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Diagonals Part 7 Stroke 5
Walking: What say the scientist and what is best practice.

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Abstract

In this part we try to listen to the science, that has and still do over the whole world investigation by stroke patients over the walking aspect and the best way to get the best recovery or compensation. Recovery is only for an group possible, that had an "minor" stroke and there we see that the old system is not too much damaged and recovery is possible. But with greater damage of the brain individual after an stroke must go another way to get his independently and that is compensation. That compensation start with the first movement in bed and will also affect the diagonal. The science has reported that the walking pattern on the EMG don't change very much after an short period and they said that this pattern are fixed within in certain period. We have our doubt and have search to other forms of training and learning and see that changes is well possible but to be sure the science must investigated that. Here is an problem because science gives another interpretation of the word intensity. For the scientist this is "more time" to do the exercises and in our view, it is the heaviness of the exercises and that can be done by an individual with an stroke an certain time before he is fatigue.
In the treatment we start with the individual with an severe stroke that need all assistance to get him on his feet and will have need of an splint on his knee because the power in the knee muscle is to limited, to hold the knee. Regrettable an individual after an stroke that the scientist never investigate because this is too difficult. From this starting point we walk through all the steps, we must make to get independent walking individual when possible and what the problem were when that goal cannot fully reached.
And we discuss other forms, approach or new development to get walking possible with the use of the diagonals. Part 8 will discuss other casus with an severe stroke. *(Jan van de Rakt, Steve McCarthy-Grunwald - Diagonals Part 7 Stroke 5 Walking: What say the scientist and what is best practice. Ita. J. Sports Reh. Po. 2018; 5; 2 ; 1013 – 1062 ; ISSN 2385-1988 [online] IBSN 007-111-19-55 ; CGI J OAJI :0,101)*

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Diagonals Part Seven pathology
The Stroke patient, how we can train the diagonals to create an better result.

Introduction.

Every individual after an stroke will ask :"When will I be able to walk independent again ?" Therefore every therapist will attend much of his time on the walking abilities. In rehabilitation center the apparatus that there appear are mostly for walking and balance training and an very big part of investigation goes to that part of research –walking and balance. It is good that we start with walking abilities so soon as possible and by individuals who has an outcome after stroke that is called the 'Pusher-Syndrome", it is even the only way to get progression. Pusher syndrome will be done in an separated part.

But independently is not only the possibility to walk. To get on your feet you must be able to standup and therefore make always time to exercise the movement in an out bed, the ability to stand up and sit down, to train the possibilities of the arms and the implementation in the A.D.L.

Normal walking.

Normal walking ask for an good balance and selectivity of both side. That means that the diagonal must be intact and the keypoint /the homolateral structure. The symmetry of our walking pattern is never entirely equal, that can we see on the swing of the arm when we walk. But that shows, that we compensated with the arm movement to reached the most perfect symmetrical movement of the leg. Problems in the trunk /hip etc. were compensated by the rotation of the upper trunk and that we see back in the difference of the swing in the arm.

An short (less than 2 cm) leg will not be see in the movement of the leg but in the movement of the arm!

Only when the upper trunk cannot compensated, than we see differences between the movement of the two leg. Rotation of the trunk is needed amongst other things to compensated the endo- and exorotation that take place in the hip. When we swing the foot to the front, is that in the hip an flexion /exorotation movement. When the heel touch the ground (heel strike) on that moment the extension of the hip start (this also the moment that the hip extensor is most active (M.gluteus maximus). The exorotation will be lesser and when the hip stand under the body (mid stance) there is no rotation in the hip. Now the last part of the stand phase start , the goes further in extension with endorotation. This until the heel comes from the floor and the push-off start. This endorotation will in the first part of the swing (pre swing) with the flexion go to zero and then (mid swing) goes in flexion and exorotation.

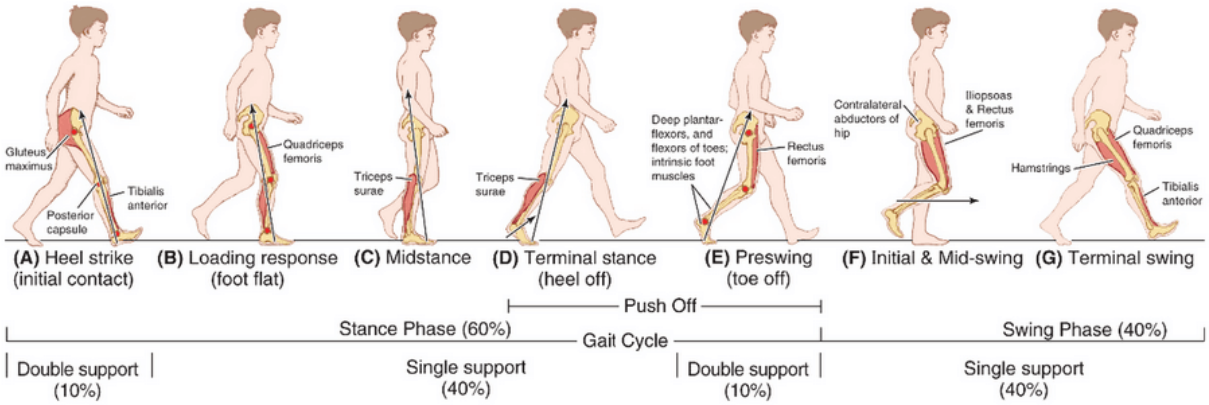


Figure 1. Walking phases

This rotation is the greatest when one foot touch the ground(heel strike) and the other is in the push-off phase, you see than also the greatest swing of the arms. The arm on other side of the swing leg is on his maximum to the front and that ask for an protraction movement of the upper trunk (protraction will rotated the vertebrae turn to that side) . On that side is the leg on his maximum in extension /endorotation (push-off) and the arm on the other side is also on his maximum in his movement to the back and ask for an retraction of the upper trunk(Retraction will turn the vertebrae to the other side). On thoracic level the turn in the vertebrae is toward the arm that swings to the front.

The back diagonal of the arm and the other leg is on his maximum of shortening and the other side swing leg and other arm have an front diagonal that is now also short .The rotation in the spine is therefore on high thoracic level to the swing arm but on the lumbar level this also the case but opposite. Here (lumbar) we see that the vertebrae turn to the swing side and that is opposite of the thoracic level. Again extension in the hip gives an turning of the vertebrae to the other side and the flexion will turn the vertebrae to that side and therefore allowing the rotation in the hip.

We can feel this by feeling the muscle contraction that occur in the erector trunci muscle.

You will feel that the tone of the muscle lumbar change from the push-off side to the heel strike side. In the same time you feel on thorax level in the m. erector trunci an change of muscle tension to the opposite side as the lumbar action. We feel therefore the action of the back diagonal on thoracic level and the same time the action of the back diagonal on lumbar level on the other side. The rotation of the upper trunk to the back and the rotation from the lower trunk to the back together with rotation in hip (less exorotation) makes, that the whole movement gives its force to move over the foot that stand on the ground with the lowest energy cost there. It is this action of the trunk that gives us by normal walking the power for propulsion. Investigation of walking with restriction of the arm swing gives always higher energy cost. Even walking with your hand on the back cost more energy or there must be an problem with stability or balance. The back diagonal that will be use in the stand phase is also the fixation of the trunk and gives the front diagonal an central fixation point. The core stability makes it possible to shorten the front diagonal and swing the leg to the front.

Core stability means the integration of all muscle of the trunk and the homolateral structure that gives fixation in which the diagonals can do their job.

The push –off is not necessary for propulsion to the front but by normal walking more for bending the knee and release the stretch of hip flexor for the swing phase. The amount of energy that is stored in muscle by asking action when the muscle is on his longest stand is an system that works with releasing energy in the structures within the muscles

Observe people when they walk.

With an slow speed the movement of the arms are less. That means not that the diagonals are not working but that there is no need. When the speed is increased the central system of the front and back diagonal gives the energy to walk with an higher speed but the muscle activity of the legs is still less. The heel strike is almost enough to walk, the rest will do the energy restore and release by the stretch muscle and we see that muscles in the leg has an different function.
The quadriceps is being used to soften the heel strike, the gastrocnemius will be use to bend the knee and not necessary to give an push –off. That will be need when the speed is increasing.
Walking with the diagonal principle has an great advantage because great pattern create energy that will release when we are walking and gives us the possibility walk far with low cost.
Normal walking is “not dependent” of the floor, we have already an “movement system including walking “ through the core stability and diagonals, we need the floor to have an fixed point on which the system can propels our body in any direction.
The rotation of trunk is the movement of the back diagonal - shoulder left-- hip right to each other – that gives an extension rotation in spine on both side and makes it endorotation in the hip possible , and the front diagonal – shoulder right – left leg to each other- gives an flexion rotation on both end and makes an exorotation in the hip possible.
The diagonals with the core stability is the center of our walking ability and the leg do what this center told.

Photo 1.
An men walking on the boulevard with an cane.
The balance and his left leg are not so good anymore.
But is step length is left and right the same, but on the right side there must be more activity of the arm and through the arm/hand also on the cane.
The problem left is that the extension in the left leg isn't so good and that he compensated with his right arm with the aid of the cane.

That result in an extension rotation of the upper trunk that goes further than normal because on this way he can longer push on the cane.

And keep the step length left and right equal.

The cane makes the back diagonal longer and in the upper trunk stronger !!

Compensation of the walking pattern on this way is very common and shows us, that not the legs are the commando centre but the brain through the use of the diagonals. The centre of the diagonals in the stomach (rectus femoris) and the fascia lumbo-sacralis on the back are the points where this compensation take place and that need core stability. By the men on photo 1, there is too little power on the lower side of the diagonal (back) left and therefore create the upper part (back) right an higher tone and an longer rotation and created an walking pattern that is the same as before. This base of this system lies low in the brain, maybe not in the brain but in the brain-stem or even also in the spinal cord. Scientist speaks about walking generators and this is the most important one. And it is an pity that never they put EMG- on this important spot. Prof.Duysens (Leuven) has investigated the stomach but only on one side but he reports that the m. abdomen internus does the opposite as the externus and that suggest that the internus is part of an front diagonal with the externus on the same side. Regrettably there is only interest for the muscle of the leg and mostly under the hip and that gives an outcome, that is important to understand the walking performance, but gives never an total view We see that the quadriceps has an more eccentric function on the end of the swing phase and that stays in the stand-phase, that the gastrocnemius and hamstring (in normal walking) has an function in knee bending and in the swing phase.

This walk generator must be capable to restore an part of the walking capacity of an individual after an stroke. But individuals with an very severe stroke will have great difficulties to reach this level of walking without support of others and the opportunity to use the diagonal system.

The double innervation of the diagonal and maybe also the keypoints (hip and shoulder) by an individual after an severe stroke will be present , maybe not complete but an great part. It is therefore rare when this will not come back and therefore it is also strange that science not investigated this.

Balance.

What science has investigated is the balance restoration of individuals after an stroke. The only point of criticism is that this is only done by 10% of the stroke survivors (the amount of individuals that has his rehabilitation done in an rehabilitation centre and that is about 10% of the stroke survivors), thus we don't know of this is also the case by the other 90% (Stroke survivors that are going home after the hospitalisation and about 33% that is dependent for the rehabilitation in an geriatric rehabilitation centre often an department of an Nursing Home) . The balance investigation has done with static platforms, dynamic treadmill with or without obstacles and dynamic walk mat . To determined what the balance is in stand (static) and when the individual is walking (dynamic). The EMG by the m. gluteus medius is often recorded and that is the muscle that plays an major role in the homolateral structure (keypoint hip) and is very important part in the stand phase and in controlling the balance. Often we see an lower activity of that muscle through the EMG and that means that the diagonal has an angle that is more than 45°. Than the diagonals (front and back together) end in the adductor muscle and walk the individual not "over" his affected hip but "beside' it and thus on the inside of the hip joint.

