

**Practical Considerations in
Selecting and Fitting
Wheelchair Positioning Belts and
Harnesses**

POSITIONING BELTS & HARNESSSES

Disclaimer:

This handout was originally written, in part, in response to requests for more detailed explanations of the purpose and application of positioning belts and harnesses, with explanations of the differences between the types and styles available and their uses. Although I have tried to address the subject with a general overview, this handout has been written by and for a manufacturer of such devices and naturally may reflect biases concerning the subject. This pamphlet is intended as an overview of the application of such devices; it cannot and should not serve as the primary source of knowledge for seating and positioning using belts and harnesses.

While this work is offered as a description of the concepts involved, when it comes to the practice of seating and positioning there is no substitute for experience and a good guide.

It is only possible to keep such a work current if those who have new and differing views share them. Although I am no longer with Bodypoint I do, on occasion, receive requests for this booklet. I always welcome recommendations about how to improve the material, and the corrections and updates that will inevitably be needed.

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July, 2003

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Where to Start?

No two people are completely alike. This becomes particularly apparent when fitting individual persons with seating systems. Recognizing each individual's needs, and selecting and adapting equipment to address those needs, requires experience and creativity. Therefore, as a practitioner involved in the selection and fitting of wheelchair seating systems, your most important tool is yourself. The more *you* know about the principles and the products involved, and the more you develop your own skills in observation, the easier it will be for you to find successful solutions to the problems you face.

This pamphlet is written for individuals who already have some level of education and experience regarding seating and positioning. With that in mind, let us begin with a concept so simple it is easy to overlook, and yet so fundamental to this work that we are doomed to fail if we skip over it:

*The proper use of anterior postural supports for wheelchair users is an **extension** of the seating system and can not succeed unless the fundamental seating system is providing optimum support.*

In other words, **always** start and finish with the seating system: seat, back, foot-rests, lateral supports and headrest. There are a number of works exploring the principles and practice of proper seating. This short work can only be a supplement to such works, yet it relies on a good understanding of the theory and application of those principles. In the midst of a seating assessment it can be easy to get so focused on one particular problem that we try to address the symptoms, instead of looking for the root problem: "She keeps sliding out of her chair, shouldn't we just add a belt to keep her in?" The belt might hold her in, but there may be other less restrictive solutions available simply by modifying or adjusting her seating system. Having a well adjusted system will also greatly improve the function of any anterior supports that may be used. Positioning belts and harnesses should only be seen as **secondary support surfaces** which assist the **primary support surfaces**-- the seat, back and foot supports.

Preliminaries:

PRIMARY SUPPORT SURFACES

Before considering new anterior supports, or when addressing problems with an existing belt or harness, reviewing several important aspects of adjusting the primary supports can reduce or sometimes even eliminate the need for secondary supports. If the primary supports are not well fitted to the individual, they will often prevent the secondary supports from working properly—e.g., if the seat cushion is too deep the pelvis will not be able to reach the back-insert for support, and adding a belt will only pull the pelvis into a posterior tilt! What follows here is a very brief review of some important aspects of the seating system and how they can result in poor posture.

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The Wheelchair

If the chair does not fit the person using it, it is likely to cause a number of complications. Sometimes it is easier to adjust or modify the chair, other times it is better to replace it.

- If the chair is too wide, lateral support and mobility become difficult. Can modifications be made to the cushion, arm-rests, or even wheels, to help compensate?
- If the chair is too short, front to back, it is difficult to provide good support or rolling stability. Can the back canes be moved or modified, or can the back be moved in relation to the canes? Can the location of the wheels be modified for better stability? Can the leg-rests or foot-rests be moved, modified or replaced so as to better support the legs?
- If the seat is too deep the person using it cannot sit all the way back, this promotes sacral sitting and a kyphotic posture. Can the back be moved forward, or the cushion be shortened or moved in relation to the back?

The Base of Support: Cushions

Since the pelvis is the key to positioning, problems with the seat and back can make dramatic differences in postural stability and function.

- If the seating surface is not stable, the pelvis resting on it cannot be stable. Does the cushion move around on the insert? **How stable is the support provided by the cushion?**
- If the cushion does not fit it can cause problems. Is the cushion too short to provide a good support surface? Is it so long that it prevents the back of the pelvis from being supported by the back insert?
- The material and the contours of the cushion will affect the stability of the person sitting on it. Has the nature of the cushion been considered as a possible source of problems? Can the cushion be modified to help? Are there other types of cushion which could be tried?
- Supporting the spine is vital to good posture for long term sitting. Does the angle between the seat and back properly balance the needs of support and function? Are the height and the shape of the back insert appropriate for the needs of the person using it? Would contouring of the back insert or lateral pads provide the needed support?

