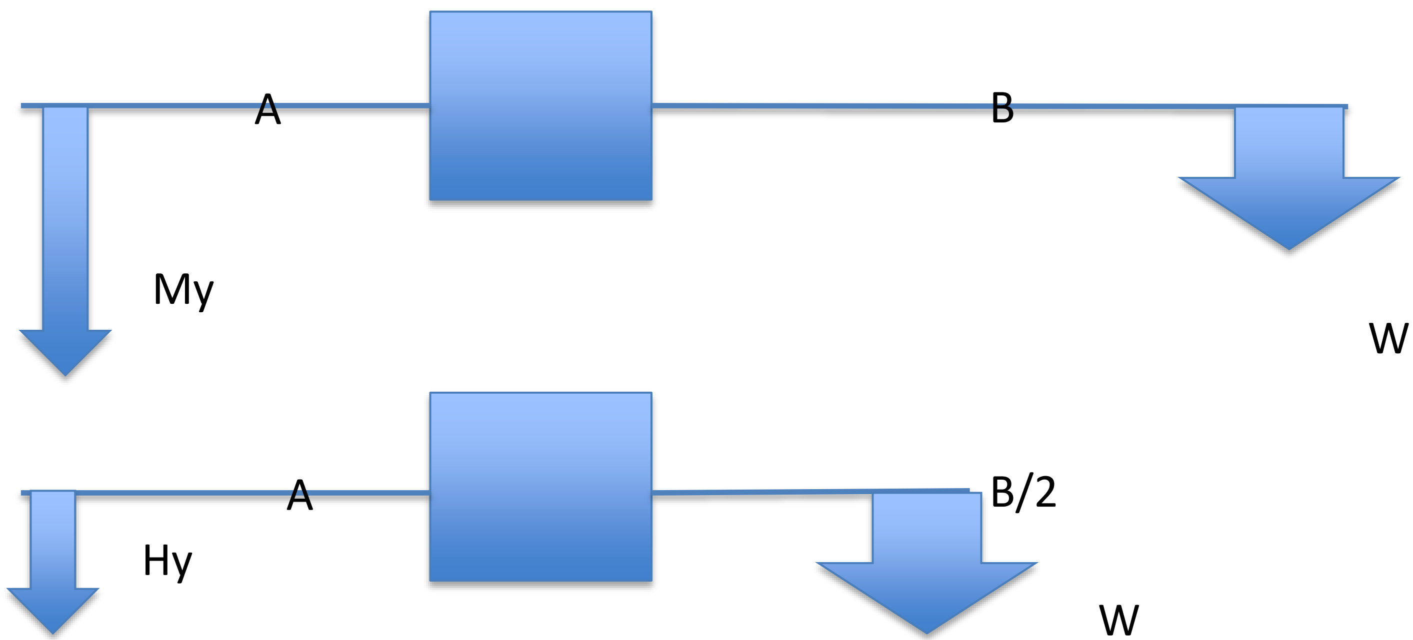
So Using A Stick In Other Hand

- Ry is reduced because Hy is smaller than My and also we have S to contend with so:
- Ry+S=Hy+W   Or   Ry=Hy+W-S