Static balance

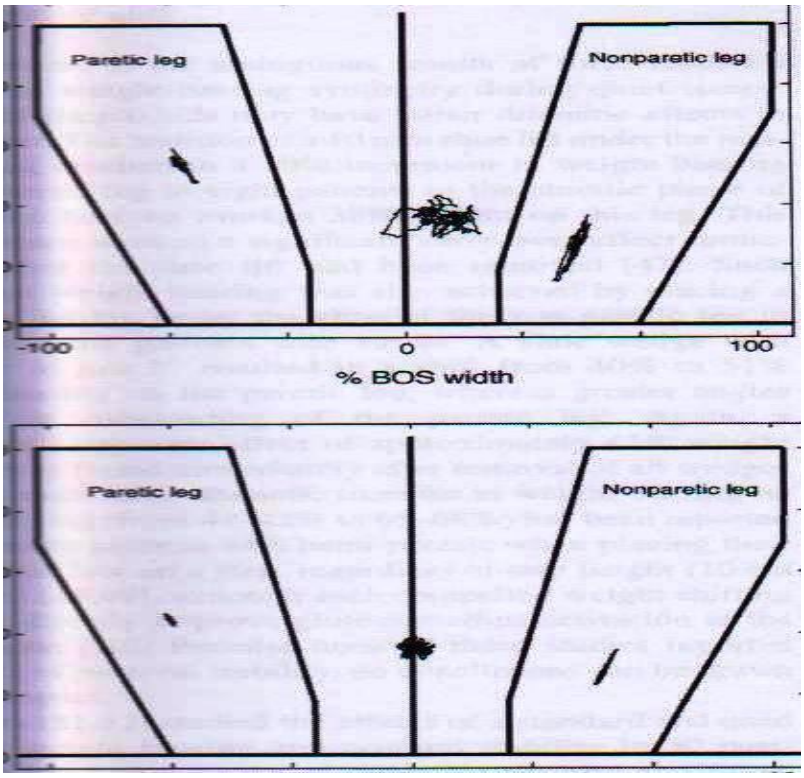
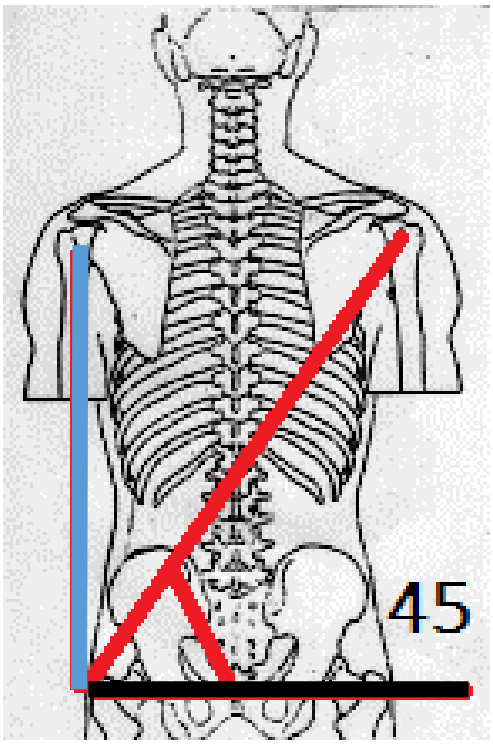


Figure 2.
Static balance Test.
The individual stand on an platform, that record two elements of balance;
1. Where is the most pressure of the foot.
And that is on the not-affected foot under the heel and on the affected foot under the fore foot.

2. And where the weight was between the two feet.
The upper gives an view in the beginning and the lower part after 3 months.

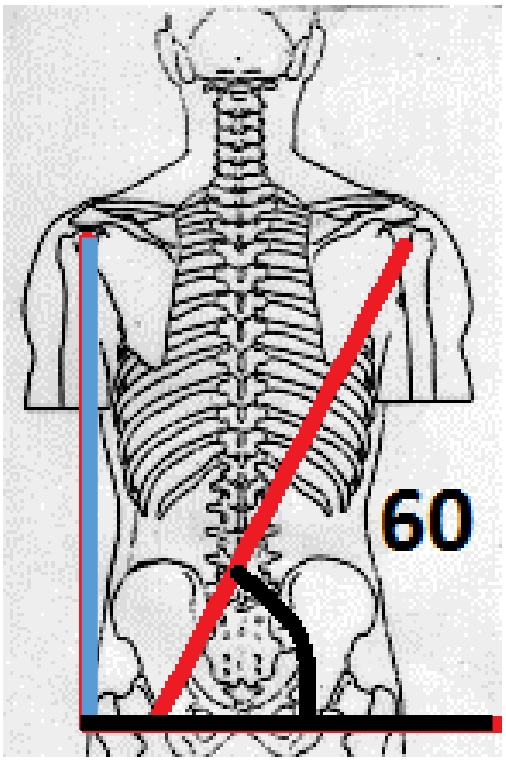
Remember that this is an investigation done by individuals that are in an rehabilitation center and that is about 10 % of the stroke population.

Therefore there will be individuals that are so good that the difference is not so big but there will be an large group, about 33% that goes to an nursing home rehabilitation center and they will show greater deficit and certainly not this recovery after 3 month.
On the upper part of picture 2 we see that weight between the feet is almost always on the not-affected foot and the pressure on the not-affected foot stand on the heel. The pressure on the affected foot is lesser and here stay the pressure on the forefoot. After 3 month (the lower part of picture 2) there is an change in the weight bearing , certainly closer to the centre but the most of the lines lies on the not-affected side. The pressure on the not-affected foot stand still on the heel and the pressure on the affected foot stand still on the forefoot. There is an change but this shows that there is more control on the not-affected side than from the affected side and the investigators suggest that this will not further change after 3-6 month. When the individual stand more on his not-affected leg than his affected leg, what will happen in the diagonal and especially in the back diagonal from the not-affected arm to the affected leg. The diagonal that start in the not- affected arm goes to the affected leg and the angle is greater than 45°. Normally the diagonal will start in the leg but in this case often the not-affected arm has more “control” and will determined more the weight shift than the affected leg and will start with the shift to the not-affected side together with the not-affected leg.



Picture 1.
The angle of 45°.
The **first** line start in the glenohumeral joint and ended in the trochanter major.
The **other** line start in the glenohumeral joint on the other side and ended also in the trochanter major.
The **last** line is an line from the trochanter major with an angle of 90° on the last line .

The angle between de last line and the line of the back diagonal must be about 45°.
When this angle is greater than there must be an change in the position of the lines.
And that means that the diagonal is run between the two keypoints –hip and shoulder – and this keypoint are the moving parts of the diagonals (front and back) in which they can participated together and created together an homolateral structure .



Picture 2.
The angle is greater than 45° .
In the picture about 60° and now we see that the back diagonal cannot end in the trochanter major but ended in the trochanter minor.
That means that the muscles that lay on the other side of the diagonal line (between the red and blue line) will have no influence in the muscle pattern that now develop.
Of course will also the function of the hip joint be different because little muscle that influence the hip movement cannot do his job through the "dominancy" of the back diagonal that ended on the inside. The influence of the adductors and the semi-muscles will be much bigger and this also through the loss of selectivity and perception.
The homolateral structure has no cohesion with the walking or standing posture.

Therefore there is certainly an shift after 3 month, but often the diagonal lies still on the inside of the upper leg and when there is an synergy than will this be further active through the back diagonal. The muscle outside the line will be weaker and inhibited by the agonist, the adductors.

Dynamic balance (Dr. J.Buurke)

When individuals after an stroke are walking the balance will change dramatically and that gives this individuals more risk to fall frequently. Is in the standing position the different between the not-affected leg and the affected leg is about 60% – 40 % with the forefoot weight bearing, in walking condition is that 90%-10%. And forefoot (striker foot) bearing gives an rotation of the pelvis to the back and that makes that angle of the diagonal will increase.
The back diagonal line will when stroke patient walk dramatically changed and the muscle of the inside of the affected leg will take over the bearing function but never the balance function.
Again this investigation is only done by individuals after an stroke from rehabilitation centre and there will be some difference . There will be individuals that has not so great deficit but there are also individual that have much more difference.
The main reason of this difference is the loss of **perception in the affected side**, therefore it is from the greatest importance that we find an solution to train the perception.

Figure 3.
Dynamic Balance. (SA =Static asymm. DA= Dynamic asymm.)
The difference between static balance and dynamic balance is extreme great. By static we see an difference of 60% -40% , when this individual walk the difference is 90%-10% on weight bearing on the not-affected leg and the affected leg and that makes that the balance is very poor and almost totally dependent from the not-affected leg and that can never lead to an good balance and good balance reactions.

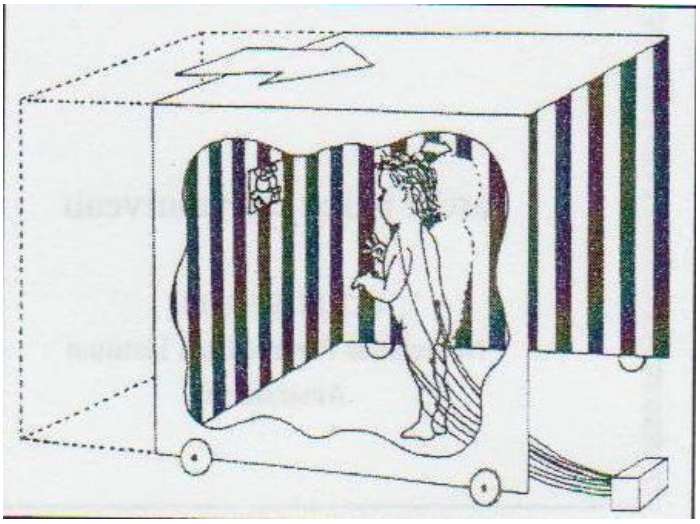
Perception.

Loss of perception on the affected side is very important factor and perception is the activation of the brain with the right input from the whole leg including the foot. The centre in the brain need this CONTINU information to instruct the balance and walking generators. But often is this centre in the brain damaged and is the information to brain is intact certainly at the beginning but cannot reach the brain.
That means that the brain cannot inform on an normal way the muscle pattern and must go to an lower projection that will used synergy or part of the synergy to get an weight bearing in the affected foot. Because of that damage in the brain will other information (visual, auditory, labyrinth, vestibular, receptor of the neck) have lesser or an different influence and will also not work so well.

Try to hold an Rani pink ball up with badge , looking in the mirror and ask someone to hold an board for you , so that you can only see in the mirror where the ball is.

One of the most important information source are the muscle spindle. And that can also not be use well because the tone is not normal.
This will lead to an lesser different information and makes the walking pattern more rigid and therefore less opportunity to react good an balance disturbances. (Degrees of freedom N.Bernstein 1967) In training there must be always an great amount of stimuli on the agenda that stimulated the brain to functioning on his highest level.
Two examples;

1. Often therapist ask the individual after an stroke to control his attitude and walking with his eyes. Looking to an wall give you the opportunity to calculated the distance and when the distance is shorter you are falling to the front thus react but is that true for individual after an stroke ? When the wall has structure and not move, than it is an possibility but when I walk the wall move. Some therapist tried this with an mirror and of course the better individual can do this but it is very difficult to control your "mirror image"!!



Picture 3.
The test of Sveistrup and Savelsbergh.
The wall is moving to the child and the child will fall backwards.
Till the age of 12 this will happen but after that there will be on the EMG an signal that the reaction is still there but we manages to inhibited that. Can this the individual after an stroke also?

By individual after an stroke but also individuals with dementia will give this test an fall backwards as the wall moves to the person and an fall forward when the wall moves away. That means that moving items makes it difficult for individuals to hold their balance. Still this can be an training but be sure that this is possible. The eyes can help, but also make it difficult and Prof. Denier van de Gon say that the correction that goes via the eyes is to slow for good balancing, information of the eyes will be good when it register how the situation is on the front not when an person is out of balance.

