INTERNATIONAL BABYWEARING CONFERENCE

Biomechanics of Babywearing

Myths, misconceptions, and facts

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Learning Outcomes	*To provide the background and biomechanical justification for ergonomic babywearing and common educator guidelines and debunk some common babywearing myths.*
Conflicts of Interest and Relevant Financial Relationships	*The planning committee members have no conflicts of interests or relevant financial relationships to declare relevant to this activity.*
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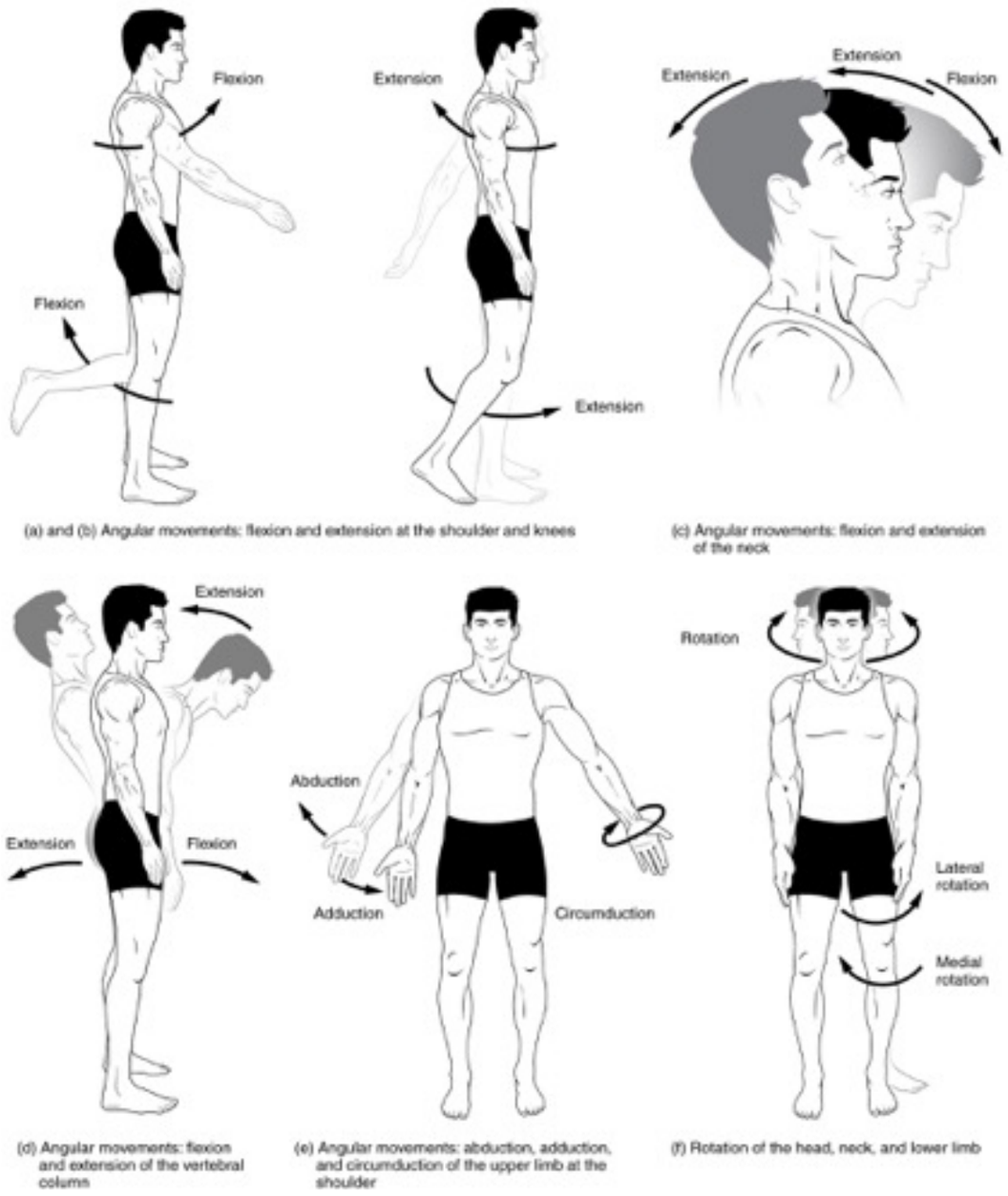
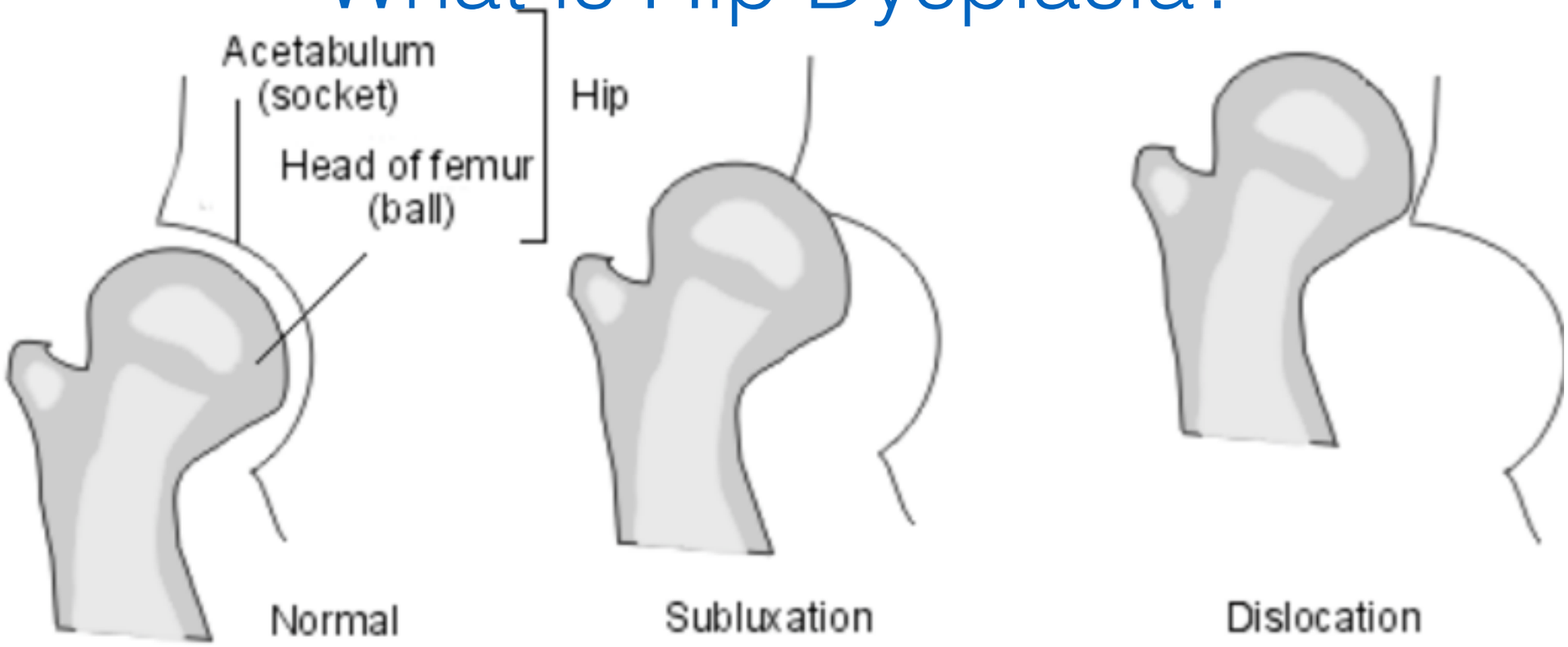
Anatomical Motion Terms

- Abduction and adduction describe movements towards or away from the midline of the body in the frontal plane:
  - Abduction is a movement away from the midline – just as abducting someone is to take them away. For example, abduction of the shoulder raises the arms out to the sides of the body.
  - Adduction is a movement towards the midline. Adduction of the hip squeezes the legs together.
- Flexion and extension are movements that occur in the sagittal plane. They refer to increasing and decreasing the angle between two body parts:
  - Flexion refers to a movement that decreases the angle between two body parts. Flexion at the elbow is decreasing the angle between the ulna and the humerus. When the knee flexes, the ankle moves closer to the buttock, and the angle between the femur and tibia gets smaller.
  - Extension refers to a movement that increases the angle between two body parts. Extension at the elbow is increases the angle between the ulna and the humerus. Extension of the knee straightens the lower limb.