Legs, Legs, Legs

The upper body and lower body are balanced on the pelvis; if the legs are not supported the torso and head will be directly affected!

- If foot-rests are not adjusted properly the legs can pull the pelvis out of alignment. Are the leg-rests so short that the thighs are lifted off of the cushion? Are the leg-rests so long that the weight of the leg is pulling the pelvis forward?
- If there are no leg-rests the floor serves as the leg support and the same questions apply. Is the chair so high that the legs are unsupported and pulling the pelvis forward?
- The angle of the legs affects the direction of push/pull from muscle movement. Will changing the angle of the leg-rests improve the effect of leg movement on posture?
- Tight hamstrings can pull the pelvis forward and out of position if the leg-rests do not accommodate the available range of motion. Does the client have a range of motion at the knee

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joint which is greater than the angle of the leg-rests? If not, can the leg-rests or foot-rests be modified or replaced to allow the system to accommodate the user?

The Setting

No matter how perfectly the equipment works during the fitting, it might still be inappropriate due to the daily environment where it will be used.

- If the equipment is not being used properly it cannot function properly. Are all of the parts of the chair attached and in use as intended? Will they stay that way?
- If the caregivers are not well trained it is unlikely the system will be used properly. What can be done to help train staff, parents and other caregivers? Are there alternatives to components of the system which are simpler to use and which perform as well?
- The more those in and around the wheelchair understand its parts and their proper use the better the odds of success. Are there individuals who could be trained as assistant seating specialists? Are there other ways in which to help motivate the person in the chair and those around to participate in its proper use?

SECONDARY SUPPORT SURFACES

To take a simple view, let us consider the skeleton as the structural foundation of the body, with natural movement resulting from muscles pulling on skeletal components, or from gravity pulling on unsupported components. A good posture is the result of balancing the skeleton in relation to gravity in order to reduce demands on muscles. Long term considerations in assessing a “good posture” include maintaining positions which improve function and which provide pressure relief through distribution of force over a larger surface area. Where external intervention is necessary for good posture it is helpful if we consider the nature of the support surfaces, the forces applied and their effects.

A quick review of the literature available on seating establishes the pelvis as the foundation of good positioning. It is the center of mass for a typical human body, and therefore the center of gravity. It participates in more gross movements than any other part of the body. Other important surfaces through which we can support the skeleton are the thighs, the feet, the sternum and ribcage, and the clavicles. When supporting a body from other areas it is important to consider how the applied force will be carried to the skeletal foundation. Supports which involve connective tissue require that those tissues have good integrity. When soft tissue is involved in support it is important to consider how the external support force is translated to force on the skeleton and how the soft tissue in-between is involved: is there a risk of skin break-down, are internal organs going to be affected, will the force applied limit function?

Start with Pelvic Support

There are several reasons for using anterior pelvic supports: the client tends to slide out of the chair, the client is subject to uncontrolled movement and cannot maintain a good seated position or is at risk

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for throwing himself out of the chair, the client has high tone and is unable to relax into the seating surfaces, or the client is using her legs for self propulsion which tends to pull the pelvis out of position. In each of these cases an anterior support may make the difference between a seating system which is successful and one which is not.

Pelvic stabilization can be seen as a three-point system: the seat, the back and an anterior support. The anterior support usually comes from a combination of things: the effects of properly supported legs, friction resisting the legs and pelvis sliding forward, an anti-thrust cushion increasing that resistance, or a positioning belt. All of these forces are passive, they **resist** movement. The more closely they are fitted the less room for movement. In other words *proper placement and adjustment of these components is essential for good support.*

The “hip-belt”, or “pelvic-positioning-belt” is the most common form of anterior pelvic support. Another form of anterior pelvic support is the “sub-ASIS” bar, most often used with the more severely involved clients and requires a clear understanding of its proper application and use. Its application falls beyond the scope of this work, but it is recommended that seating practitioners at least learn the principles of its use.