2. There is great evidence (Sato) that walking in water increase the information of the brain. Standing in water has also an effect but walking much more. The activity of the input channels is increase and the activity in the brain is also increase. But the brain is damage and that means that there is an limit what that brain can do. But there is another advantage the up thrust of the water has an inhibition effect on the tone of the individual after an stroke. This decreasing from the tone makes movement easy and give the muscle spindles the opportunity to do their job better. Dr. Tripp has evidence that rehabilitation in water for individual after an stroke is positive, better than on land.

That because through the increase input and perception in the brain and because through the decrease of the tone and the possibilities of the muscle spindles but also because moving in water looks easy but you must always work in the water, when you are walking, lying or sitting, the water will ask that you control your body.

That gives the possibilities with lower tone to build up an better selectivity and that will changes the projection in the brain.

Water therapy such as Halliwick can stimulated the recovery of the stroke patient and should be have an placed in the rehabilitation of the stroke patient for 2-3 times a week. That means that the patient 3 times a week an hour constantly is moving on different level of difficulty,

we can give task-specific resistance therapy in the water and the situation is never the same , that means that brain must search for solution.
Task-specific resistance training can be given also for the muscle pattern – diagonals- front and back and the homolateral structures .

Photo 2.
Task-specific resistance treatment for the back diagonal of the affected side by giving resistance on the front diagonal of the not-affected side. Resistance to the not-affected foot to push this foot up , will need an stabilization by the back diagonal on the other –affected side.
The patient is floating in water and if necessary we can give what support.

The therapist had his hand on the front of the not-affected foot and the other on the heel of the affected foot.
Now he ask to lift the not-affected foot and he experience the power she had without an movement. That is the 1 R.M. (Repetition Maximum).
But he will feel that the heel of the affected side will push downward and he is now capable to give an exercise with an R.M. of 75%, till there is muscle fatigue and that is an stimulus for an better coordination and muscle power in both diagonals and homolateral structures (keypoints) . The best movement we can get is an movement of extension on the affected side that gives an great muscle contraction in the m.gluteus maximus and that is often the missing link in the back diagonal. Be aware that when the foot makes plantar flexion with inversion(striker foot) that this is the extensor synergy and then often will this be done by the adductors and semi muscle and not by the gluteal muscle.

Stroke walking- pattern.

Many investigator have found that the walking pattern of an individual after an stroke have little difference when they start and several months later.
Everyone see the individual walk better and with more speed, confidence and over all kinds of ground, but the pattern that they see on the EMG didn't changes.
That give them the believe, that the walking pattern are settled pretty fast after the stroke and that therapy cannot change that. In other words when the brain have create an new pattern with the remaining perception and muscle pattern than will that be the highest possible level that this individual can get according the EMG results.

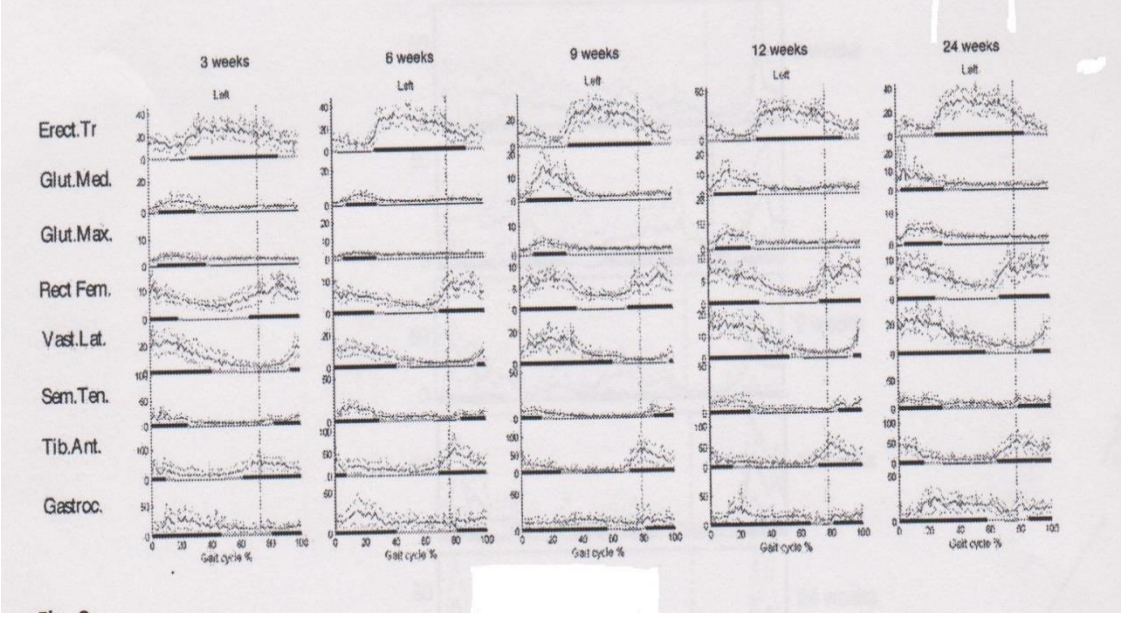


Figure 4.
This is out the work of Dr.J.Buurke and show that the EMG values not changes over an period from 3 weeks till 24 weeks.
But the remark is here again on his place, this is an investigation with patient out rehabilitation centre and that is 10 % of the total of stroke patient. There can be better EMG result but also much worse results by the other 90%.

In figure 4 we see in left axis the muscle that were investigated with EMG . Gastroc – Gastronemicus, Tib.Ant. -Tibialis anterior, Sem.Ten.-Semitendinosis, Vast.lat.-Vastus lateralis, Rect.Fem. – Rectus femoris, Glut.Max. – Gluteus maximus, Glut.med. – Gluteus medius, Erect. Tr – Erector trunci.
On the top stand the moment that this EMG investigation take place; 3 weeks after the stroke, 5, 8, 12, 24 weeks. That means that the group that cannot walk after 3 weeks didn't participate.
And the EMG values are drawn in the walking cycle with an black balk how long and the curve how much. The light line on 3 / 4, marks the moment that the swing phase start.
1. The m. gastronemicus start to early , his is active in the swing phase. An the change is little there is an increase in time that this muscle works. (striker foot)
2.The m. tibialis anterior works before the toe off moment but not on the heel strike moment. That seem to be equal in time and the height.
3. The m. semitendinosus is active after the toe off and this stay in time equal but in height there is an decrease.
4. The m. vastus lateralis stay active through the stand phase qua time and height.
5.The m. rectus femoris is active on the moment that the swing phase will start and that means that the knee bending isn't possible and this stay the same qua time and height.
6. The m. gluteus maximus, now there is difference with all other muscle. In the 9 weeks we see an height increase and an little increase in time that is gone or decrease after 24 weeks. Nobody has given there an answer or explanation for.
7. The m. gluteus medius does the same as the gluteus maximus , in week 9 an increase in height and little in time but this is gone after 24 weeks, how is that possible ?
8. The erector Trunci is in 3 weeks prominent present in height and time active also in the

period that the toe goes off the floor and that is normally the moment that the other side comes in action and is this side “still”, that on and off system isn’t working anymore or working on an lower level.
There is thus an great similarity between the period and the height and the moment of action of the leg muscle that explain the walking pattern that we see. No flexion of the knee , the forefoot first on the ground , no clearance of the forefoot on the end of the swing phase and no relaxation of the spine muscle after the stand phase but…..
The action that the gluteus muscle makes indicated that there is an moment of action of this two muscle but that this lost , but why?
One explanation for this phenomena could be :

The muscles were not used by the individual !

How is that possible? The use of the 4-leg cane makes that they back diagonal goes not through the buttock. The extension synergy makes it impossible to create an extension action of the affected leg on the moment that the individual must move over his hip. Now he stay behind his affected hip and makes an small step with the not-affected leg. And he makes an flexion of the trunk of get more weight to the front and create so an optimal balance. Now the gluteus medius is not need anymore and the gluteus maximus will only react when the muscle is on at most greatest length. That action is action on spine level and no brain or walk generators action.
But can we change this ?
I think so, make alteration and then the pattern will change not the whole EMG picture but we are capable by an number of individuals to get more hip extension by using an therapy that listen to the diagonals.

How teach and train an stroke patient to walk again? Casus Mister R.

This individual cannot walk after 24 weeks in rehabilitation centre but was able to learn it in an nursing home after that 24 weeks and go to his home within 1 year after his stroke. Main problem: - no extension in his affected leg especially in the buttock and the perception was very poor. In the rehabilitation centre he goes in the Lokomat, an apparatus that can take over the walking abilities but can also when the individual can do something, give that ability access, very nice but very expensive apparatus. But walking at this apparatus will increase the walking speed because what the individual cannot, the apparatus will assist. But still there is an support moment on the not-affected side and the diagoinal angle isn’t optimal and the action of the buttock muscle is not directly necessary. The action of this muscle is there but not great enough to get the stimulus to increase the power and coordination and see it back in his walking abilities over the ground. Then he walks with an 4- point cane and was the action of the buttock muscle not present

Photo 3 Lokomat. See the support that he makes with his right arm and that will give an increase of the angle at hip-height and give more action of the adductors as an hip extensor muscle !

The movements in bed and in and out bed need assistance and he was capable to do the low transfer on A.D.L. level . Standing up and stand for the bed was possible, but the affected knee must be support by two knee of the therapist. Further there was an little plantar flexion with inversion stand in his foot therefore the dorsal flexion was decrease and the mobility of the hip was increase in the exorotation direction (about 10° with no end resistance).

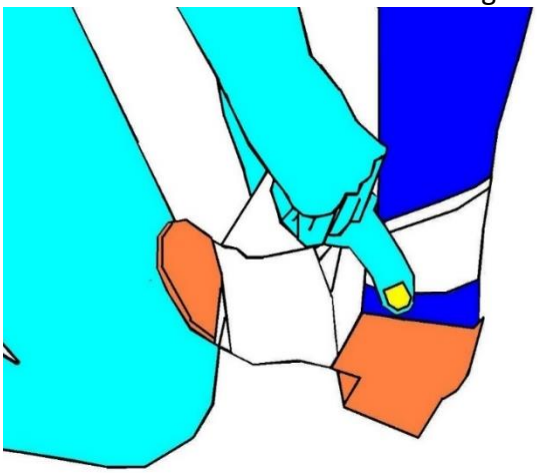
Important is that from day one the level of A.D.L. is known on the ward and how much assistance he need. Than it is possible to functioned on his level and that is not the training level because that will mean that he does the whole day everything on his highest level and that will give complaints. Most of shoulder complains will occur when the individual is focusing on an job and that job is very difficult. Than his focus cannot be also on his shoulder and when he is doing this on his own, we have an situation in which complaints can occur but also the feeling of failing.

Another example, he has in the rehabilitation center much complaints about his shoulder after the exercise in the Lokomat. The speed of the apparatus was so height that the affected shoulder goes in complete flexion synergy and the head of the humerus push against the roof of the shoulder joint. Normally by him, the scapula stand was in an retraction and the head of the humerus was subluxation inferior. Pain was there only in the morning by the A.D.L. when he of someone else move his affected arm, without releasing the tone of the scapula. Therefore one of the first therapy we did from day one is an bed attitude on his affected side with the shoulder blade in the right position. Every morning he lie on this way and learn to move over the scapula and release the tone and had an better experience by the washing and dressing after that.

The front diagonal was heavily affected , there was no flexion in the affected leg when we give resistance to the not- affected arm in the direction of the affected leg (see also Part 2), there was only a little bit endorotation of the affected leg.