What is Hip Dysplasia?



In the Ortolani test for Developmental Dysplasia of the hip (DDH), a trained medical professional flexes and adducted the hip to dislocate it. The results can be classified as none, a “click” or a “clunk”:

- Clicks are fine, short-duration, high-pitched sounds that are common and benign.
- Clicks are usually innocuous: they may be suction noises from the hip or knee joint or a tendon snapping over the greater trochanter.
- Clicks are common in normal infants

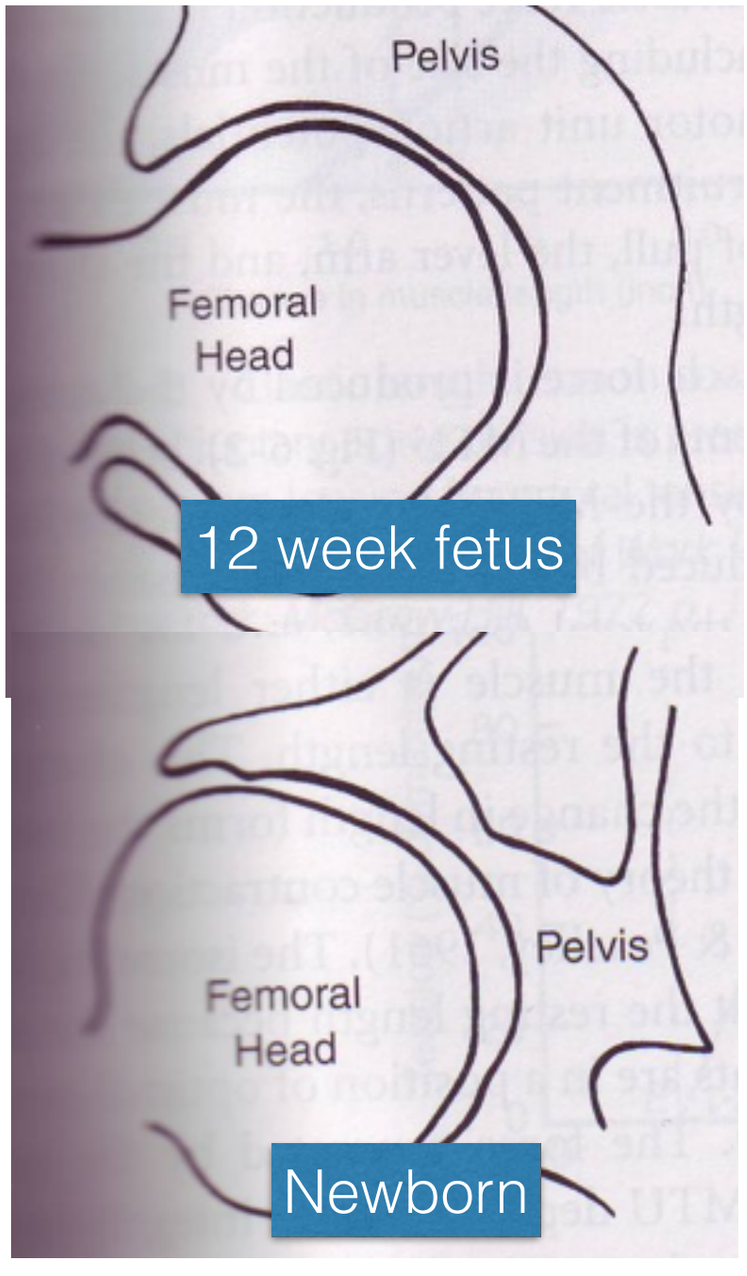
- Clunks are the head of the femur being displaced over the acetabulum.
- Clunks are a positive Ortolani sign.
- Treated very aggressively (Pavlik harness)

Myth: FFO or NBCs cause hip dysplasia

False

Short-term positioning does not cause hip dysplasia, but extended positive repositioning can improve outcomes

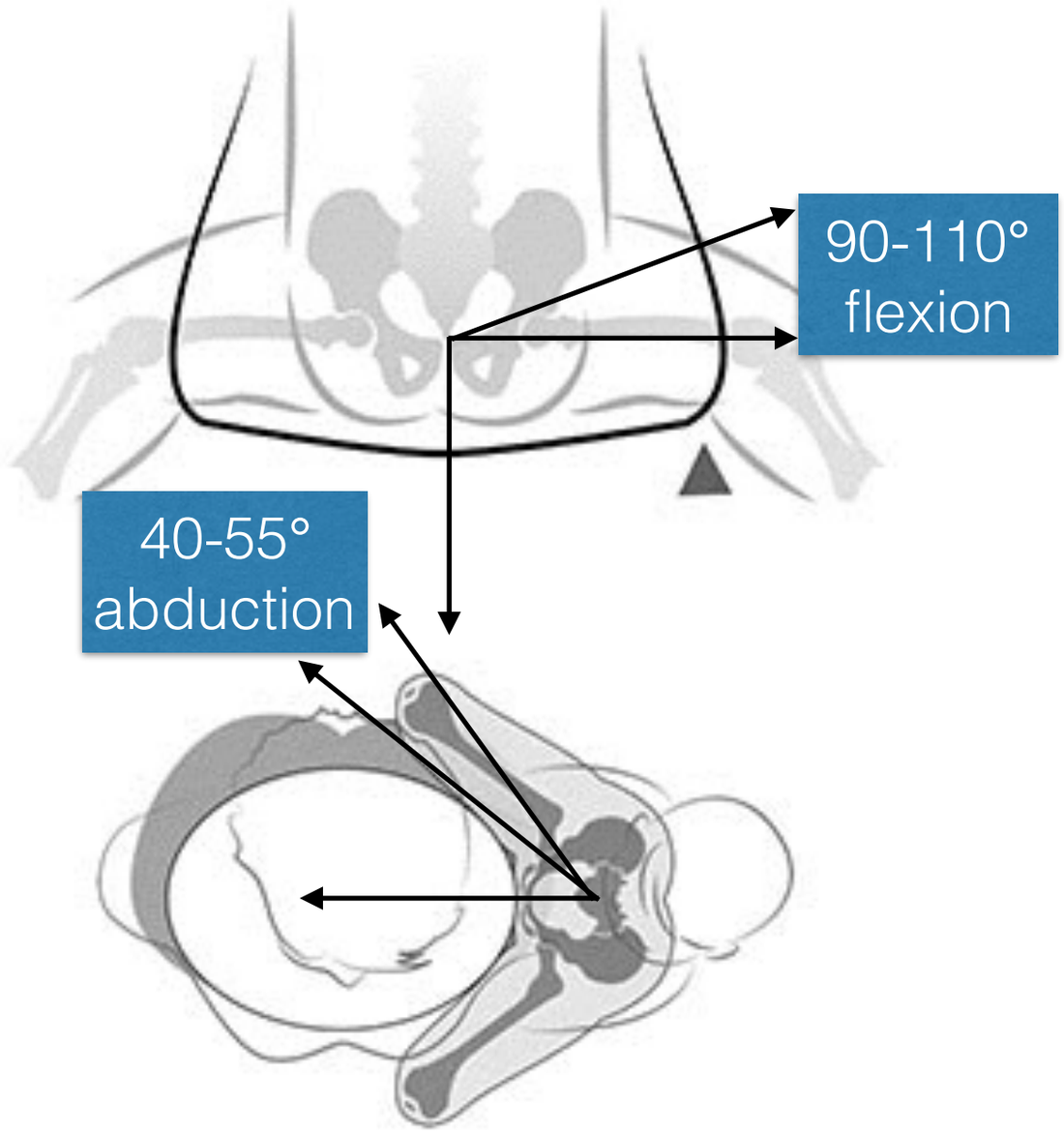
- The majority of cases of dysplasia are diagnosed at birth, but if the socket is unusually shallow a dislocation can happen weeks to months after birth
- Infant hip sockets are shallow, so extended pressure can push the femoral head out of the acetabulum
    - A cadaver study showed that 3-6 hours continuous pressure must be applied to dislocate a normal hip (Seringe, R. 1982)
- Extended tight leg swaddling or extensive use of cradle carries with the hips bound in adduction (tightly together) could exacerbate a hip condition
- Extended dangling (in adduction and extension) legs (like in a NBC) could exacerbate a hip condition