*For everyone’s sake please do not mistake a positioning-belt with a “seat-belt.” The requirements of a belt used for postural support are **very** different from the requirements of a belt used for transportation safety. In a pinch, would you use the belt holding your pants up as a substitute for the seat-belt in your car? The principle is the same as relying on a positioning belt for transportation safety.*

Positioning Belts

Pelvic belts are used to maintain the pelvis’ position in the seating system. Typically a belt comes from the frame of the chair, over the users lap and back to the frame. Its angle is normally described as somewhere between vertical, 90° and horizontal, 0°. These two angles represent the two primary forces involved in pelvic positioning. The first is a downward pressure, perpendicular to the cushion. With this the wearer is pulled into the seating system, allowing the advantages of its shape and materials to come into play. This can be achieved with a lap or thigh belt coming over the thighs from the seat rails at about 90°. A second directional force is often applied by adding a horizontal or rearward pull, with the belt located on the lap just in front of the ASIS’s. This rear-ward component helps resist the tendency to slip forward underneath the belt. Traditionally the rule of thumb has been an angle of 45°, which is halfway between the rearward and the downward forces. However, for several reasons **we recommend an angle of 60°**. Please see the attached article, “Potential Hazards of Wheelchair Lap Belts” for details on the mechanical reasons this angle tends to hold better.



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Moving the belt angle from 45° to 60° also pulls the pad down flat, in front of the pelvis. We believe this provides more control: In positioning it is common to use our thumbs underneath the ASIS's while locating the pelvis in the seating system. Imagine trying to use the flat of your palm. Using a pad across the front of the pelvis is, in effect, the same as your palm-- it may apply pressure but it is difficult for it to control tilt. In addition a rearward pressure against the top of the pelvis actually encourages a posterior tilt; most of the time this is what we are trying to prevent.

ASSESSING FOR POSITIONING BELTS

- Start with reviewing the seating system. Have the “preliminaries” been checked?
- Define objectives for the belt in relation to the seating system and end user. Is the belt intended to improve posture, to keep the user from slipping out, to overcome tone or to reduce risks from uncontrolled movements?
- Consider specific needs of the user. Does it look good? Will it be used constantly, or only at certain times?
- Consider needs of the person operating the belt. How easy is it to buckle? Tighten? Clean?
- Consider the seating system and the chair. Where will it mount? Are there lateral pads or other parts of the system which might interfere?

A specific note on deeply molded and otherwise over-size cushions: Much of the positioning control is lost if a belt is pulled too far away from the pelvis, either by a cushion that is wider than the pelvis or by having lateral components which the belt wraps around. The positioning value of a belt will be much improved in a deeply contoured system when allowances are made for the belt to wrap as closely around the pelvis as possible. A lot of time and trouble can be saved by accounting for the belt during the process of making, ordering or molding the cushion.

THE BASICS OF BELTS

If a belt is to be used for positioning, it is necessary to be able to position the belt itself. It can be very important to place the buckle such that it is accessible to the user, and that it is not near a bony prominence or near a feeding tube. Using special mounting methods and hardware can prevent the belt from bunching-up or from tearing out; proper mounting can also extend the life of the belt and improve its pressure distribution. The use of end-fittings and sliders allows just this sort of adjustability and force distribution. When feeding the webbing through the slider and end-fitting, a final, or third pass is very important. When only one bar of the slider is visible and the slider is placed very close to the end fitting the webbing is locked in place.



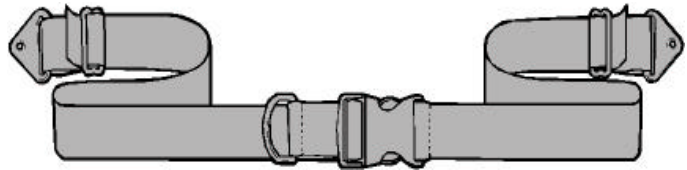
Padded belts have the advantage of a lower risk of skin break-down and higher odds of attendants being willing to tighten them properly. Pads that are sewn to the belt won't slide away and leave bony

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prominences unprotected, nor can they be over tightened once they are adjusted properly. Well made sewn pads also have the advantage of providing attendants with a **visual cue**: if the belt is positioned and tightened properly, **the pads will be touching**. This gives the attendants a simple way to recognize if a belt is not properly tightened or if the client is not sitting properly, e.g. the pelvis is not all the way back or the cushion is not in the chair properly. It can also indicate a need to re-adjust the seating system due to growth or other changes. Washability, durability of materials, and construction should also be a consideration when choosing positioning belts.