Lifting the not-affected leg was possible but not with an knee in extension and resistance on the not-affected leg was almost zero. In the affected leg was some extension but no heel pressure but well an increase in tone of the plantar flexion with inversion (striker foot) and an reaction in the upper part of the leg; some adduction with endorotation. The shoulder on the affected side goes in retraction when he lift his not-affected leg even his head goes in extension. He must find his fixation in the upper trunk to be able and lift the not-affected leg. That means that the back diagonal(the stabilization on the other side) is very weak and has an angle from more than 60°.

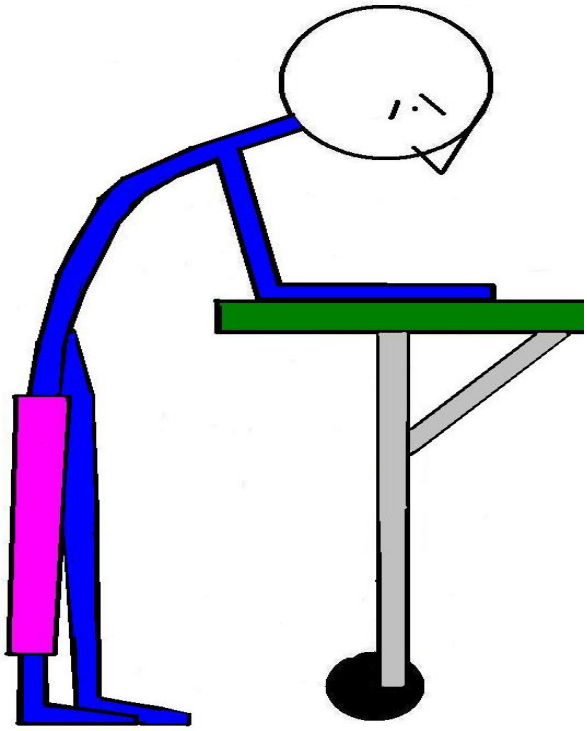
Extension will come back only when we stimulated the body to make an **dynamic** extension- an muscle contraction! An standing table is often not dynamic but static and will give an extinction or the not-affected leg will overreact and then we have an cross stretch-flex reaction (static segmental reaction) .
Start with an fixation of the foot and the knee. The knee with an back- splint that placed the knee in extension and with an bandage fixated the foot in dorsal flexion with eversion.



Picture 4
First inhibited the tone of the plantar flexor and search for the greatest mobility in the ankle. Often is the movement between the talus and the furca malleoli of the ankle not correct. Than is an manipulation necessary to overcome that problem.
Mostly this is tone, because the high tone of the plantar flexor places the talus too much to the lateral side. You can feel that because the space between the talus and the furca malleoli medial and lateral is not equal. That must be equal will the dorsal flexion movement can take place. Is the space equal and the Achilles tendon is tight , than it is only the tone that restricted the dorsal flexion.

Bandage.

Now take an bandage and turn that on an good shoe with an firm leather sole, pull the lateral side up and wrap around the under leg. Around the foot we fixated the bandage every time, but never around the under leg because this will pinch off the circulation to the foot**.**
We place an Bobath bench on the wright height and asking to stand up with his not-affected arm on the bench supporting on his elbow. Upper trunk forward movement and we assisted this movement because his affected leg is in extension through the back-splint and he can make the standing up movement only with his not-affected leg. He stand for the bench with his upper trunk in flexion supporting on his not –affected elbow and his affected arm is on the bench or hanging in front of the bench.

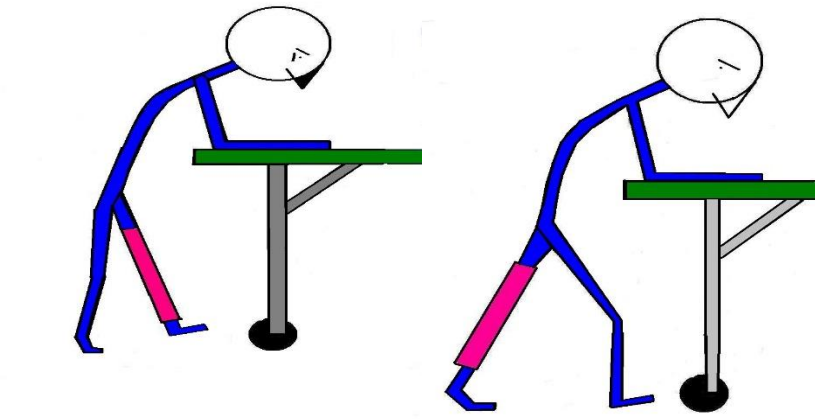


Picture 5
Standing for the bench with the back-splint and support on the bench with the not-affected arm on the elbow.
Let no movement occur with the upper trunk backward because that can evoke the S.T.N.R. static reaction that caused an flexion in the affected leg. That cannot occur because the leg is an back-splint but will always give an fear – reaction. Therefore ask him to look to the bench and hold the pressure on the elbow.
Important is the pressure on the treatment bench and that he try to push the bench away so that this bench is riding on his wheel. That will stimulated the walk movement.

The individual (photo 3) was very afraid that he will fall because he experience that he was according his perception, too far to the front. That means that he has already an wrong senso-motor track and must now learn to create an better one.
He was unable to lift his affected leg to the front and pushing the Bobath bench to the front thus we started with walking sideways in the not-affected direction. Lifting his not-affected foot and placed it sideways gave him the experience that he can hold his weight on his affected leg and stimulated the back diagonal. This diagonal is now very long and all muscle of the trunk and buttock are elongated and often an stretch is enough to get an contraction, an contraction on spine level, but an **contraction**. He was able to placed his affected foot against the not-affected foot by making an upper trunk sideway to the not-affected side, than will the affected foot come free and with his adductor, he can place his foot and so he walk around the bench. On the end we try to go back that means upper trunk side way on the not-affected foot and try to kick the affected foot away , there was movement but not enough thus assistance was needed.. Now we train backward walking support on the small end of the bench and the bench on his wheels . He hold the support on his elbow now he try first to kick the affected leg to the back, therefore he make the attitude upper trunk forward greater and elongated the back muscle and was able to place the affected foot to the back and placed after that his not-affected leg.
This are all exercises against the border of the R.M. and after 10 steps the muscle fatigue was great and an stop was necessary.
We did this 3 times on a day, 5 times in an week and of course the exercises (movement-transfers in, and in and out bed, chair , toilet etc.) on the ward were continuing 5 days an week. The amount of time that was necessary, was on the ward 20 minute and in the therapy room in total 25 minute thus each day 45 minute. That is not much, that means that still the greatest benefit for the recovery or compensation was obtain by the A.D.L. through the day on the ward by the nurses.

After 14 days there was an increase of extension in the knee but not enough to exercise without the back- splint but we lose the bandage and stimulate the knee extensor and make than 10 steps. Again an exercise on the maximal R.M. level , further his was capable to place his affected foot to the front by making an upper trunk sideways to clear the affected foot and by pushing the bench to the front.

But in this stage an volunteer is often necessary to ride and control the bench. Pushing the bench gives an stimulation of the front diagonal starting on the not-affected side and that can increase the tone of the stomach and make it able for the hip flexor to react. But start than with the not-affected leg, make with that leg an step forward and push the bench to the front, now we create an elongation in the hip flexor and an increase of tone and the hip flexor need little effort to place the leg to the front with an upper trunk sideways because the leg is in extension through the back- splint. When the affected leg is on the ground ask again for an pressure –an support- that will active the back diagonal and will give an movement over the hip joint thus an m. gluteus action.



Picture 6 and 7.
Pushing and lifting the affected leg and with pressure on the bench and created an contraction in the affected leg in the stand phase.

Pushing and swing the affected leg to the front and pushing with pressure and make an step with the not-affected leg. Pushing gives in the not-affected leg an flexion in the knee, there we can see that the patient push the bench away and activated both diagonals.

After 3 months the behind splint was not necessary anymore and was the extension in the leg enough to hold the weight of the body with support on the not-affected arm. Thus the back diagonal must have an fixation on the two endpoints. That means that his homolateral structure is only exercise when he walks sideways thus this must be trained –Task-specific – and also in side lying exercises on the bed and the bench. Now we can give resistance on the not-affected leg to increase the muscles of the affected leg in their stabilizing function and that can exercises with an 75% R.M. 10 rehearsal, 3 times an day 2-3 times an week every time till we have muscle fatigue.

Shoulder pain.

In this period the pain complains in the shoulder was decreased. The subluxation was the same but the shoulder blade has more mobility and the tone decreased faster after he has done his walking exercise. Furthermore every time he has work on his walking ability the retraction of

the shoulder blade was inhibited and the protraction was stimulated by support training in sitting position. The influence especially of the back diagonal starting in the not-affected leg is very great. Not only is he active in stand phase on the not-affected leg , but also has he great influence on the swing phase of the affected leg. To get that leg to the front he will use upper trunk movements sideway and lift the affected leg from the floor (Circumduction movement). But there are other technique to get the affected leg to the front ; - shifting the pelvis to the back with the not-affected leg and created an swing in the affected leg or – turning on his not-affected in endorotation and that create and swing in the affected leg or- an combination of all three. But this gives so much tension in the last part of the back diagonal that the upper trunk on the affected side stand continue in an retraction stand with an increase of tone in an flexor synergy and by associated reaction. Often is the affected arm in an sling but there is an negative aspect on wearing an sling. When people are exercise the balance and walking, the burden of the arm must be carried through upper part of the back diagonal on the affected side. We see often patient walk with the trunk in flexion (upper trunk forward) but that is an eccentric contraction of the back diagonal upper part affected side. The retraction will still there and the humeral joint is not align and can sub luxate and by movement of the shoulder the structures between head and cave can be impressed. When after the walking no relaxation is possible than will the tone further increase and make things worse and will give shoulder complains and pain.

Photo 4,5 and 6.
This are sling but on the photo are no individuals with an stroke. How we see that ? They all stand symmetrical and that will the individual with an stroke never perform so nice. This slings were designed to get support for an atone arm and inhibition of the subluxation but and especially photo 6 will be an disaster to wear and will push the stroke patient to shortening the neck and spine on the not-affected side and will created an greater subluxation in the humeral joint through the amount of abduction in shoulder.

Wearing an sling is of course an possibility but after the exercises (walking or balance) that will always create more tone in the upper part of the back diagonal on the affected side, there must be inhibition and stimulation of the arm in support training.
Further the upper trunk must able to relaxed in sitting position and that can only by remove the sling and lay the arm on an pillow in front of him. By the exercises with the “bench walking “ the arm where put on the bench and when that was not possible in front of the bench.

Chair.

The treatment behind the bench was now leave and replaced with walking behind a chair but often there was the question to walk with an 4-leg stick. When it was possible we don’t used the 4-leg stick because the diagonal from the affected leg had an bad angle that was much

bigger than with an chair. On the ward was standing up with an chair common and walking and especially walking sideways, back ways and turning where practice with an chair and mostly nobody ask for an 4 leg stick, only when people go home in the weekend that there were some individuals that needed that stick to move safely at home.

Photo 7 and 8.
Walking with an chair.
This pictures are taking on the end of the rehabilitation-period, walking with an chair seems so easy but ask power to push the chair to the front . In the beginning he pushed the chair and then used him as an support.
Support as he stand on his affected leg and the push to get the affected leg to the front.
That means that he had than not the power to do and the pushing and the walking together.
That gives an moment, that ask for more than 100% 1 R.M. and by helping him with pushing the chair and facilitation /stimulation of the tone in the affected leg, we create an 75% R.M. situation and we get an muscle fatigue and an improvement of coordination and muscle power .

Photo 7. Swing phase.
He push the chair away and on the same time he swing his foot to the front. Because he push the chair the tone in the front diagonal will increase and makes it easy for the hip flexor to make his action. Furthermore he makes an little upper trunk sideways and lift the pelvis on the not-affected side and make it so easy to free the affected foot.