Myth: Ergonomic carriers can prevent or treat hip dysplasia

Hip Dysplasia Institute :

"When baby wearing is practiced with each hip in approximately 40° to 55° of abduction and 90° to 110° of flexion, the femoral head – the ball of the hip joint – is pressed evenly into the center of the hip socket. Muscle action of the infant further presses the ball into the socket as the infant moves and clings to the mother. This type of muscle activity is beneficial for healthy joint development."



Japanese Study:

- In 1965: 3% nationwide incidence of hip dislocation
- 1975: National program (aimed at grandparents) to eliminate tight swaddling in extension
- 1984: reduction to 0.2% incidence of hip dislocation

Pediatric Physical Therapy Curriculum, "Management of Clicks":

- Observe and refer to MD
- Keep hips abducted using a Snuggly™, baby swing or a blanket between legs.
- NO SWADDLING!

Partially True

Myth: knee to knee support matters less after age 2

- The growth potential of the hip steadily decreases after birth.
    - Development ceases as early as 18 months and as late as three years
- But leg support isn't only for hip development.
    - maintaining seat in wrap/sling
    - spreading weight across the back/hips
    - child's comfort/reducing pressure on legs

Partially True

Myth: My 1yo needs a toddler carrier

- Most “toddler carriers” are not actually designed for a toddler-sized child

	panel width	panel height
Ergo	14”	13”
Standard Tula	14.5”	15.5”
Toddler Tula	19”	18”

- Approx 2T knee to knee = 17”
  - Toddler carrier would be too wide and would keep the knees in extension
  - May force hips into >55° abduction
- SSCs don’t need to be knee to knee to maintain M shaping for optimal hip development

False

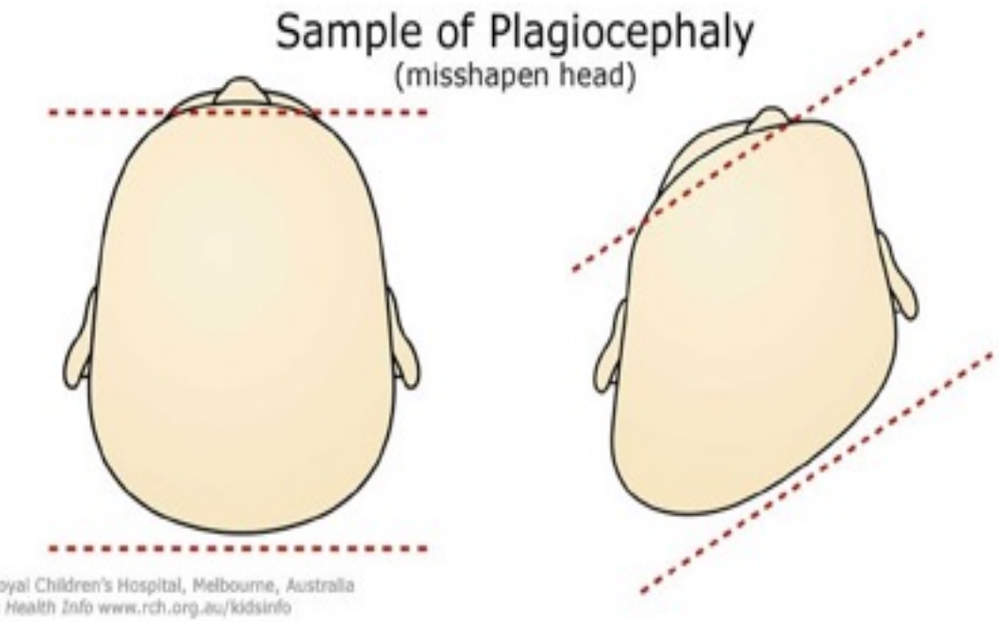
A M Fredriks, S van Buuren, W J M van Heel, R H M Dijkman-Neerincx, S P Verloove-Vanhorick, J M Wit

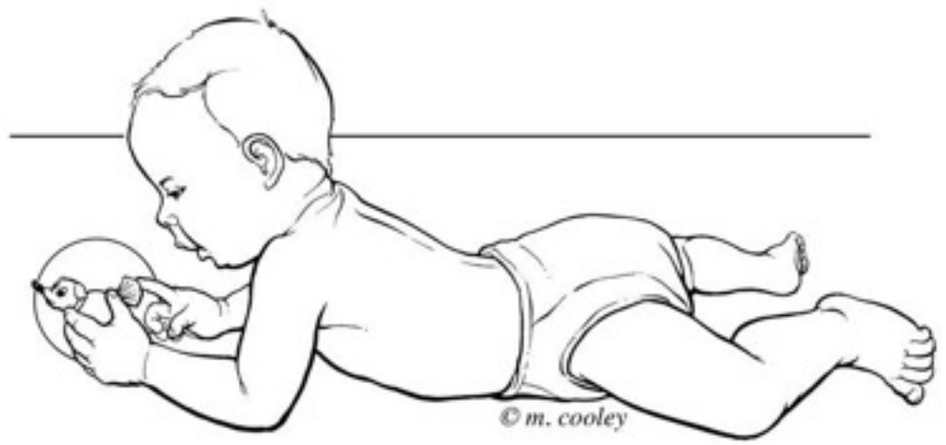
http://warmingtheheart.wordpress.com size chart

Myth: Babywearing can replace tummy time

Goals of Tummy Time:

1. Prevent and treat positional plagiocephaly
   - Babywearing does help with this!
   - Provides non-supine time (repositioning) which is a primary intervention strategy[1]
2. Strengthen shoulder muscles by pushing up against gravity
   - Babywearing provides limited exercise for this
   - Arms can be in either flexion or extension when worn. Even when baby is pushing against wearer (flexion), they are pushing perpendicular to gravity rather than directly against it



