Prosthetic Extension of Supraspinous Ligament to the Sacrum.

Prepared by John Gorman. (2005ish)

Note; This document puts some detail to the fairly obvious suggestion which stems from the explanation of low back pain in this website. I first made this suggestion in 1987 (in my book "Update 87") I added this description on my website in about 2005 but it was only in 2011 that I came across the work of Dr Markwalder in Switzerland between 1990 and 1995. This adds the very strong evidence that it was successful and would be even more successful if implemented in the way described here (as well as being far less invasive.)*

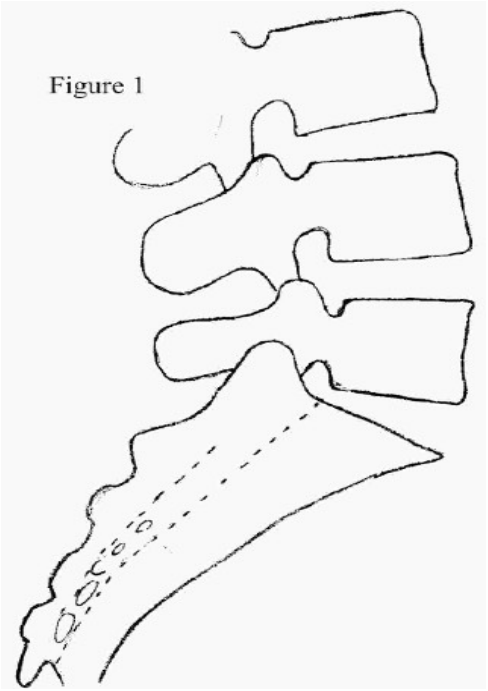
This paper is confined to the details of how this would be done in a particular case. The reasons for doing this have been discussed elsewhere.

As an example I will take the case of someone I knew about 17 years ago, whose x-rays I still have available. She was female aged 28 with severe back pain over a period of some months despite osteopathic treatment. X-rays and other medical examination gave no clues as to the cause.

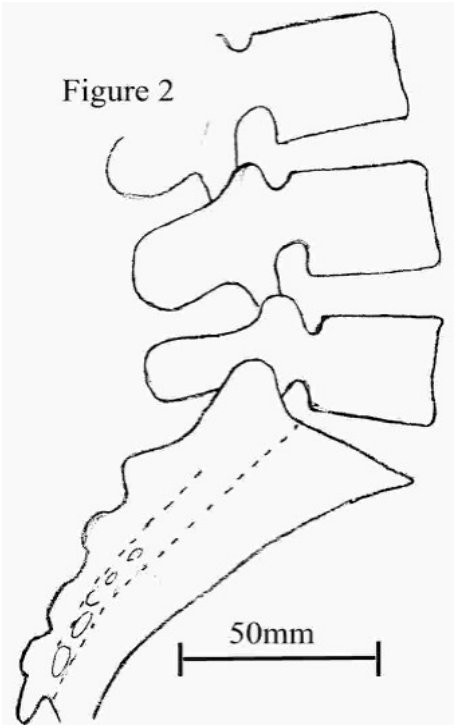
Figure 1 is a tracing of her lateral lumbar x-ray. I believe it was in the standing position, as an osteopath or a chiropractor would require, but I do not know the focus, object, film distances. Scaling of the figures is obviously critical for this application. (Would an MRI scan give exact dimensions?)