Photo 8. Stand phase and the loading moment.
There is an increase in weight on the affected leg but still there is weight on the not-affected arm, the trunk is flexed and the muscle of the back and buttock are in an elongation position. But still there is an lot of weight on the not-affected leg and we see that there is still an moment of seeking. That means, that the perception is still an problem and that he increase the weight slower because he is still not total sure that the affected leg hold it. The homolateral structure of the affected leg isn't working optimal and he has no control about this situation. Furthermore observe the shoulder on the affected side and we see that the retraction is increasing.

Photo 9. End of the stand-phase.
His weight is back on his not-affected leg but we can see what the affected leg has performed.
On photo 8 we see that the pelvis is horizontal and that is on photo 9 almost equal but that pelvis was dropped when the not-affected foot was in the air. The homolateral structure is poor. And we see that his not-affected foot isn't far to the front and the affected hip is still standing in the same position. There is no active hip extension that created an big step of the not-affected leg

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There is also an slight difference of the exorotation of the affected hip and that comes through the hypermobility of the affected hip.

What is the great difference with the 4-leg stick.

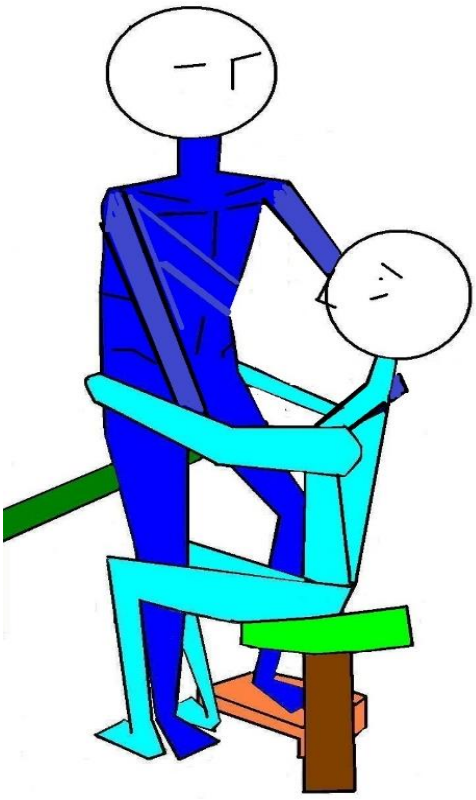
Photo 10.
An lady with an stroke on the right side.
She is walking with an 4-leg cane. Using that cane can only when you lean on him with the 4 legs equal on the ground.
That means that you must come with the not-affected arm exactly on top of the stich.
She do this with here elbow moving sideways.
She is feeling or her affected leg will hold the weight, that means that the movement is slowing down, exactly the same as with the chair (photo 8) **Perception problem.**
But she has her weight still on the not-affected side. Now you can see that the homolateral structure will be not capable to hold the pelvis in the right position.
That because the 4-leg stick makes it impossible to decrease the angle of the back diagonal and therefore goes the diagonal through the adductors and never through the abductors .
That will be never be possible when an individual support his body on an 4-leg stick.
The affected arm ? Is this extension synergy of flexion synergy? You cannot feel it, but it is an flexion synergy with much retraction in scapula and therefore an wrong alignment between head and cave of here shoulder.

Observe the fingers and thumb around the grip of the cane! This we see when individuals after stroke try to use the cane to pull their body over the affected hip. But with an 4-stick cane this is far more difficult than with an normal cane.

What will happen when this patient learn to walk with this cane ? And on many places in the world this stick is the only support that many stroke patient receive. That means an lot of repetition without variation. Bad for the brains they must search for solutions! And the abductor will be never used, therefore no restoration of the homolateral structure.
When walking with an chair is possible and goes in the ADL program, than it is on the time to get further strengthening of the paretic leg. Because so walking is now less than 70% R.M. and the individual is capable with the not-affected arm and leg to keep that R.M. so low as possible, because that will walk the best. Thus we must create more coordination and power in the affected leg to get this leg stronger and the program must increase and with more variation by walk faster with the chair or with another support and with more load- resistance until with no cane but with facilitation.

Task specific resistance Treatment .

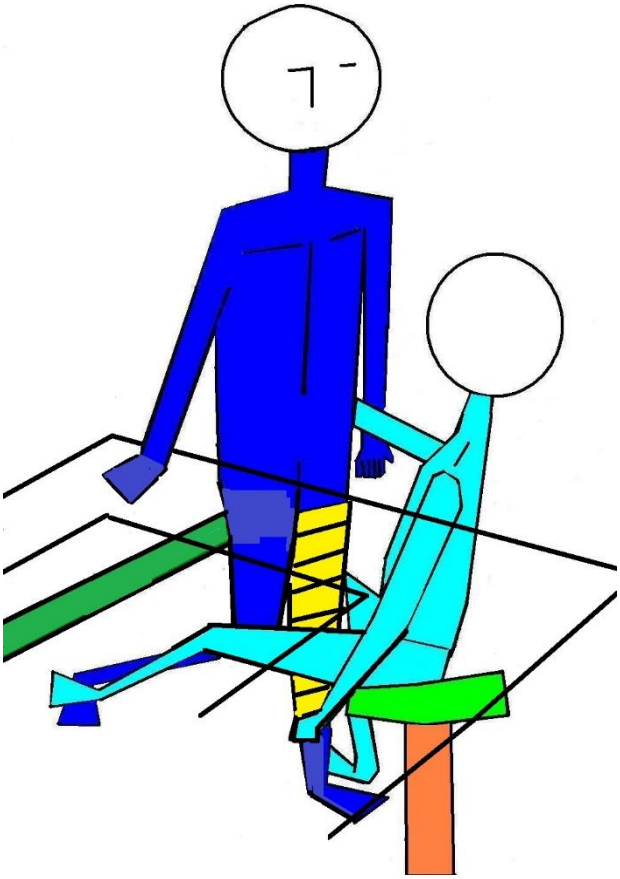
That means that we must exercise with resistance that part of the walking phase that need more coordination and power (power = Strength × speed). In this case that is active concentric hip extension in the standing phase. Therefore it is necessary, that he learn to stand on the affected leg and when that is possible we can give this movement resistance. Therefore we will start with lifting the not-affected leg and put this on an small bench and that will in the beginning about 100% R.M. but it is often an very small moment with little muscle activity. It is than almost 100% R.M. but when the not-affected foot is standing up the bench almost all muscle activity is gone in the affected leg.



Picture 8.
Start with lifting the not-affected leg on an small bench.
Be aware how difficult this is and ask of the patient will support himself by his not-affected hand on your shoulder, than you feel also how much support he used to get the job done.
Further will the patient try to get the weight of his body on his not - affected leg and sometimes the patient will “extend” his not-affected leg (he try to get his weight on the not-affected leg) and evoke an cross extension –flexion reaction.
Then will the extension in the affected leg suddenly disappear and when he started, the individual with an severe stroke will not be capable to stop that reaction and an total collapse will occur .
Therefore this appearances of this static reaction give us the sign that this is to heavy, maybe to early or you must fixated the affected leg that the extension in the not-affected leg isn’t necessary.
Therefore work in this stage with an back splint .

When this is possible , we know now how much the patient support and we can now exercise in the diagonal (chair or table picture 9) and create an better – longer- stand phase but also an stand phase that isn't only stabilization but also an movement. Photo 9 shows that the not-affected leg cannot go so far to the front because the affected hip is only capable to give some stabilization, no concentric extension in this joint that makes the step of the not-affected leg greater.

This exercise will give not only an increase in power but also in coordination and that is the important part of the perception that gives information through the muscle –spindle. Therefore the next step must be pushing away the small bench to the front , back or to the side (homolateral structure). Then will the affected leg be do more than only stabilization, but be sure that you know what exactly 100% R.M. and then you can calculated how many times , how many repetition and how many times in an week .



Picture 9.
Exercise the weight bearing and task specific resistance treatment with the affected leg in an back splint.
In this case no standing up exercise on an small bench but an resistance against the not-affected leg.
The direction of the resistance is very great. In this case to the front –straight- but it can also with endorotation /exorotation /adduction and abduction or an combination even from the front to the back is possible. But every time the affected leg must build up the best stabilisation and also help the movement of the not-affected leg to the end spot. An great step ask from the affected leg more hip extension to get the not-affected so far to the front.
In this case the not-affected arm support on an table and is there the possibility that the back-diagonal angle is to large (more than 45 degrees) . Than try to correct with your legs the stand of the affected leg or increase the height of the table.

When I started 20 years ago to gives this task-specific resistance treatment, was told to me that is was impossible. Change an eccentric or maybe only an stretch reaction of an muscle (the buttock muscle) in an concentric contraction, because the eccentric contraction lies lower in the Brain than an concentric contraction (according to Dr. Lieber 1990).
But I got an concentric contraction by almost every individual after an stroke, an individual that was able to lift his not-affected leg and most individuals create an walking pattern in which the not –affected leg passed the affected leg and increase step length and speed.
Still are there people that don't believe that this is possible by stroke patients.

And what Dr. Lieber said , isn't true at all. Eccentric control ask more from the brain (nerve system) than concentric but not in an direct way to the muscle contraction but in controlling the contraction eccentric and concentric.
This task; controlling the concentric contraction is very important and ask an lot of the brain and the other nerve system on spinal cord and motor unit level .
And despite the damage in the brain this coordination is still possible and can be evoked in the brain and therefore in the muscle again.
But it ask that this is used by the individual in his way of walking or moving.
Figure 5 gives an image what happen on motor unit level , spinal cord and brain between eccentric and concentric muscle activity.

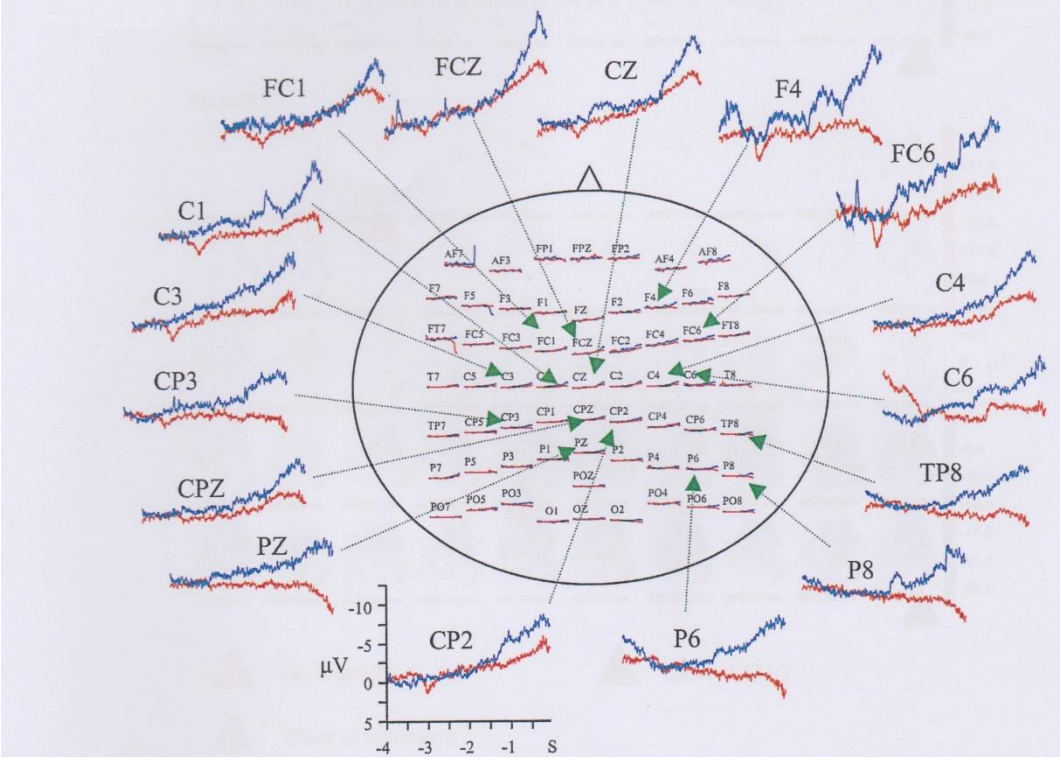


Figure 5.
Concentric is red and eccentric are blue action in the nerve system.