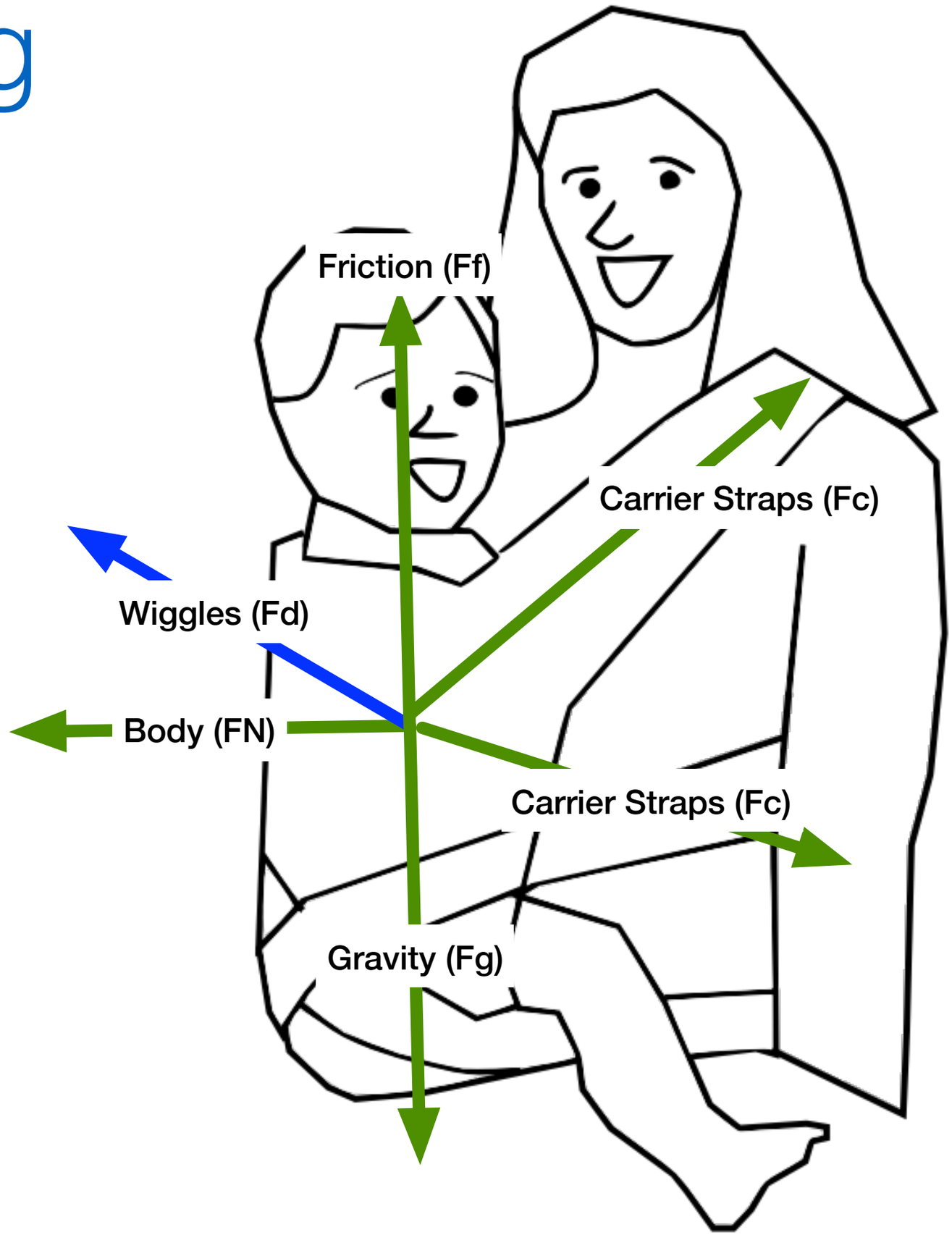


Partially True

(1) Kift, Sarah. https://wrapsodybaby.com/positional-plagiocephaly-and-babywearing/

Forces acting on the child

$$\Sigma F = 0$$

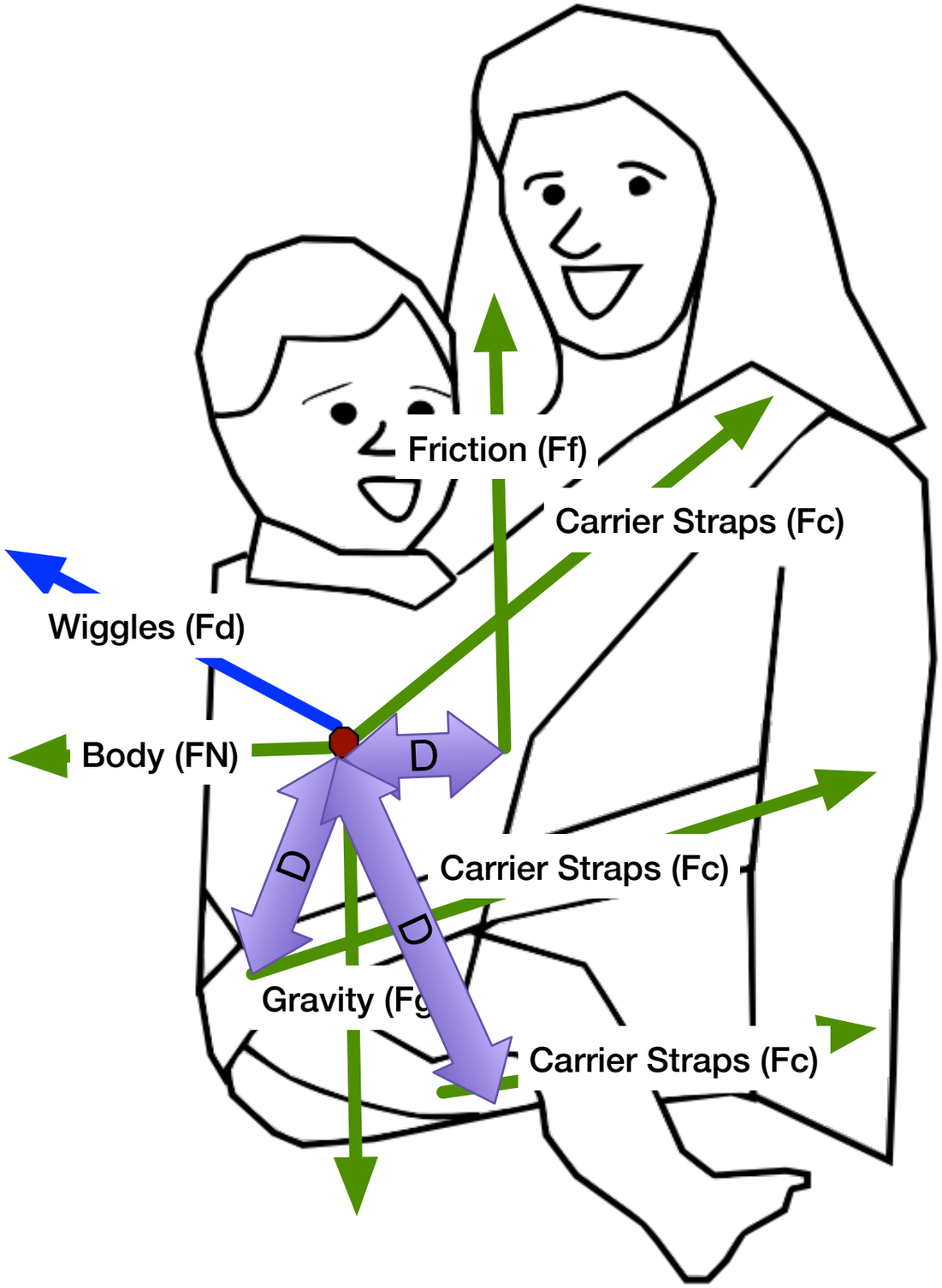


Forces acting on the child

- Forces don't act on the child's center of mass, so a torque is induced
- Torque is the inclination to rotate around a point (and is another kind of force)
- The longer the distance between the wearer's center of mass and the location the force acts on, the greater the torque

