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Disclaimer: The following are unofficial notes which have not been read by or approved by the speaker.

Points of discussion:

I. In the last 10 years, there have been three major innovations in lower extremity bracing:

1) use of new materials to decrease weight and increase strength of supports.

2) "stance control"/knee extension assist designs

3) use of new materials (carbon composite) and custom engineering for true triplanar control in coronal (frontal), sagittal, and transverse (rotational) planes.

II. The need for new designs is related to the disadvantages of a locked KAFO, which are:

1) high energy expenditure = decreased activity levels

2) induces gait deviations (circumduction, vaulting, etc.)

3) uneven stride length

4) functionally longer affected limb

5) secondary medical/biomechanical complications due to compensatory motions and excessive "wear and tear" of joints on contralateral limb, foot, knee, hip and trunk.

III. Advantages of a "stance control" orthosis are:

1) knee flexion during swing phase of gait

2) stability during stance

3) reductions of gait deviations = less compensatory motions and less medical/biomechanical complications

4) smooth transition to unaffected limb

5) the hand is not needed to unlock the knee joint prior to sitting

IV. Disadvantages of a "stance control" orthosis:

1) some brands have increased size of components, which may increase weight and projected mass on medial and/or lateral uprights

2) increased fabrication time due to the complexity of the components

3) increased cost and may not be covered by the patient's insurance

4) nearly all require gait training with new device to use correctly and achieve maximum benefit

V. Minimum requirement for most stance control braces:

1) patient must have some ability to get affected foot in front of contralateral leg

2) must have ability to extend knee on affected side -- can be accomplished from gastroc, hamstrings or body weight shift. (Ideal is at least 3/5 hip flexion and 3/5 hip extension)

3) must have passive range of motion of ankle (can be as little as 5 to 10 degrees)

VI. Categories of design(s)

1) preloaded spring in upright of knee joint which resists knee flexion (Becker LR-9200)

2) electronic: computer controlled with sensors in footplate to identify when weight applied to footplate and lock the knee and to unlock knee when weight is released (Becker E knee)

3) gas spring pushes knee into full extension at heel strike. Allows passive knee flexion during swing (Becker G knee)

4) cable from ankle joint to knee joint that unlocks knee joint as the ankle dorsiflexes at end of stance (Becker UTX and OttoBock Free Walk)

5) internal pendulum mechanism locks and unlocks knee depending on angle of joint in a sagittal plane. Locks just prior to heel strike and unlocks at heel off (Fillauer)

6) Cams block knee flexion at any degree on heel strike; free motion during swing phase (Horton Stance Control)

7) triplanar control with knee flexion controlled by floor reaction forces applied anteriorly through pretibial shell and energy stored in the upright as it is "loaded" during stance and forward motion of trunk over footplate that extends beyond toes is then used to propel leg forward at toe off (Dynamic Bracing Solutions)

Comparison of orthotic designs for knee control

Company/Brace	Becker LR-9200	Becker 9001 E-knee	Becker- 9003 G-knee	Becker- UTX	Otto Bock Free Walk
Mechanics/design	pre-loaded spiral torsional spring in a mechanical knee joint that is part of lateral upright that make up a KAFO resists knee flexion in loading response phase(heel strike/initial contact to foot flat) of gait, providing shock absorption, preservation of progression,and limb stability to accept body weight	foot force activated computer controlled. As pressure is removed from footplate a ratcheting knee brake disengages permitting free flexion & extension during swing phase Joint will allow knee to extend but not flex when weight is applied to footplate. This knee joint is incorporated into a KAFO. The knee is powered with 2 long life lithium ion batteries.	A gas spring pushes knee joint into full extension at heel strike. Allows passive knee flexion during swing phase This knee joint is attached to uprights of a KAFO--only lateral joint required, but medial joint strongly recommended by Becker.	At end of swing, as knee reaches full extension a ratchet engages to stabilize knee. A cable runs inside a single upright from the ankle joint to knee joint -- at end of stance, as ankle dorsiflexes, the cable is used to unlock & destabilize the knee. KAFO with single upright.	Same principles as the Becker UTX KAFO with single upright
Indications:	generalized lower extremity weakness, quads, hamstrings, & hip extensors. weak hip musculature is not a contraindication Some knee malalignment can be accommodated. Hyperextension can also be accommodated.	quadriceps weakness & also for combined muscular weakness at hip and knee. Typically,not recommended for bilateral use	quadriceps weakness Needs a minimum of 3/5 hip flexor strength to initiate swing.	quadriceps weakness genu recurvatum ** also needs to have: 1)passive ankle dorsiflexion of at least 5 deg. 2)hip extensor strength at least 3/5 3)full knee extension 4)hip flexor power of at least 3/5	quadriceps weakness one sided paresis/ paralysis **also needs: 1.minimum of 10 degree mobility of ankle. 2.hip flexor strength of 3/5 or > 3.hip extension at least 3/5 power and/or knee extension power of at least 3/5
Contraindications	patient weight>220 lbs.	lack of cognitive skills fixed knee flexion contracture pt. weight >220 pounds any spasticity in hip, knee,or ankle muscles fixed varus or valgus deformity at knee >15 degrees.	Pt. who does not have relatively normal hip strength. Pt. weight >190 lbs. Non-correctable knee valgus of >15 degrees Knee center to top of thigh piece must be greater than 23 cm. In walking, contralateral limb must be stable.	for UTX 80- patient weight over 80 kg. (175 pounds) for UTX 120 - pt. weight over 120 kg. (265 pounds) for UTX FS {indicated for genu recurvatum}- pt. weight >100 kgs (220 pounds) Any spasticity Foot/ankle instabilities Substantial shortening of affected leg	Pt. weight >120 kg. (265 pounds) knee flexion contracture>10 degrees unstable valgus/varus of knee while standing valgus of knee >10 deg. significant spasticity significant instability of ankle cognitive problems
Weight of device	Aluminum joints weigh 2.4 lbs; stainless steel jts=4.2 lbs; titanium = 3 lbs.	Joint (midsection) = 1.21 pounds	Gas shock with lower bar only weigh 0.97 lbs for stainless steel and 0.37 lbs. for carbon fiber.	Total brace = 1.65 to 1.98 pounds	Total brace = 1.5 to 2.0 pounds
Other :	Allows 18 degrees of flexion during stance phase of gait			Height of shoe lift can affect function of brace	
Cost:	not given	$3,570 for central fab.	$1017 for central fab of KAFO with solid ankle	$1500 to $1625	
Advantages:		locks at any angle will lock regardless of uneven terrain or slope doesn't limit KAFO design options	extension assist, locking option carbon fiber upright is lightweight Provides assistance when rising from sitting	Comfort in sitting due to lack of rigid structures posteriorly Lightweight Manual unlock in better position than Free Walk brace	
Disadvantages:		battery pack to change	Is NOT a stance control ortho~~s~~	Very little foot/ankle control except dorsi-assist & plantarflexion stop for flaccid ankle muscles.	