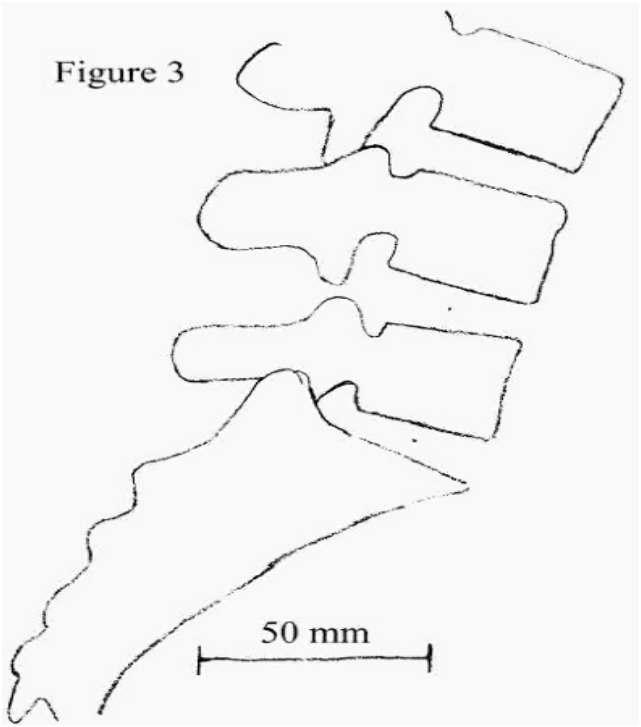
Figure1

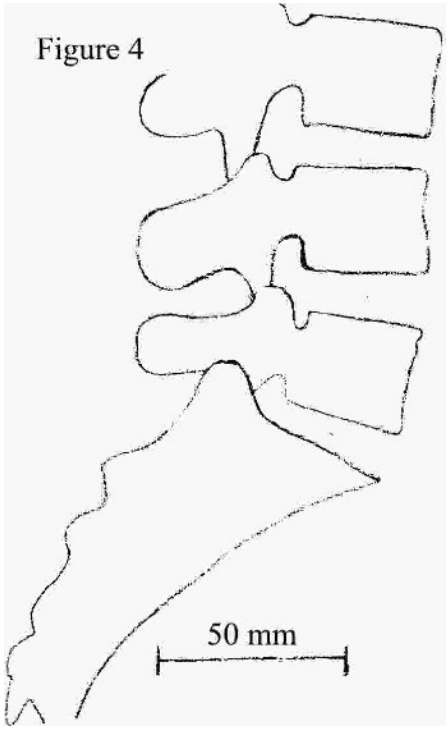
Note; I have sized all pictures in this document so that the whole picture fits on the screen. To get a correctly scaled print out, save the picture (right click –save as) then use your printer commands to get the correct scale by trial and error using the 50mm scale, which is on all subsequent tracings.



As this information is not available I have simply assumed a ratio of five to four in order to produce Figure 2 and added a 50 millimeter scale. This will allow the Scaling to be checked in any subsequent figures. (If lateral x-rays are taken for this particular purpose then power should be reduced so that spinous processes and tubercles on the sacrum are clearly outlined. Maybe a 50 millimetre object could be included in the x-ray close to L5 to allow exact scaling.)







Some angles on Figure 2 are probably worth noting. The angle of the sacral endplate from the horizontal is 30°, which is far less than the average of 50°.(but well within the 'normal' range)
The wedge angle of L5 S is 20°, which is not far from the average.
The wedge angle of L4 5 is only about 5°, which is far less than the average of close to 20°. (Note that 'average' in this case means 'of those selected because they are free of back pain')

If we try to estimate the flexed shape of this lumbar spine by applying the joint nobilities from various published papers (9° for L5-S, 14° for L4-5 and 12° for L3-4) the result is Figure 3. Clearly L4-5 does not meet the criterion that L4-5 and L5-S should not flex beyond parallel sided. I therefore suggest that we limit the flexion with the addition of a prosthetic ligament crossing these two joints and limiting the flexed shape to approximately that shown in Figure 4.

The next question is where to make the connections for this ligament. *(Obviously any suggestions made here are only subjects for discussion, as I have no experience of this sort of work.)*
Cranially, connections should probably be made to the tip of the spinous process of L4. This would then be a direct mechanical continuation of the supra-spinous ligament, which normally terminates at L4.
Caudally, I suggest connection near the last, i.e. lowest or most caudal spinous tubercle on the sacrum. A quick survey of recent chiropractic patients suggests that this is always fairly prominent. Since it is fairly prominent it seems reasonable to assume that it is also a fairly strong structure otherwise damage would occur frequently. (How to make these connections will be covered later)