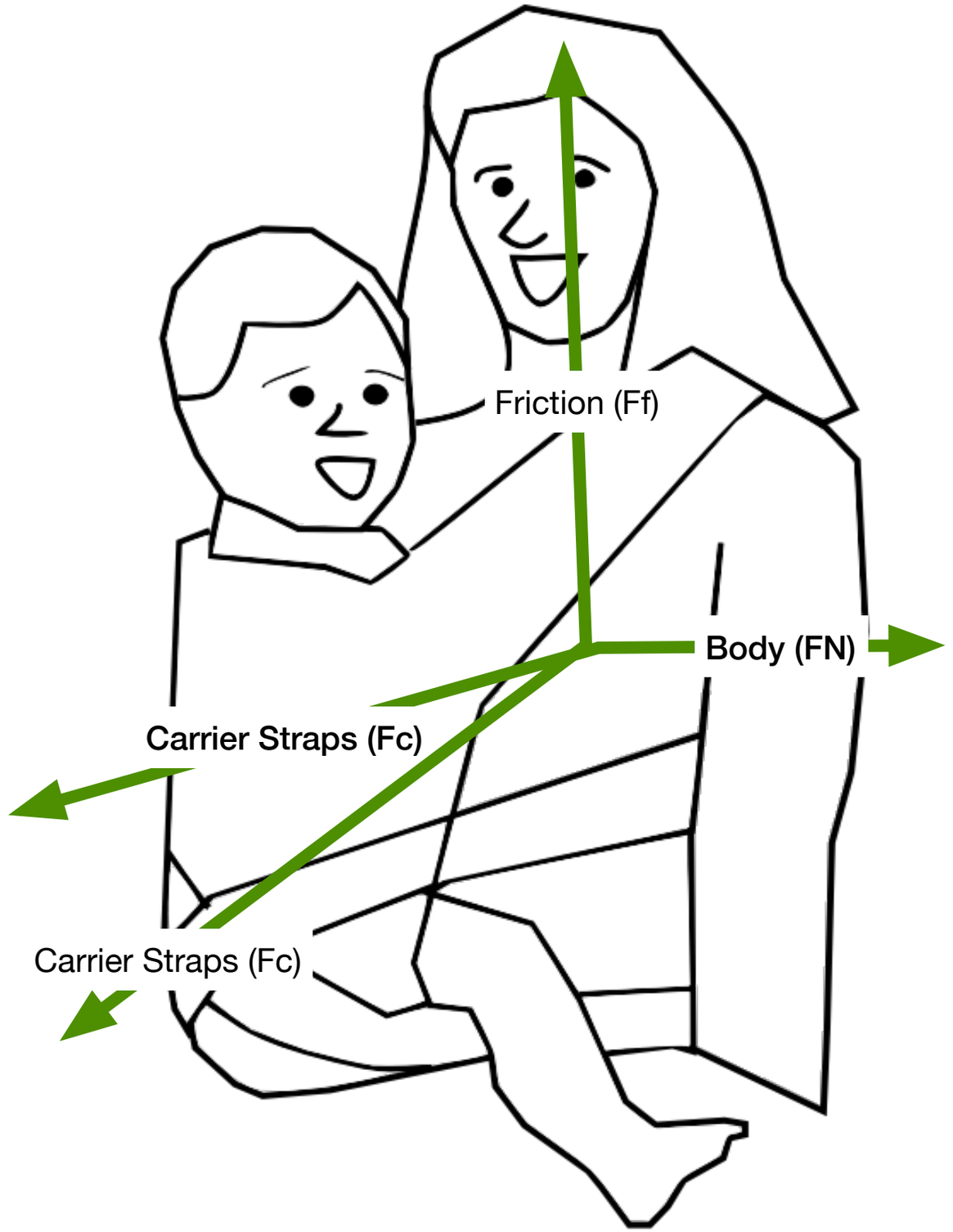
$$T = FxD$$

$$\Sigma T = 0$$



Forces acting on the wearer

$$\Sigma F = 0$$



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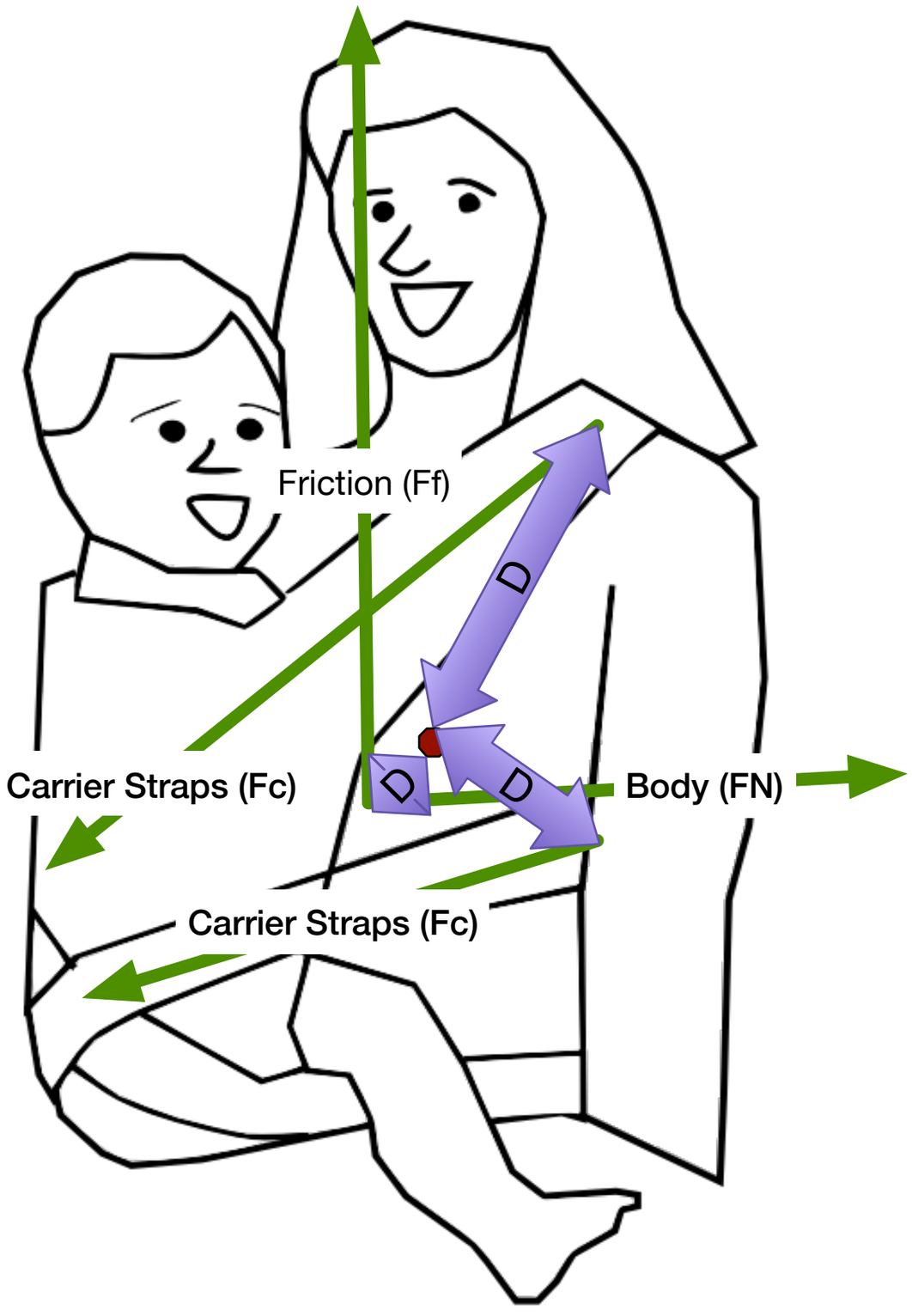
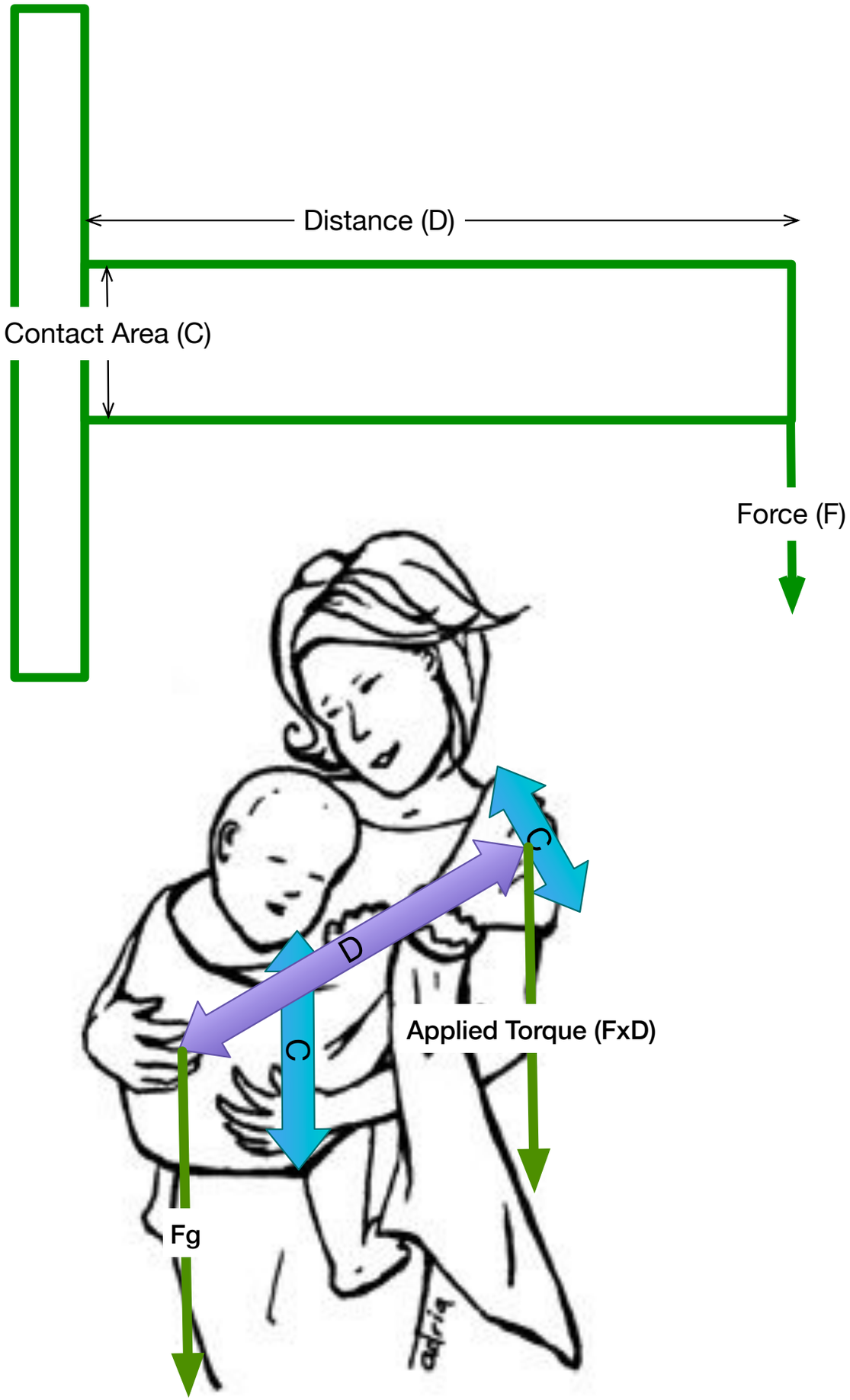