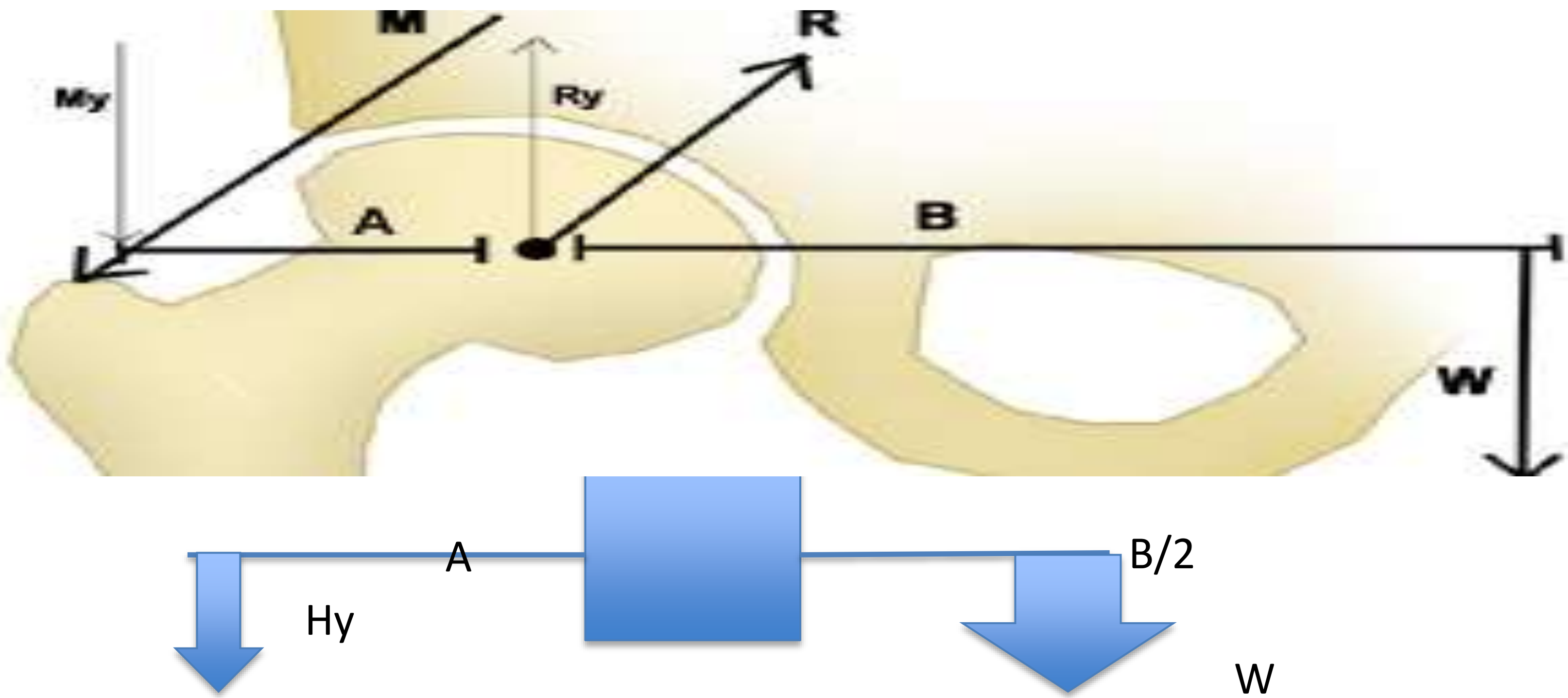
Or Leaning Over a Bad Hip

- Decreases the WB distance
- So WB/2=HyA
- So Hy is less than My



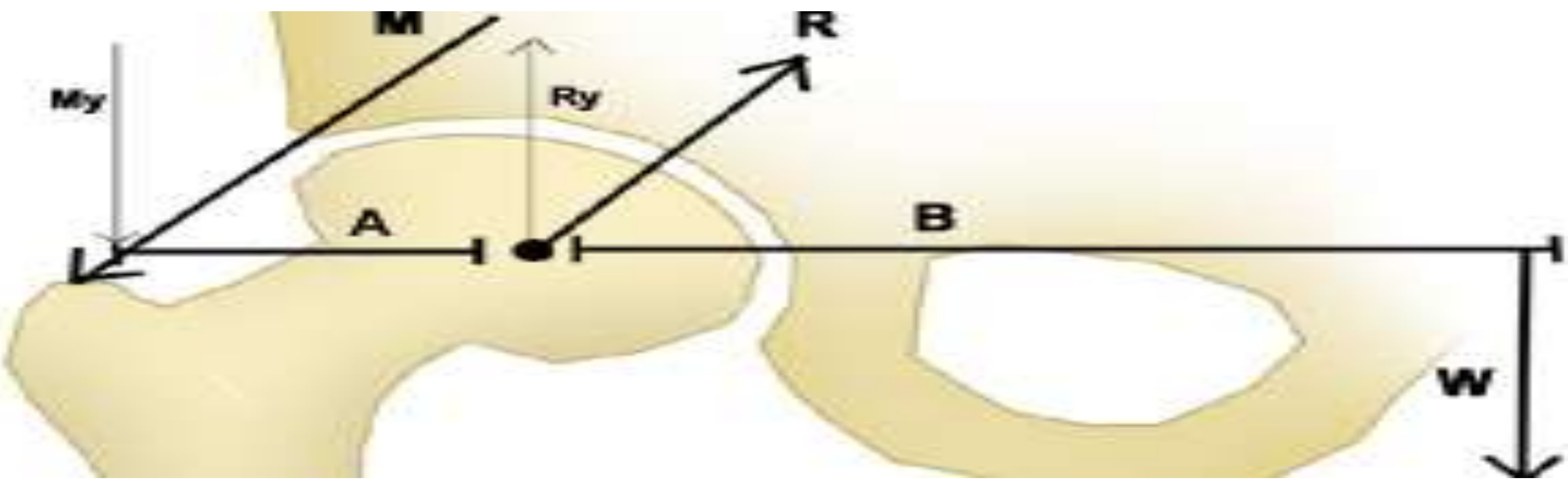
Or Leaning Over a Bad Hip

- Ry is decreased as Hy+W= Ry



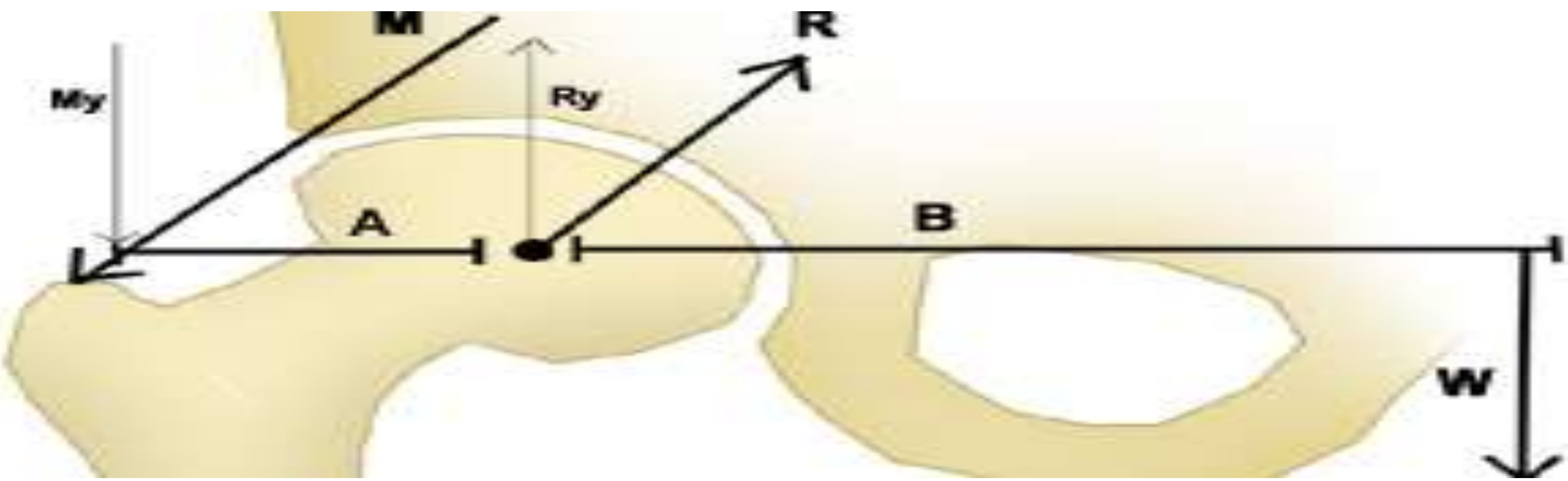
So Some Basic Trigonometry

- The Ry we have been working out is not the Joint Reaction Force