Comparison of orthotic designs for knee control

Company/Brace	Fillauer Swing Phase Lock	Horton Stance Control	Dynamic Bracing Solutions
Mechanics/design	Uses an internal pendulum mechanism to lock & unlock knee, depending on angle of joint in a sagittal plane. During gait, the device locks just prior to heel strike & unlocks at heel off. SPL joint on one upright of KAFO & must be used with a Swing Phase Control knee joint (mounted medially) which uses friction & a spring to regulate knee flexion during swing	External knee joint mounted on uprights. Automatically blocks flexion at any degree on heel strike/free motion during swing phase. Can be switched from free knee, to locked in 180 degrees extension, or to stance control mode.	A unique design, based on advances in prosthetics. Utilizes advanced floor reaction with triplanar control combined with a dynamic response to enhance stability & dynamic balance throughout the gait cycle. Each solution includes a geometrically designed/engineered device and a mobility program to enable the individual to maximize their potential. The device provides ACTIVE propulsion propulsion of the limb & allows for more efficient (less energy consuming) ambulation. Triplanar control offers better alignment of the bony segments in the 3 cardinal planes to achieve better balance & security (It is like advanced stance AND swing control) and it also controls them in full load bearing! Good knee control can be provided for most users with only an AFO; KAFO needed when there is medial-lateral instability of the knee.
Indications:	partial or total paralysis of knee extensors. Can be used with KO or KAFO User needs to have at least 170 degrees of knee extension range	isolated quad wkness/absence Unilateral leg paresis /paralysis,but some persons have been fit with bilat. Horton stance control knees Increased stability for: 1)Floor reaction AFO candidates 2)offset knee KAFO wearers 3)free knee KAFO wearers 4)solid ankle/PF stop AFO wearers	weakness of ankle dorsiflexion &/or plantarflexion with or without quad weakness or absence. Unilateral or bilateral weakness can be addressed.
Contraindications	Knee flexion contracture >10 degrees central paralysis hip flexion contracture hip musculature involvement poor balance/coordination Knee hyperextension greater than 10 deg.	Patient weight >102 kg. (225 pounds) significant impaired cognition/balance/ motivation uncorrectable genu varum/ valgum > 10 degrees knee flexion contracture greater than 10 degrees biological knee joint > than 5 degrees off line of progression in swing phase.	hip flexion contracture IF 0/5 quadriceps moderate or greater spasticity significant weakness of lumbar/pelvic muscles inability/unwillingness to engage in intensive gait training program (Neuro-Balancing/ Ortho-Balancing)
Weight of device	not given	weighs 10-14oz. more than a similar KAFO	Total brace (AFO) 1.5 to 2.5 pounds. KAFO = 2.0 to 3.0 pounds.
Other :	Patient must be able to initiate swing through. Can be used during cycling (bicycle)		Can be worn in water, can be worn while bicycling
Cost:	not given	not given	$6,500 up to $10,000
Advantages:			Progressive knee control allows the knee to continue forward with controlled resistance as the uprights flex. This allows the hip & pelvis to advance forward allowing a longer step length and a fluent forward motion with safety & security Anterior stop limits this progression.
Disadvantages:			