Pressure

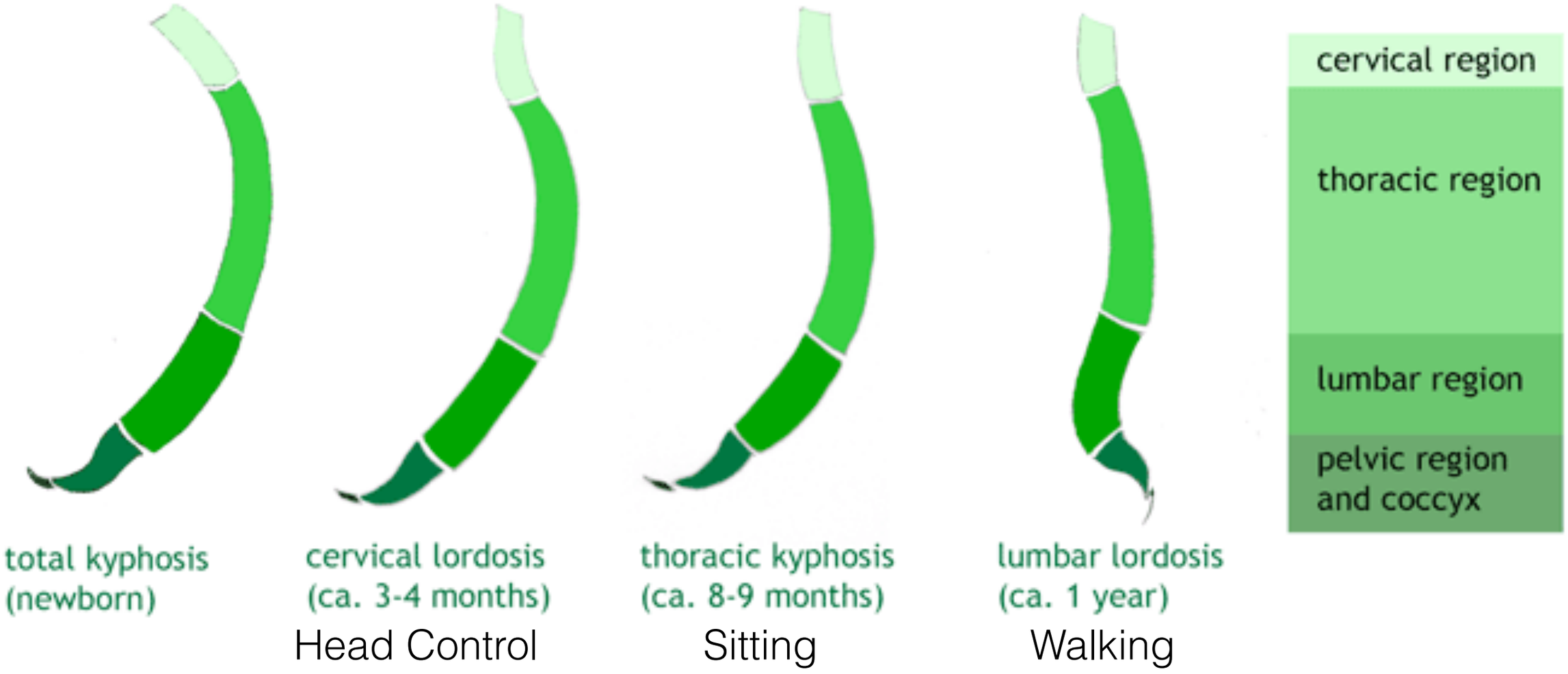
$$P = T/C$$

or

$$P = \frac{FxD}{C}$$

- Spreading out the area the force acts on decreases the pressure (making the carrier more comfortable)

Spine Development



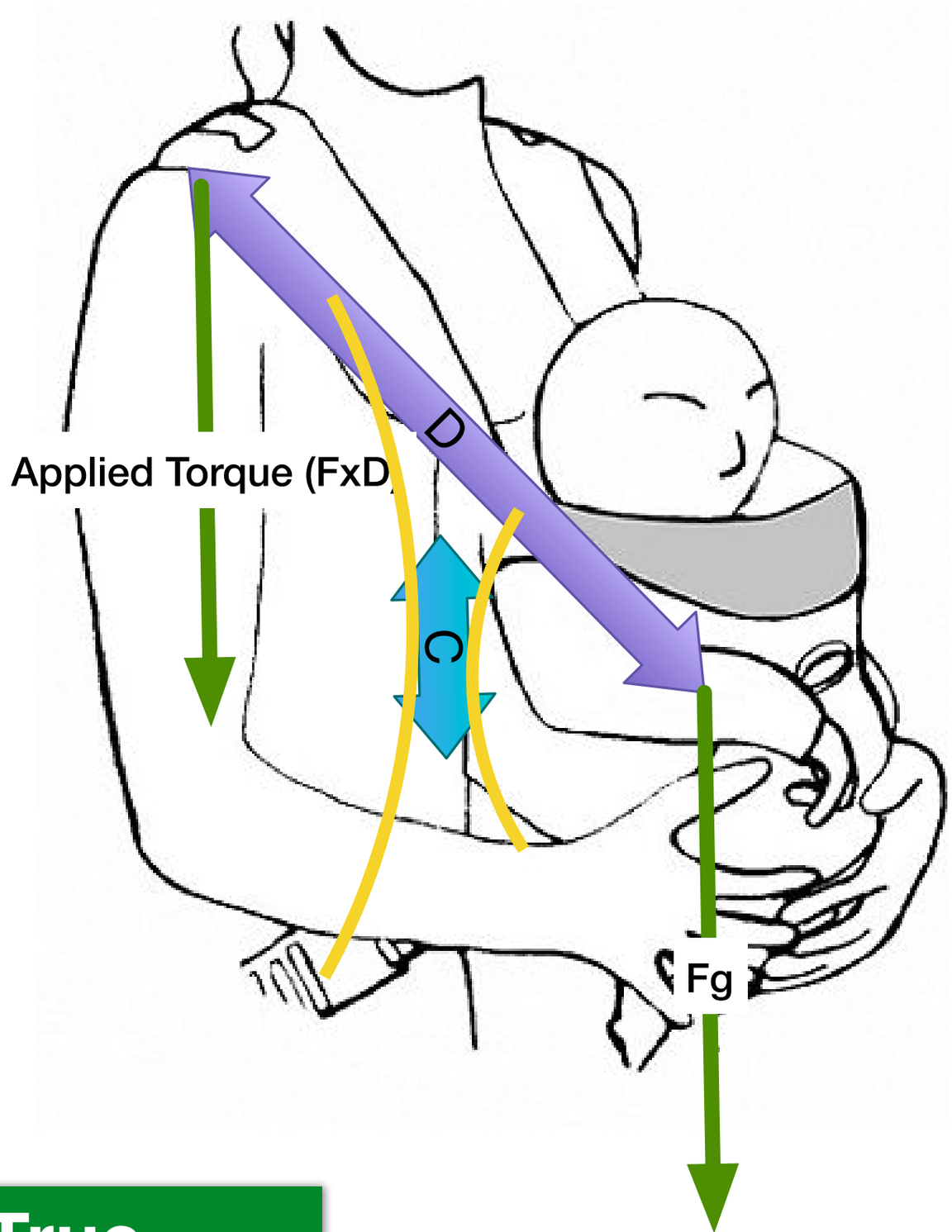
- The spine of a young child develops the adult “S” shape as the muscled strengthen over the first year
- Infant holders need to conform to and support the spine for the child’s comfort