- SOHCAHTOA



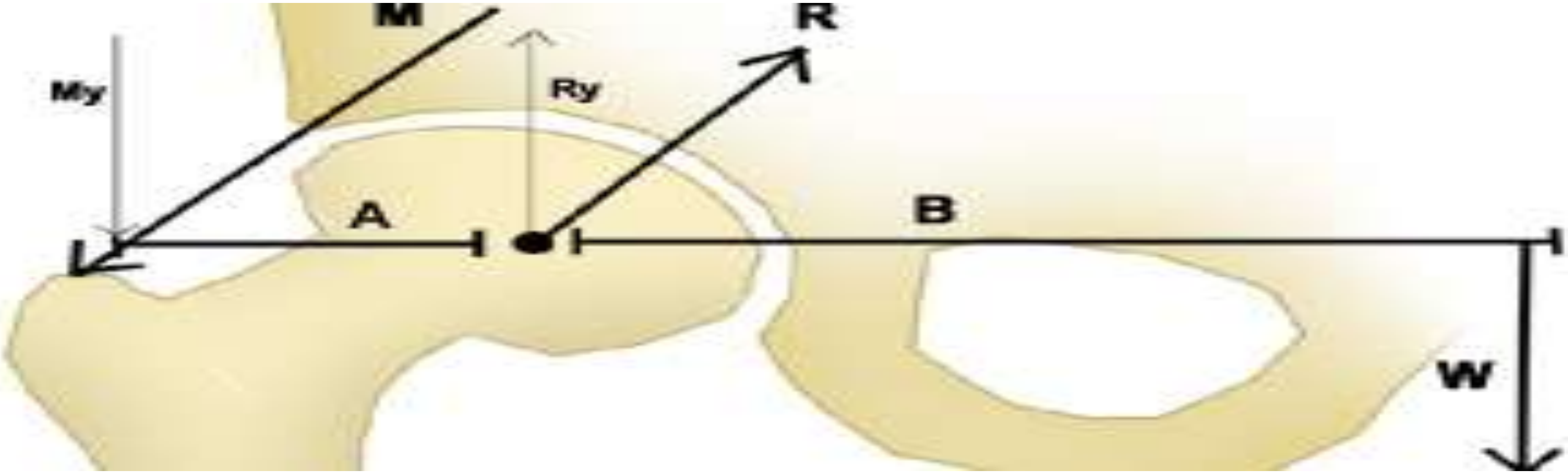
So Some Basic Trigonometry

- Ry is Adjacent
- R Is Hypotenuse
- Angle Looks about 30 Degrees



So Some Basic Trigonometry

- Therefore Cos 30 Degrees=Adjacent/Hypotenuse
- So Cos 30 Degrees= Ry/R
- So R=Ry/Cos 30

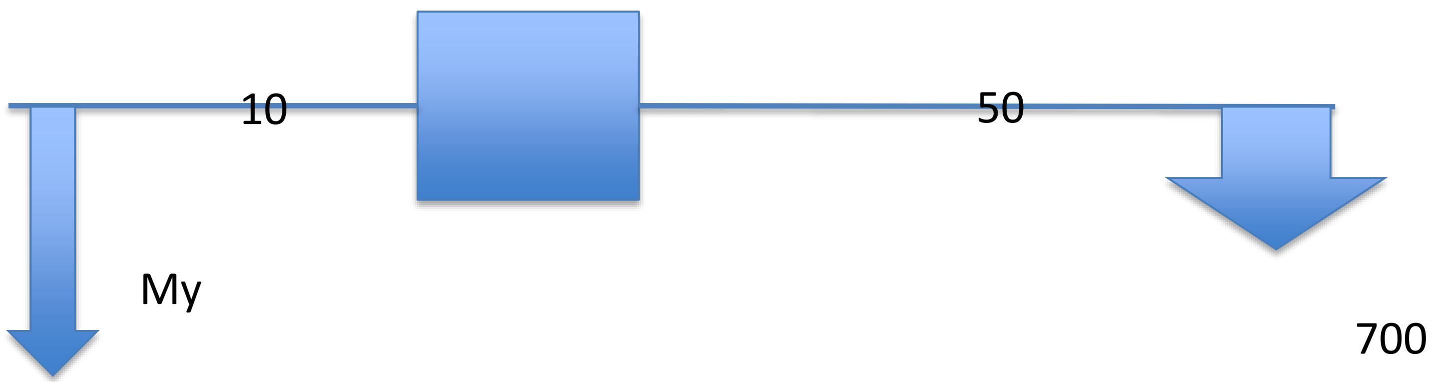


So Milton: What happens if you are carrying a Suitcase?

- First Draw Out the Diagram without:
- Body Force 700N, Centre of Weight 50cm, Abductor Distance 10cm
- What is your Abductor(y) force?
- What is your Joint Reaction (y) force?
- What is your Joint Reaction Force?

So Simple Extended Free Body

- Looking at Moments: 700Nx0.5m=350Nm
- So My=350nm/0.1= 3500N



So Milton: What happens if you are carrying a Suitcase?