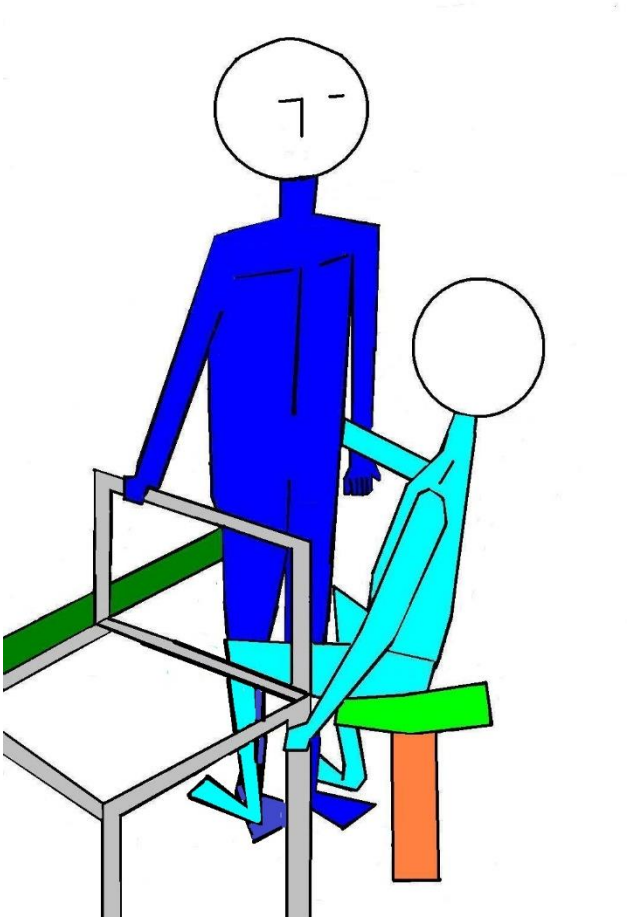
The action of the buttock muscle to make more stability and on the same time more movement in and over the hip is to train through an task specific resistance treatment, in which the not-affected leg must be placed further to the front against resistance.
And the reaction in the buttock can be feel and convinced us that this is an concentric contraction.
This can also when the individual is walking by giving the swing of the not-affected leg an load !




Photo 11, 12, 13 and 14 .
Task-specific resistance treatment.
First, we must know how many resistance there must be to get no movement from the not-affected leg (swing phase from back to the front. That is 100% R.M. for the **affected leg** in the stand phase. Decreasing the resistance to 75% R.M., we make the movement possible. This is than an stabilization but also an movement in the hip joint almost to the end of the hip extension.
We can create muscle fatigue with an proper rehearsal and frequency and will created an increase in coordination and power of the muscle pattern.
And feel the buttock, because this is the weaker part of the back diagonal. That part must work otherwise the hip goes to the back and that means an hip flexion. And we want to see an hip movement to the front because that is an hip extension movement.

Photo 11 : The measurement of 100% R.M. , you see the reaction of the affected leg there is flexion in knee and hip. More is not possible.
Now 75 % (photo 12) and now the extension of the hip is there, an concentric contraction of the whole back diagonal with in the center the M. Gluteus Maximus.
Photo 13 and 14 gives the movement two times behind each other, never is the movement exactly the same and that means variation and fatigue is also an variation !
When we see the movement of his not-affected leg and affected arm, it is obvious that are some possibilities in that arm. This looks still an flexion synergy but the front diagonal from the not-affected leg to the affected arm/shoulder build up the tone an created an protraction in scapula but an increase of tone in the arm /and elbow. That isn't an flexion synergy- sec- because there are dissociations of the synergy. There is protraction and action in the upper part of the front diagonal in the upper trunk. In the shoulder is anteflexion with abduction, but anteflexion is part of the extension synergy and therefore the remark that in this arm /shoulder more is possible. What is possible in the hand, is another story because that is dependent from the present of the cortico spinal track. There are three important aspect that we must see and control to get this movement in the affected hip joint also in the walking performance later on.

1. There is often no push-off and that isn't necessary but the push off has also an function in bending the leg in the beginning of the swing phase, that means that this part will not occur when this push-off isn't there.
2. The foot must be stable. An movement over the hip is only possible when the foot is carried the weight without loss of stability. When that occur, stop the movement over the hip . And this movement will also stopped when there is an restriction in the ankle or to many tone in the calf muscle, that ask for adjustments.
3. The movement in the hip has often need for an fixed point and everybody thinks on the affected foot but there is often less perception and therefore it is maybe better to give this "perception" to the not-affected arm and that ask often for an point from the arm/hand to the floor. On the photo we use, to learn this, an chair but other aid are possible to create the back diagonal starting in the not-affected arm/hand. The amount of force must lead that the movement and stability are both there. That asked for an co-contraction with movement in and over the hip and that we see on photo 13 and 14.



Picture 10.
An example of an exercise task-specific for the homolateral structure around the affected hip.
Be aware that this is very heavy and the patient will not have much power and will thus search for an compensation to "win" from the therapist !!
The foot must be held straight forward , no rotation may occur in the hip especially exorotation will immediately lower the pelvis on the other side.
By holding the not-affected foot straight to the front there will be an lift of the pelvis on the not-affected side and when the upper trunk stays in the same position, we have an co-contraction that involves the whole homolateral structure including the front and back diagonal on the affected side.
The keypoint hip is stable and moving !
Look to the photo 13 and 14.
There we see that part of the pelvis goes up and there is an elongation of the trunk on the affected side, thus there is an co-contraction and movement

Task-specific resistance treatment alone is never enough. There must be an variation with all kinds of walk pattern exercise and selective exercises with and without load, to get the brain stimulated to search for solution and that solution can again an task-specific exercise .

In the corridor using the railing there.

Starting with walking along an railing in the corridor and then not only an support but an pulling movement when he is standing on his affected leg and by pulling and swinging the not-affected leg so far as possible to the front with or without load can be an very good start.
Other examples are following in the next part about the diagonals and walking .

Co-contraction.

R. M. of 100% is determined by the co-contraction, that occur in the affected hip. And that asked for re-assessment every time to get the right amount of resistance or load to create an increasing of the power and coordination.
Resistance asked for an progression in resistance according the performance of the individual. An important aspect in rehabilitation to get an increase. Still there must be also and learning aspect and that is only be possible by much variation and rehearsal – Rehearsal through variation Differential learning (Prof.W. Schöllhorn)

Photo 15 and 16.
Look to the white line and the movement of the upper trunk. Is that correct than we have an perfect task-specific resistance exercise. But variation is very important therefore work on other forms of stability and dynamic of the affected leg and make from that, when it is possible, a task-specific resistance exercise !

Variation of movement over the affected hip.

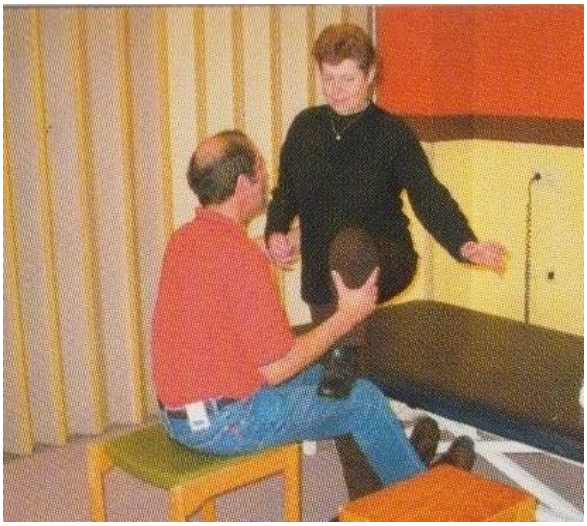


Photo 17 till 21. Variations with the not-affected leg to get active rotation in the affected leg. Photo 17 gives the picture with the affected leg on the knee of the therapist but this was an exercise in which the individual must change every time with his leg. On the photo stand now the affected leg and the next step is the not-affected leg on the other leg of the therapist. In this example with no load or resistance. Al the other example are without load but all are possible with load or resistance and resistance is very easy because the hand that now gives assistance , can also give resistance.

When you facilitated that means that this is difficult without an little and good assistance, than you create through the assistance an movement with less than 100% R.M. The next step , before resistance , can be more speed. Than the R.M. will increase and at the end this can be an resistance treatment , task specific , and there is also the possibility to use the speed again but then with resistance or load.
The variation is endless and that will stimulates the brain in his search for solution, on this 4 photo's (15.16.17.18) there you see exercises for balance but also for rotation in the affected hip and the step to do exercises on the stair are simple because going up and down the stair is easy in comparing with the exercises on the photos.
Photo 18 this lady was capable to place the not-affected foot on my right upper leg, but now she must try to put that leg on the bench and then in one time on my left knee with little resistance . **Active Rotation training of the not-affected hip.**

In the guideline Stroke we find task-specific exercise but often this is an exercise in the task or context or an combination.

That means that learning is the goal, not an increase of coordination and power. Investigation of the combination task-specific resistance therapy and differential learning is still very poor.

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Walking – differences- training

Walk forward with increasing speed , backward and sideways , first with no crossing but then with crossing. Walk with different support tools that will increase the variation and stimulated the brain. Take the stairs and go outside in the park but also in the city. Now we can train in endurance and make his walking abilities greater and every time we have an new movement, that we can make in an task-specific resistance treatment.

Photo 22 and 23.
Crossing the not-affected leg over the affected leg.
Be aware that there must be an active elongation of the homolateral structure of the affected side, otherwise the not-affected leg cannot cross, but goes to the other side . When the weight is on the not-affected leg (Photo 23) now shortening on that side and we have an abduction – an kicking away movement and can create an good, firm support area.
Facilitation is done in the centre of the front and back diagonal.
Learning technique and search for variation and possibilities to increase the load or speed or both.

The achievement of this man is remarkable**,** certainly when you know his age – 90 years old **!**
Learning walking starting with an behind splint and an bandage around his foot behind an bench. First walking sideways and then backwards and then forward along the bench, after that pushing the bench and so create more power in his diagonals.
Than the moment that the behind splint was not necessary anymore, the exercise to create more power and coordination in the paretic leg and learn to walk behind an chair and this also in the A.D.L.
Walking behind an chair was replaced with walking behind an frame rollator with an cross rod, so he can managed him with one hand and at the end walking with normal cane and even with an nordic walking cane.
But without support was possible but makes his walking pattern stay poor.

He had extension in his affected leg, he was able to stretch his knee and even had an little push-off but that had no use because his was not able to endorotated his hip when the hip goes in extension. With an support he can compensated but without not.

Photo 24. See below.
Crossing the affected leg over the not-affected leg and take weight on the leg and that need an elongation of the not-affected side and after that the kicking away movement with an shortening of the trunk on the affected side .
Photo 25. Stand in the push-off phase with the not-affected foot in the front on the heel. The therapist hold his weight on the paretic limb and ask the patient to push his heel up. That he can but only one time the first time. That means with assistance an R.M. exercise of 100% , with an little bit more weight on the leg in front now we have 75% R.M.
But be aware that the strength that he can create in his not-affected leg in this position of the foot is very great.
Therefore it is important that you feel that the extension in the hip is increasing and that the heel of the affected foot is from the floor.
When this occur than the knee will always hold his light amount of flexion. And that is important part of the function of the m. gastronemicus in the push-off phase of normal speed walking.