NON-PADDED BELTS

Let's start with the most basic belt: a buckle and webbing. In general, non-padded belts are best used where there will not be a risk of skin break-down over bony prominences.

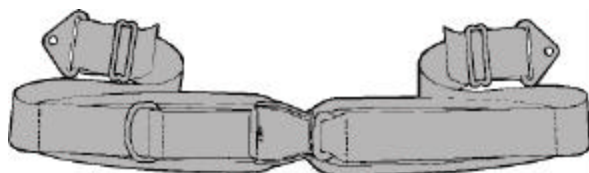


There are a variety of buckles and sizes of webbing available. The *Side-Release* buckle, also called a back-pack or Fastex™ buckle, is made of plastic and releases by squeezing its sides. It is light-weight and comes in many sizes; it can also be difficult for some people to release. There are also *plastic push-button* buckles, usually lighter weight than the side-release buckles and also a little lighter duty but they are very easy to release and have a brightly colored button to aid occasional caregivers in releasing the buckle. The most common buckle used for positioning belts is the *push-button*. It is very strong and usually easy to release, although buckles vary according to manufacturer. Push-button buckles are however, bulkier and heavier than plastic buckles. The *aircraft-latch* style buckle is often easier to release for persons with limited hand function, but it is only available for 2" (50cm) webbing. These vary in weight according to manufacturer but can be heavier than push-button buckles. Hook-and-loop closures are also used on some lap belts but due to the nature of the closure they are most often used only across the thighs and not against the pelvis.

PADDED BELTS

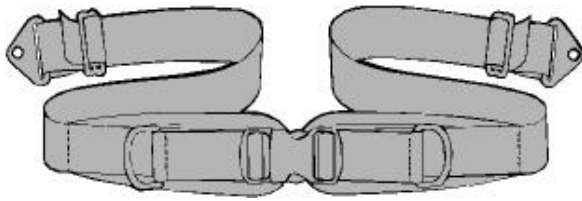
It follows then, that to provide pressure near the ASIS's one ought to use a padded belt. The pads need to be long enough to fully protect the bony prominences. In measuring for padding area one can generally use the pelvic width, trochanter to trochanter. Otherwise, measuring ASIS to ASIS and adding an inch-and-a-half or two inches works fine.

Center-Pull: The simplest style of belt. It is tightened from the buckle, pulling away from the center. There are more varieties of center-pull belts than any other. This is the form we are most accustomed to seeing and is a good general purpose belt.



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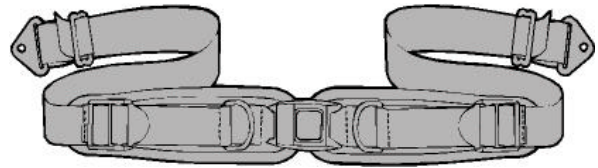
Dual-Pull: Dual-pull belts still adjust from the buckle but rather than just one tab for tightening, there are two. This requires a special buckle made such that it adjusts from both sides. Not many buckles



are made like this and very few work well for positioning belts. Fortunately a *dual-side-release* buckle is available. The main advantage to a dual-pull belt is that it has twice the length for adjustment without having a tab that is twice as long. This helps when positioning “thrusters,” since there is

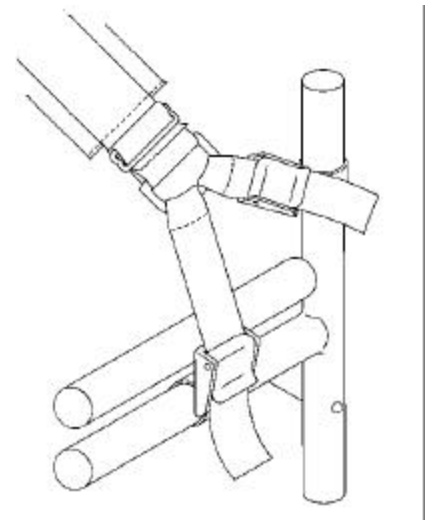
twice as much room to work with as you fasten the buckle before tightening. It also allows extra room for temporary changes, such as winter coats during transportation, although, *much of the positioning value is lost when the belt is over heavy clothing.*

Rear-Pull: Rear-pull belts have two special fittings just for tightening, they are located at the *rear* of each pad. One adjustment point over each side of the pelvis allows the attendant to tighten one side of the pelvis at a time. This is particularly useful on a rotated pelvis. It also makes it easier to rock the client into the seating system by moving each side back a little at a time. The *mechanical advantage*