http://www.babywearingadvice.co.uk/anatomy.htm

Myth: FFO is inherently less comfortable than FFI

- Ergonomically harder on wearer
  - Increased moment of inertia
  - Decreased contact area with child leading to increased pressure on the shoulders
- If carrier is overtightened, increasing contact area, the child's spine can be temporarily deformed out of "C" position
- If legs are not held in flexion (M position) the carry does not promote healthy hip development
- Positional asphyxia risk if child has poor head control or falls asleep

Some of these can be mitigated with careful carrier design and use to get the benefits of FFO (especially socialization and visual exposure) with less of the drawbacks



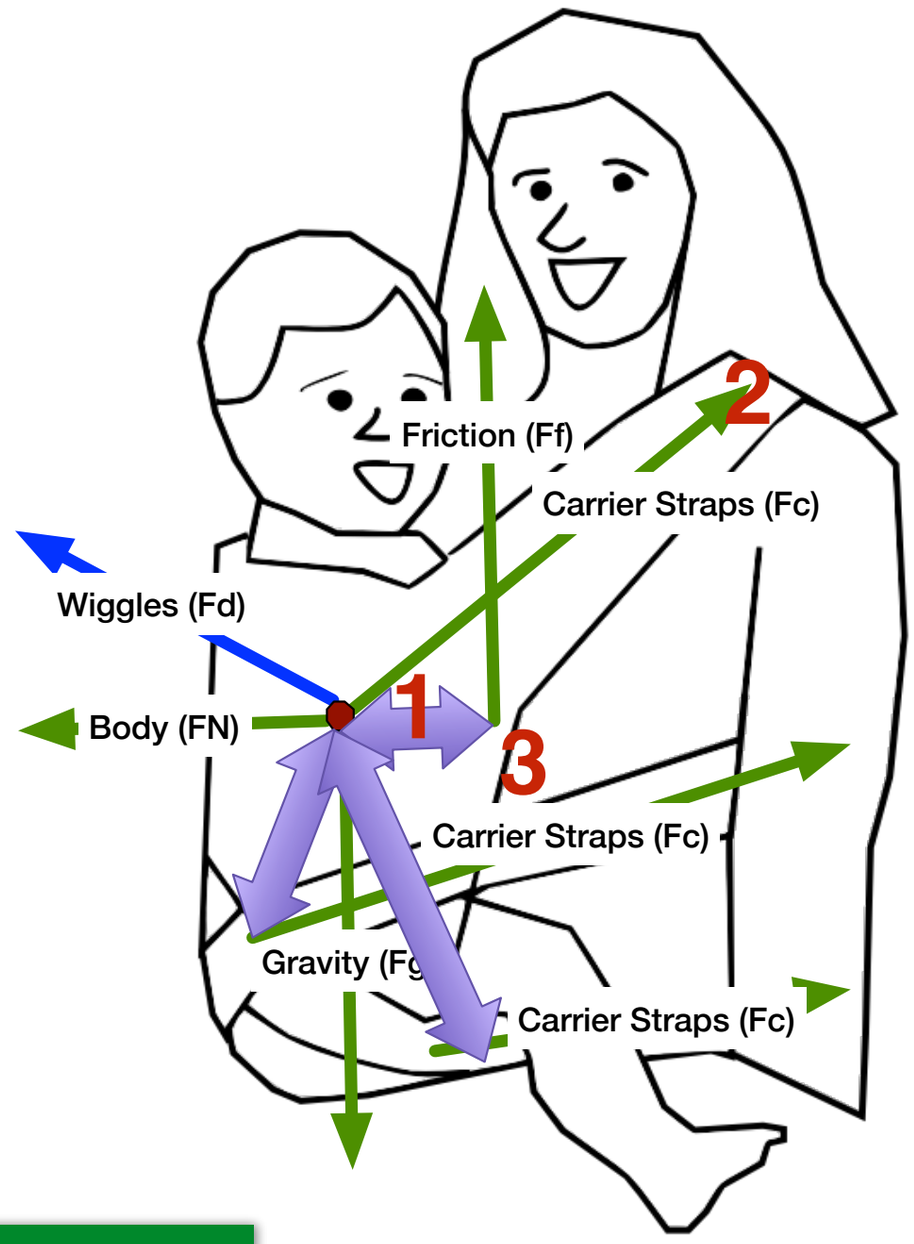
True

Myth: Loose carries cause lower back/shoulder pain

1. Brings baby further from the force transfer point (where weight of child transfers to wearer), increasing torque/ moment

2. Redistributes force to wearer's shoulders, rather than waist belt or full-body

3. Reduces the contact area of baby with wearer, increasing the pressure and decreasing friction



True

This phenomenon also explains what makes carrying the carseat particularly uncomfortable:

- The force of gravity is increased because of the mass of the carseat
- The torque on the person carrying the seat is significantly increased (compared to carrying in arms or wearing) because it must be carried far away from the body