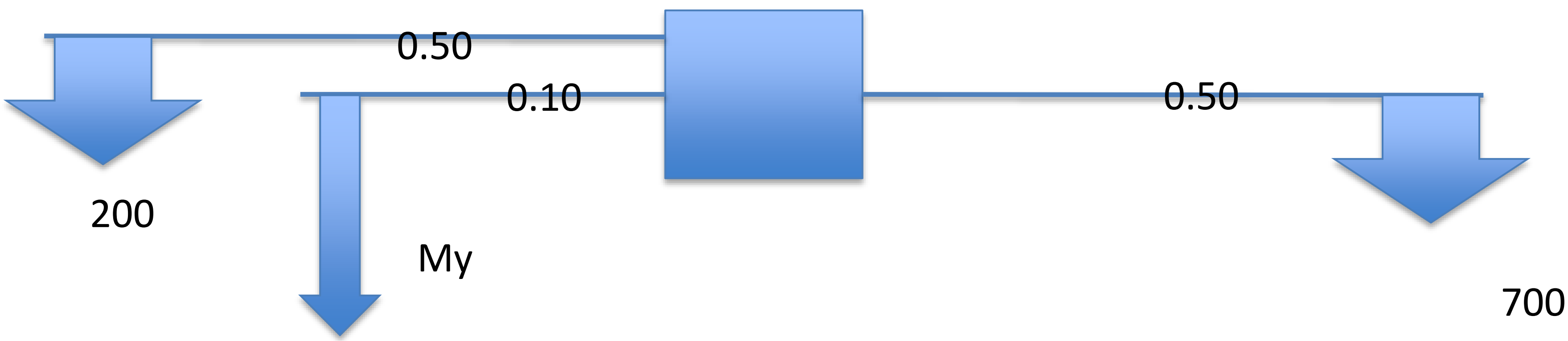
- So Reaction Force(y)= W+My
- 3500+700=4200N
- So Reaction Force= Ry/Cos30
- So Reaction Force= 3637N

So Milton: What happens if you are carrying a Suitcase?

- So The Suitcase weighs 20Kg and is 50cm from Hip
- First Draw Out the Diagram:
- Body Force 700N, Centre of Weight 50cm, Abductor Distance 10cm
- What is your Abductor(y) force?
- What is your Joint Reaction (y) force?

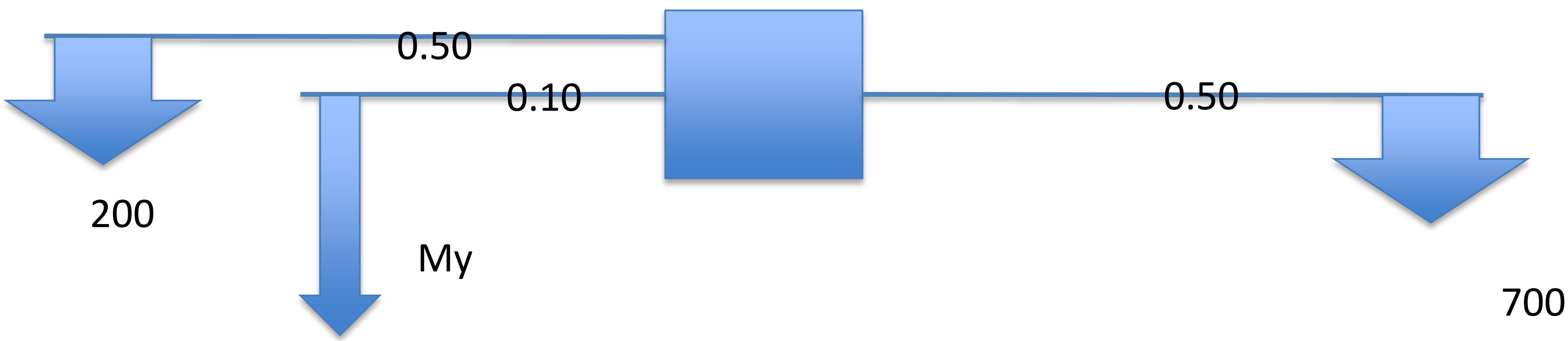
So Simple Extended Free Body

- Looking at Moments: 700Nx0.5m=350Nm
- So 350Nm=200x0.5+0.1My
- So 350Nm-100=0.1My



So Simple Extended Free Body

- So 250/0.1=My
- So My=2500N



So Milton: What happens if you are carrying a Suitcase?

- So Reaction Force(y)= W+My+Suitcase
- 2500+700+200=3400N
- So Reaction Force= Ry/Cos30
- So Reaction Force= 2944N

- So Carrying a 20Kg Bag decreases Joint Reaction Force 700N

Summary:

- Newton Laws
- Basic and Derived Quantities
- Free Body Diagram
- Joint Reaction Force
- Reducing the Joint Reaction Force
- A Little trigonometry

Questions?