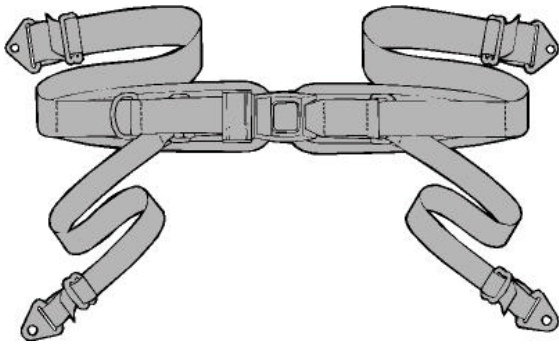
provided by this belt quadruples the operator’s hand strength, allowing the belt to be used to bring the pelvis into position, not just hold it there. This mechanical advantage is also useful for overcoming high tone.

Four-Point or “Y” belts: So called because they are made such that each side splits into two straps, for a total of four mounting points. The objective is greater stability than a standard belt can provide. There are several variations of this belt and more variations on how it is believed to work. There are two distinct origins for the concept. For the first, the four-point belt provided an alternative to two separate belts which were being used. For the second, it is an application of the principle of triangulation: When it is under tension, the split point of the belt, or apex of the triangle, can only be in one location. The belt is therefore more stable. Sometimes the idea of specific tension on each strap is added: having the belts pull 60% down and 40% back. The construction of this belt usually involves a D-ring, with the straps able to move along the ring, however, rather than lend stability this acts as a swivel point. These belts still have the advantage of a shorter length of rotation than a standard belt, and therefore, less free play which would allow the pelvis to slip.



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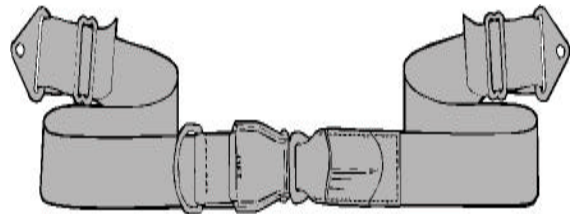
Medial-Four-Point: This belt re-works the original ideas of a four point belt in pursuit of greater stability. Rather than splitting into two straps on each end, it works from a primary belt which is fitted



and functions just as a normal belt would. The difference is it has two straps which come from mounting points *medially* placed in relation to the ASIS's. This provides a simple tether to keep the belt from riding up. The principle of triangulation still applies but rotation beyond the split point is not an issue due both to how it is sewn and the fact that the split point is medial of the ASIS. This belt takes longer to set up than a two-point belt and holds the

pelvis significantly more aggressively. It is recommended only where standard belts have not been successful.

Quad Belt: Versions of some of the above styles exist with special loops to make it easier for people with limited hand function to hold the buckle. One version of the Latch buckle belt includes a special stiffener to hold the tongue rigidly in relation to a thumb socket or loop.



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Anterior Torso Supports

Never use an anterior trunk support without a properly adjusted pelvic support!

Just as with belts there are several reasons for considering anterior torso supports: to provide a limit of movement for persons with limited trunk control, as a limit to the range of involuntary movement, to assist trunk support for individuals who lack the strength or control to remain upright, to provide more stable head control, or as additional support during feeding, driving or performing other daily activities. Before selecting an anterior torso support all of the considerations for the pelvic belt apply, now with added emphasis on the shape and contour of the back, the seat-to-back angle, and the use of lateral pads. Even in the cases where it is being used only as a limit to range of movement, the importance of proper supports remain, and the risks of strangulation or other injury increase in the absence a well fitted seating system and *properly tightened* pelvic belt.

SUPPORT SURFACES

The best surfaces for support, once again, are the structural rather than movable surfaces: The sternum, upper rib-cage, and the clavicles. As part of fitting any anterior device it is important to check its orientation and consider where pressure is being applied. Although bones provide good structure they are also literally behind most skin breakdown. Distributing pressure and padding the support surfaces are very important. Which surfaces are to be used will be determined by the objectives for the support and special needs of the client.