Photo 26.
He tried to make the step so big as possible without an support but much further as this he can't.
You see that he is also landed on his fore foot instead of his heel.
Further there is decline of the pelvis and an rotation of the hip backward and an upper trunk sideways. And the affected foot stand firm on the floor in exorotation.
The extension in combination with and endorotation wasn't possible.
The reason for this has two reason; The first lies in the hip and the second in the impossibility of an transfer of his weight to the fore foot on the affected side.

When we give him an chair and he push that chair throw the department , he was faster, the chair stop never and the step are better but the heel stand still firm on the floor and the heel don't get free of the floor.
That means that that the extension of the hip can go on because there wasn't the possibility to get the heel more to the outside by endorotation of the hip.
The reason of this problem lay in the first day of his hospital stay after the stroke, maybe all in the first day and that occur by the loss of tone and the extreme exorotation that occur in that first days.
That will give an stretch on paretic muscles that have no "connection" with the damage brain but apparently also little with other lower nerve system because the leg was after hours of lying on the back not changes from position.
Individuals after an stroke can therefore suffer from an loss on muscle power in the endorotator of the hip through the forced elongation and loss of sarcomeres.
To restore that we must be able to get :

1. Power and tone back in the muscle group.
2. But also it is necessary that the muscle is contracted for more than 12 hours (Tardieu) to get sarcomeres out of the muscle and create the original length.

It is clear that this is an task that cannot be done.
Till now it is never succeed to create an situation that sarcomeres are removed out. The only success that we achieved, was that the movement exorotation in the hip wasn't so far and wasn't so light .
Far, often the exorotation in the hip was 10-15° more than the other side and
Light , there was no resistance against this movement and often its hurt on the end of the movement and when we test this on the not-affected side there was an normal resistance and no pain.
Light , the resistance was an little bit increase but still far below the level of the not-affected leg.

Photo 27.
An photo out the article about the occurrence of the striker foot.
This attitude of the affected leg for several hours (Tardieu say more than 12 hour) can created an muscle elongation through placing in of several sarcomeres.
That means that active endorotation is almost impossible and normal extension/endorotation in walking in this hip cannot occur. And the border of the movement in the hip has no protection.

Photo 28 .
Now in action with the chair, no pelvis drop and also lesser upper trunk sideways.
All possible through the compensation of an chair in front of him, compensation for the balance but also an fast point for his not-affected arm to create an base for the diagonals.
On the front for the swing of the affected leg and for the back diagonal for the stand phase .
But the whole hip extension was not possible because of lack of power in the calf muscle and lack of power in the endo rotators in the affected hip. Despite the increasing of the coordination and power in the muscles of the knee and ankle, the hip remain the weakest point.

With an chair he was faster and the hip was stable and the step of the not-affected leg was increased but still not with the full extension over the affected hip. And the reason is, that the transferring of the weight to the fore foot is too little and that means that there isn't no endorotation in the affected hip to give more extension in the hip.

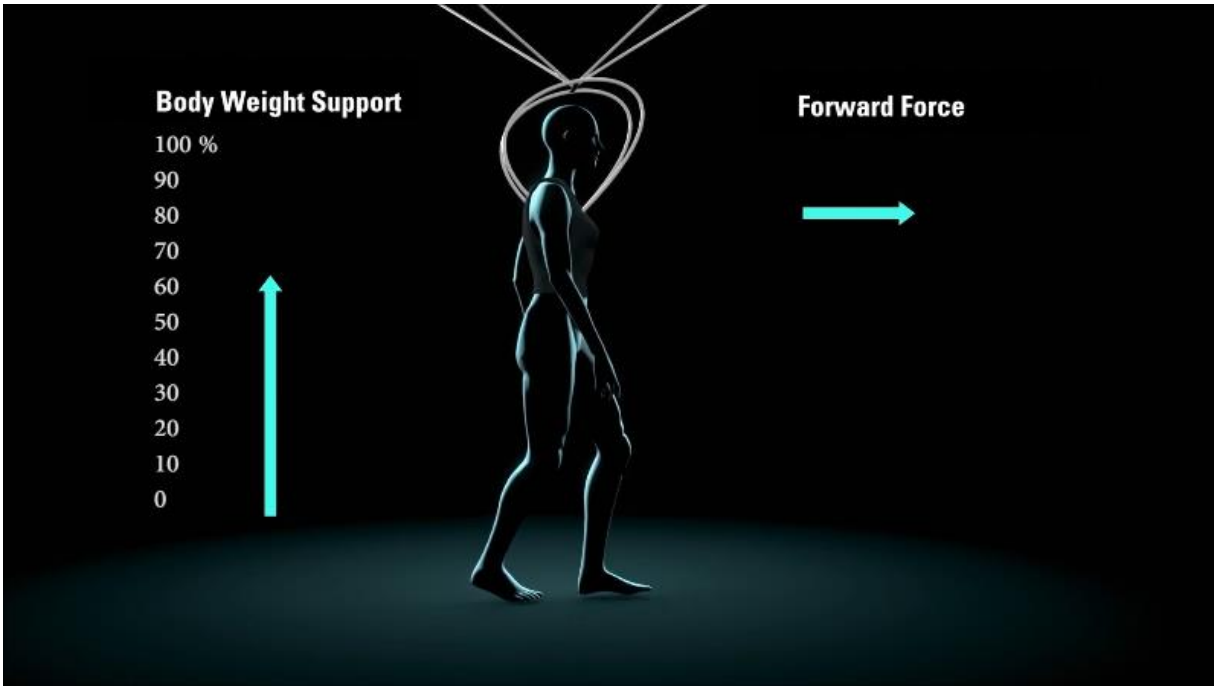
The whole chain of care for individuals with an stroke must be alert on all this parts, that can make recovery very difficult, maybe impossible.
And it is so important that the people working on different places in an Brain (Stroke) - Chain talk with each other to prevent this increased exorotation, because it will affect the outcome of the rehabilitation!

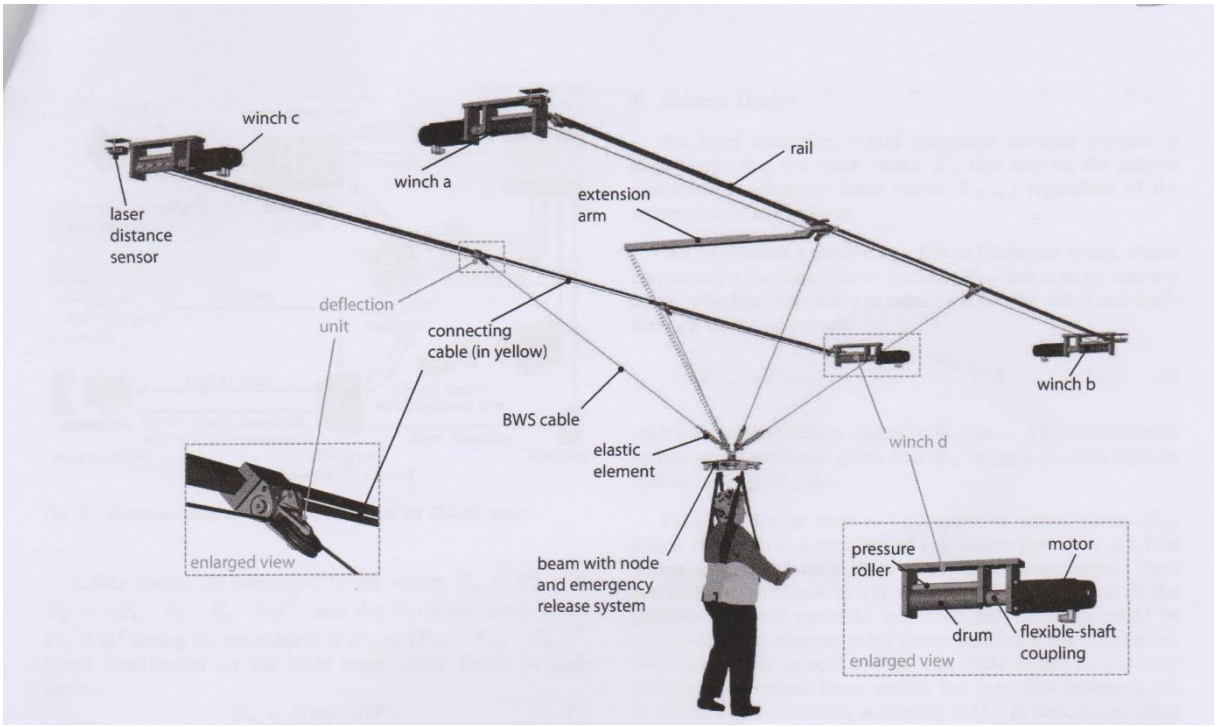
New developments and "old" treatment possibilities in an new Jacket to stimulated the diagonals. New developments to teach people after an stroke to walk again and scientific research gives signals that walking with the Lokomat or with treadmill with an support that preventing from falling but also lift the body has not that effect she taught .
But there is now an new design that will cope with the limitations of that apparatus and makes walking an challenge that will push the individual to his limits and we teach him how to hold balance and how to walk in all different directions.
And the exercises will have the right intensity, is task specific with an very great variation. Variation in all direction but also walking with obstacles and even stair climbing is possible. That will give the individuals the opportunity to exercise much often and created every time new situations.
And the combination with task-specific resistance therapy is easy and we can exercise on that two pillars ;

- Differential motoric learning ,: rehearsal with variation
- Task specific resistance therapy ! Creating more power and coordination.

Photo 29.
To see the difference between the old and the new approach.
Here first an photo of an individual with an partial spinal cord damage .
He is capable to walk with two crutch and he use his crutch as an part of his diagonals. But he need this two crutch also to stabilized his posture and get control over his balance.
Too much control is needed through the arms/crutch for balance, makes it very difficult to restore the diagonal impact on the propulsion and the speed of walking. The walking pattern and speed isn't now the first priority, balance is.
That means that the crutch must stand wide and you see on the photo that the right arm with the crutch stand far from the left foot and almost on toe level. The back diagonal activity can therefore not start in the arm by moving the crutch to the back and can therefore give no activation of the back diagonal to get an propulsion.
Therefore the whole back diagonal will put the joints on the end and we see an extension knee, elongation hip extension and an little retroflexion in the shoulder.
The angle in the back diagonal will be greater than 45° and that means that the contribution of the homolateral structure around the left hip isn't working .
In photo 34- till 37 we see the same person walking in an new system and now the arms have an great contribution in the walking performance, speed and balance all together.

Figure 5 and 6
Gives an picture how the support is established.
There is an connection with the sealing that can lower the body weight and give the certainty that falling is impossible. That means that the person can exercises on the borders of his capacity and when he makes an mistake that will this system preventing from falling on the floor but he will experience the fall and the mistake !!
But there is also an system that helps with forward movement and that will help the individual to hold his upper trunk in an slight flexion.
This is also very important for backward walking and sideways walking.
Stair climbing and obstacle avoiding . (Jean Baptiste Mignardot)





Backward walking ask for the possibility to place the free leg to the back and then it is important that there is an slight flexion of the upper trunk especially by individuals with stroke because there selectivity is less in the affected leg and this leg will react faster on an wrong trunk attitude.
Sideways is also the slight upper trunk important because than is the crossing of the leg in the front easier.
Obstacle avoiding need the eyes and again is than an slight flexion important .
Stair climbing is an trunk flexion very important to get the body weight good on the leg that stand an step higher. Only downstairs the trunk must be erect and still eyes must can see where the next step is but never with an lower trunk to the back because than there is to many weight behind the feet that carried the weight.

Another great advantage is that the feet stand on the ground and that the hip with the feet must “push” the ground away to get walking possible.
This in contradiction with the Lokomat, Treadmill, Grail , CAREN where the floor is moving and forced the individual to follow.
Now the floor is an balance point as at home or elsewhere and to get walking the body must push the ground away. And this can be done with aids but also without. We can also train individuals with an cane to stimulated the back diagonal starting in the arms or we ask to swing the arms to the back to stimulated the back diagonal and make the movement over the hip better.
The same is possible for the swing phase of the leg faster to the front by an early arm swing.