Myth: for back carriers, the higher the better, even in a SSC

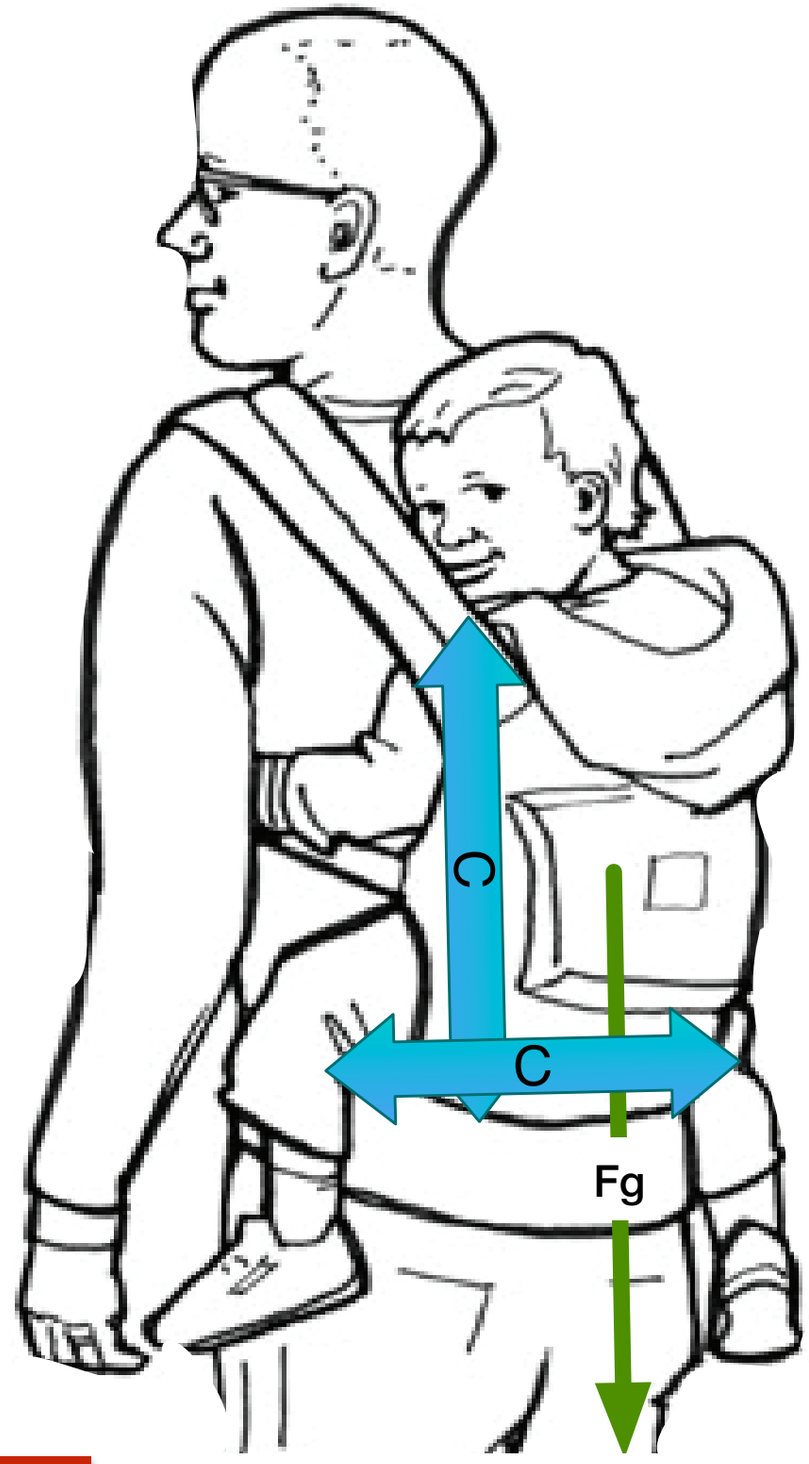
- High back carries bring baby further from the wearer's center of mass, increasing torque on the wearer

- HBCs reduce the contact area of baby with wearer, increasing the pressure and decreasing friction

    - Even if straps can be fully tightened, like in a MT, contact area is less because baby is higher

- Most SSCs have structured waist belts meant to curve to the body at the natural waist, sitting above the hips to transfer weight to them

    - Putting the waist belt too high or too low will reduce the contact area and increase pressure



Back carries in a SSC should be at the wearer's waist with the waist belt fully tightened

False

Myth: footed pajamas make it hard to make a good seat

- When the knees are in flexion, it gathers cloth around the knee, and cloth can catch/bunch on the carrier fabric

- In loose pants, this causes a gap. In footed pajamas, this pulls up on the child's feet

- In infants, this will trigger a stepping reflex—baby will attempt to "walk" as if they were standing on a flat surface and will extend and adduct the leg. This makes it difficult to keep the knees in "M" position and make a good seat

True

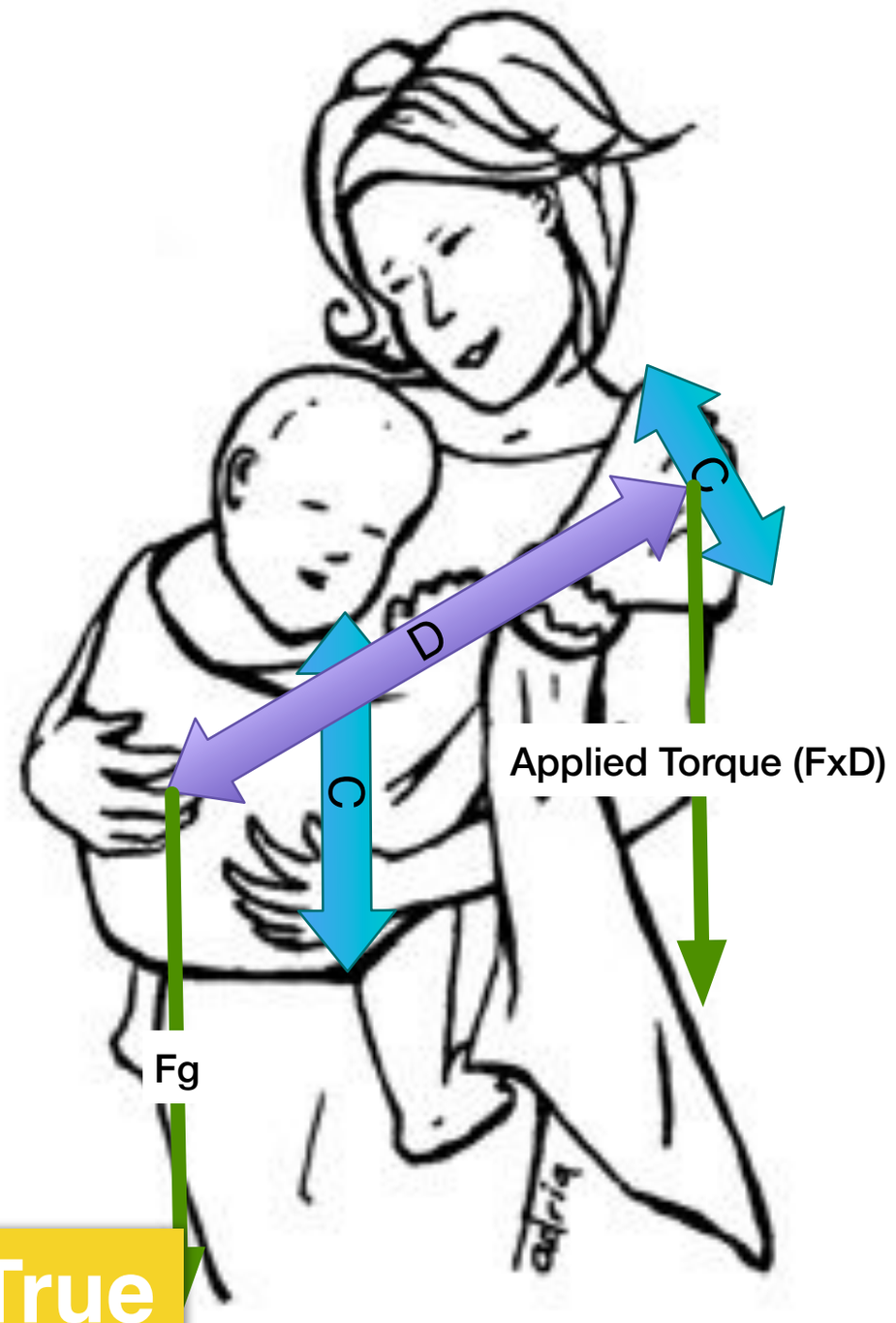
Myth: one-shouldered carries can hurt your back

- Force on only one shoulder torques the body, creating more work for the wearer to balance and stay upright and putting the spine in abduction

- Spreading the fabric increases the contact area across wearer's back, shoulder and front, mitigating the additional torque by spreading the force across the body

- Tightening keeps baby's weight against wearer's body, both decreasing the moment of inertia and increasing contact area, which decreases the pressure on the shoulder

- Alternating shoulders can help by working different muscle groups, but will not help as much as spreading the fabric and proper tightening



Partially True

Questions?

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