There are four main varieties of anterior trunk supports: chest belts, shoulder harnesses, butterfly harnesses, and shoulder retractors:

- The *chest belt* is just like a lap belt but it is used to hold the user against the back insert. It is simple to use and may be used where the back is below the shoulder line, or where there is only a sling back in use. It allows more upper torso movement but for the same reason it provides very little shoulder support. It can also restrict breathing.
- *Shoulder retractors* are padded rigid bars which provide pressure against the clavicles to maintain an upright posture, these are intentionally restrictive of torso movement with the objective of providing postural stability. Used properly they can hold the user in a good posture, They are often used where they are not needed all the time. Like the sub-ASIS bar they must be fitted and used with care so as not to exert too much force in the wrong place.
- *Butterfly harnesses* focus on the sternum and rib-cage as a support surface to limit forward range of movement. Butterfly harnesses involve semi-rigid, usually padded, butterfly shaped pieces held by four straps, two coming over the shoulders and two coming around the middle of the torso and attaching behind the back insert. These can be good for more rigid support, especially with children and smaller persons. They can be harder to remove, and are not adjustable in size.
- *Shoulder harnesses*, depending on the design, can have the advantages of both the butterfly and the retractor. They are also much more adjustable, and as they are not rigid, they easily conform to the wearer's shape, helping to spread the pressure over a large surface area.

Here again, since the other forms fall outside of the scope of this work we shall concentrate now on shoulder harnesses.

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ASSESSING FOR SHOULDER HARNESSSES

- Start with reviewing the seating system. Have the “preliminaries” been checked?
- Define objective for the harness in relation to the seating system and end user. Is it for postural support or to provide a limit to movement?
- Consider specific needs of the user. How will it affect daily activities? Will it be used constantly or only at certain times?
- Consider needs of the person operating the belt. How easy is it to buckle? To tighten? To clean?
- Consider the seating system and the chair. Where will it mount? Are there lateral pads or other parts of the system that will interfere?

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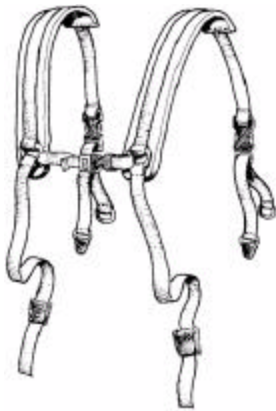
As a rule, a shoulder harness provides the best support and leverage if it is mounted so that it pulls straight back from the top of the shoulder; this requires the solid back to be the same height as the shoulder, or perhaps 1” shorter. (With some clients there are reasons to expect a “righting response” from a downward pressure caused by a lower back height; however, this is a technique best used only when it is well understood.) It is also important to mount the top straps of the harness so that the pads are close to the neck but not chafing. This usually requires the straps to be mounted only a few inches apart. Otherwise, there is a risk of the straps pulling on the shoulder joint or slipping entirely off.



Postural Control: How the harness is fitted and adjusted affects how it functions. If no sternum strap is used then the two straps come straight down over the clavicles and function similarly to the shoulder retractors. The placement of the *lower* strap affects how aggressively the harness pulls up and back: the higher the mounting point the more aggressive the pull, but likewise the more restrictive it is of movement, especially arm movement. In the more aggressive uses scapular relief in the back insert is recommended.

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Defining Range of Movement: By using the sternum strap the padded straps are pulled onto the ribcage and sternum, relieving some of the more aggressive support in favor of more passive support. This is the so called “H-style.” The level of support depends on the adjustment of the sternum strap; by tightening the strap the pads are pulled onto the sternum, providing anterior support and establishing a limit to forward movement, and at the same time allowing greater arm mobility. The extreme of this application is to use the harness without the sternum strap again but criss-crossing the harness in an “X” style. The placement of the lower mounting points will still affect the postural support.



Rear-Pull Harnesses: The “rear” here, refers to the point from which the harness is adjusted. Since the release and cinching points are behind the user, this harness is intended as an attendant operated system. This keeps the hardware out of reach, which may be needed for client Safety. This can be made even more effective by mounting in an “X” style.

Front-Pull Harnesses: Front-pull harnesses move the attachment and adjustment points forward to the top of the pad just over the top of the shoulder. This allows the attendant to face the client while making adjustments. It also moves much of the hardware away from behind the back; this can be important where the back already has a lot of hardware. Another advantage is that this style has a shorter attachment point and is much less likely to slip off of the user’s shoulder.



Conclusions

The variety of hip-belts and harnesses available reflects directly the variety of client needs. When the products are understood in terms of the client, and not the client in terms of the products, the chances of having a seating system that works well improve greatly. The answer to the question of which product to use is often a simple one when we look at the question one step at a time. Remember always: if you get lost, go back to the fundamentals and work your way up from there.