More swing of the not-affected arm will stimulated the affected leg in the stand – and swing phase !! Photo below:
Compare the two photos than it is obvious that the swing of the arm and the movement over the affected hip is almost symmetrical and that this is also the case with the affected arm and not-affected leg (swing not-affected leg) but the difference with swing of the not-affected arm and the swing of the affected leg is very asymmetrical.
Still the movement of the not-affected arm when the affected leg stay within the stand phase is also asymmetrical because at the end of the swing phase of the affected leg start the not-affected hand immediately with the movement to the back.
He start than with the stand phase with an the start point that is far away and the arm start first and that means that the back diagonal is brought on tone through the wide of the swing to the front and the return with more speed to the back. That the not-affected arm is more in abduction is an control over his balance and his trunk stability that is lesser on the affected side.

Photo 30 and 31.
On photo 30 this person with an hemiplegic side on the right side has his left arm/hand far in the front but his affected leg is still not passing his not-affected foot. This swing of the not-affected arm increase the length of the front diagonal and help him to create an greater swing with his affected leg.
In this case the arm swing increase the tone and muscle power of the front diagonal to the affected leg.
On photo 31 we see the not- affected arm goes far to the back and create so an higher tone in the whole back diagonal to get an good movement over the affected leg .

Photo 32 and 33
Photo 32 the affected foot is on the floor but with little load but his not-affected arm is on the way back.
Photo 33 he is standing on his affected leg in almost mid stance and the not-affected arm is not so far but his speed of movement is higher because at the end of stand phase this arm (photo 31) is far to the back almost symmetrical with the movement of the affected leg.

Therefore is it important to look of an new apparatus give people with an stroke the possibility to use this movement control .
Not the leg movement will create the swing of the arm , but arm swing (to the front and back) makes it possible to improve the walking pattern and the speed/ stability!!

Photo 34.
Gives an impression from the search that people make to combined the search to balance and the power of the arm to get more control over the swing - and stand phase of the affected leg. Searching for an combination that makes walking under their own control possible. And here we see that this is possible in this new apparatus.

Photo 35 and 36.
We see progression , on photo 34 was the movement of the upper trunk to the front to big and ended in hanging in the harness. We see that both arm go to the front an indication that his is out of balance and makes an attempt to brace the fall with his arms.
But after an while the position changed and now we see still wide arms but the arm are moving to the front and back in the opposite way and he has discovery the possibility to create an better an stable walking pattern by using the diagonals but now initiated from the arms.
Look at the difference with the walking with the crutch;
More flexion in the knee, that means more dynamic and using of freedom degrees to get more speed .
The heel of left foot is of the floor and he use active extension in his hip right.
The swing of the left arm (photo 36) is on the front but is making an movement to back to get the hip movement over his right leg.
He use the arms as an propeller to stimulated the diagonals and is also searching for the balance situation.

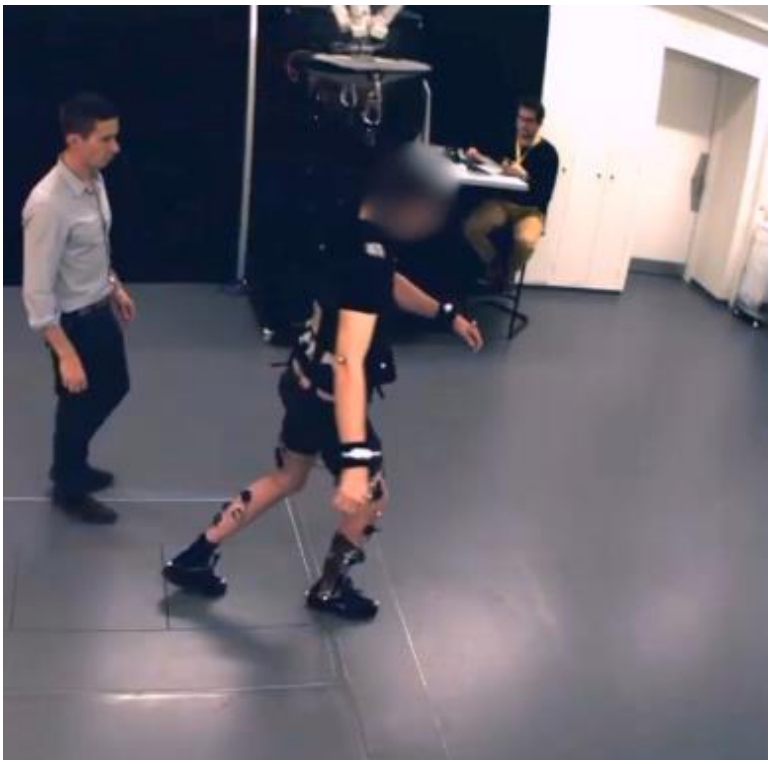


Photo 37.
On this photo we see the contribution of the arm better.
The left arm is still in the front but he stand on his right leg and that looks like mid stance. That isn't so because his hip is behind his heel and that means that there is still weight on the other leg. The opposite arm is still back and wide. The stabilisation on the right leg isn't complete.
Now will the left arm goes with an higher speed to the back and push the hip-extensor to an higher tone and the person will move over the hip.

This is rehabilitation of the highest form, because here the individual can search within his possibilities for the best way to deal with balance and walking activities and that walking activities can be varied endless.

That is motoric learning and we can give an task specific resistance treatment to increase the power and the coordination but this learn us also that we must do something with the power of the arm, especially by the individual with an stroke .
When we give the not-affected arm an rigid point that this individual will use that point to control all movement or diagonals. When that is an fixed point, this is good when he is standing and search for balance in standing position but….. not for balance and movement /walking.
Even when the floor is moving but the not-affected arm/hand is still an fixed point the individual isn't learning to search for balance and walking within his capacities.
He is learning how to perform on the Lokomat or Treadmill !
At the moment that he use his arms – his total body – to control the balance and walking , than we have achieve where he is searching for.
Therefore this apparatus makes more possible!
But is this the only way possibility ?
NO !!!
The cane /Nordic walker / railing in the corridor can be used to increase the diagonals and makes walking and balance better possible and …. with variation - rehearsal - therefore learning and training.
But individuals with an severe stroke will need an fixed point because the balance is to weak ?
Yes and No !
Yes , there amount of freedom degrees in their body must be lower and mostly we give an support on the not-affected side but we can differ that support.

Not always an 4-point cane but an support of an chair, an bench that can be push away is something total different that the 4-point cane .
That cane(4 –point) can only be change to another position when we stand still. Then he can take support on this cane to place his feet to the front and then there must be an stop to change the 4-cane. With an chair or bench he can walk through without stopping every time !
An better possibility is to minimized the freedom possibilities in the affected leg. By giving an back splint for the affected knee and an splint to stabilized the foot .
That change the balance and the movement, but still there are possibilities to search FOR BALANCE AND WALKING with great variation and good rehearsal . Both learning and training is again possible.

In the next part we discuss other individual after an stroke to give explanation how to change something and created an learning and training environment.
But an last remark , this amazing apparatus on the ceiling and walking over the floor can also be done in an swimming pool when the water level is below thoracic 11.

Photo 38.
Control on the body but the arms are free. That means that he must search for the good balance and walking pattern in the diagonals. The hands-on approach makes it possible to facilitated the movement over the hip in the stand phase but can also give resistance.

Variation through rehearsal is endless because all different forms of walking and obstacle avoiding is possible and that means again an perfect learning environment and the possibility to give task specific resistance therapy.
Of course is it possible to place the hands on the edge of the pool but the balance is than done by the arms and not through the whole body to get the weight perfect on and over the feet.
And the search to the border of the balance is than immediately different as this is when he is walking without aids.
But near to the edge is always possible , here an example when he is trying to stand on one leg.

Photo 39.
Balance exercise standing on one leg. The environment is without danger for damage and the step to resistance is easy . Let the swing leg move faster and we have resistance in water or give resistance against the swing leg.

Photo 40.
An great moment ! He walks through the pool without assistance and his strategy was:
Hold his both hand to the back and move little with his shoulders and had now an good control over his balance and was able to walk in the turbulence of the therapist.
Control of the balance on total different way he did on land, because there he had an rollator frame that give him the stability and balance control.
His damage brain has find an solution !!

An further advance of the water was that the chorea- athetosis movement he had in his legs and arms were decreased by the resistance of the water, but when we lower the water level than he must deal with this movement especially in his arms.
There is still an lot of unbelieve that exercises in water are equal or better than exercises on land, still Dr. Tripp prove this by an investigation with individuals with stroke but beside this prove, this environment makes it possible to walk and exercise people for an long period without sitting and learn this people to search for solution.
The positive effect of water is that this is an environment that always changes and that makes it so easy to create variation. People with an severe stroke that can walk with an 4-leg cane or between the walking – bars can do that for short time. In water this people stand and walk for an half hour and the whole time the brain must find solutions.
Of course we use aids on land to create an environment that give this people freedom but learning and training has the purpose to create an even better walking pattern and an higher level of freedom.
That ask for training of the balance but also for more power and speed and endurance and that is this new apparatus or the swimming pool an perfect tool.
Too often is the walking performance almost equal with what the individual can and then there is no learning and no training aspect in that treatment.
Walking in an walking –bar is nice but the solution individuals after an stroke find in their arm especially what the balance in walking concerns and will lead to an form of walking with an

rollator frame . The level must be higher the whole body must search for an balance and walking control and then must the environment be so that the whole body can act .
Especially the diagonals are than very important and the most important part are the 4 keypoints .

Photo 41 and 42.
The same individual as in the swimming pool but now exercising in the walking –bar. Still he has only one hand on the bar when he is walking through the bar but when he must turn he use both.
The difference is great, he is now much more acting with thinking how he must perform and in water he is acting and reacting on the changes that occur.
Still he use his left arm to pull on the bar and make the movement over the hip by activating the back diagonal possible but the therapist must be aware that the angle is correct or so correct as possible and that the hip extensor is act. When that is minimal than resistance will give more perception, increasing the power and the coordination when this is done with the good structure and training impulse.
42. Sideways walking ask for an balance moment on one leg in which the other leg can go away and that is shortening of that side and on the photo this is correct done but he isn't capable to do this without an support when we only give this kind of exercises. Before that leg is setting sideway, this leg must be free and that asked of the other leg an elongation of the trunk and standing on one leg and after that the shortening can take place because the balance in going to the free leg.
Now the arm hold the trunk the whole time in an shortening position and he will not experience what it means elongation and free the other leg. Angle diagonal isn't 45°, therefore no right homolateral muscle performance.

Photo 43.
Another approach now the facilitation is done on hip level and that can be assistance but also resistance as facilitation. Again the arms are free and we see immediately that he lift his arms up and away.
He is search for balance in walking and set more power on the back diagonal in the upper body (photo 40).
Now he use his total pattern of the trunk (4 diagonals and 4 keypoints together) to control the balance in walking in this case forward.

My great teacher Jacques van der Meer said always;
“Walking will individuals after an stroke only learn through walking at his highest level !”
This remain true forever and every apparatus can give an contribution to restore the walking performance but be aware of the rules there are to get the highest level.
When we use the arms to control the balance than the legs and the trunk will learn little or nothing.
When we do always the same the brain has no stimulus and will not learn.
When we don’t have the right intensity , the power and coordination will not increase.
When we exercise isolated muscle the transfer to an better walking performance will be very late and sometimes not there.
When exercise only in one context , the individual will perform there on his best , but elsewhere ?

End of part 7. Part 8 will discuss other individuals after an stroke and their problems regarding walking and what is the best therapy.

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