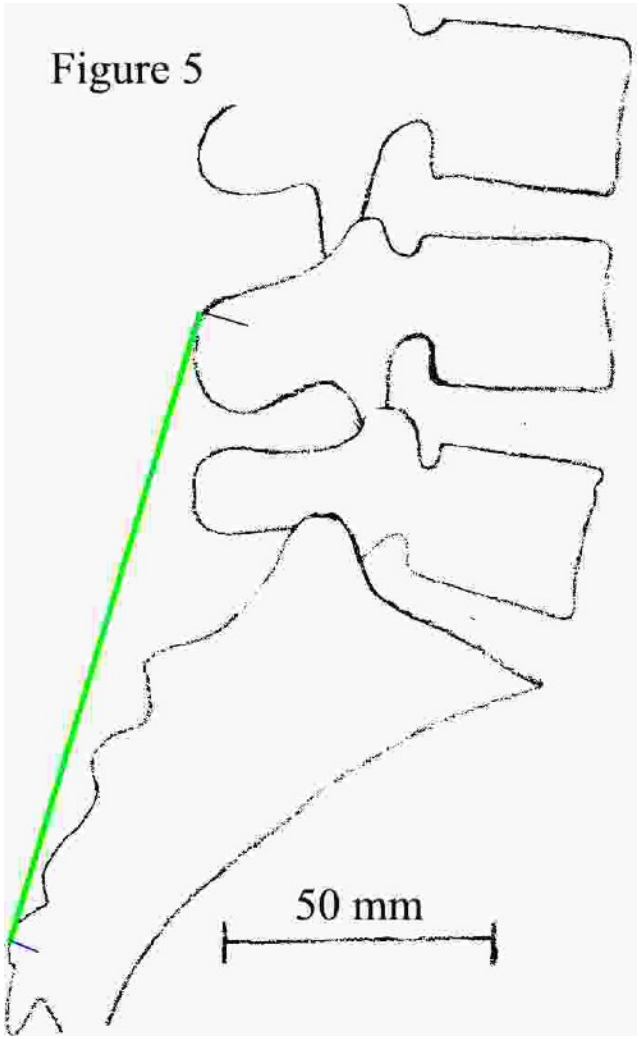
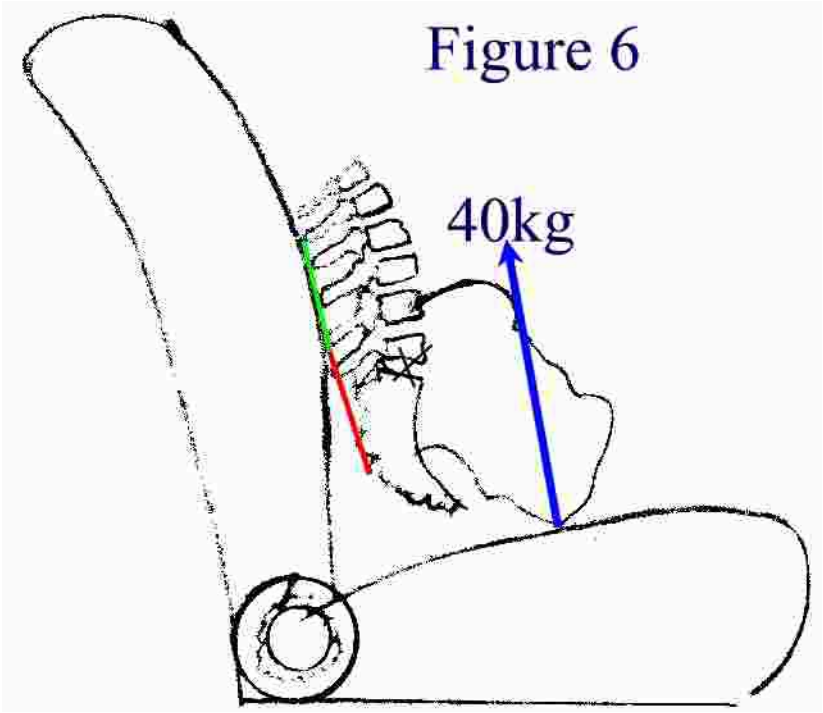


Figure 5 shows the ligament connected between these two points and with a length such that it is tight in the fully flexed shape chosen for Figure 4. The actual length of this ligament between two points indicated would-be 120 millimetres. In any spinal shape other than this fully flexed shape the ligament would be slack and simply lie under the skin close to the spinous processes and tubercles.

The next important question concerns the forces in this ligament and the strength required. It must be emphasised that the ligament would not be structural. It could not possibly be strong enough to take the full force of lifting or the forces that might occur in landing from a jump. The function of the ligament would only be to limit the flexion in sitting and therefore to allow all other components, ligamentous and muscular, to tighten up and take the forces in all other activities exactly as they would if the flexion mobility had never become excessive due to civilised sitting habits.



What therefore are the likely forces that must be resisted in sitting? Figure 6 shows very roughly a body in a lumbar support car seat with the bodyweight (excluding the legs-say 40kg) supported at the seat bones and the backward tilting force on the pelvis being resisted by the prosthetic ligament (shown in red) and the supraspinous ligament (shown in green). Simple moments about the centre of the L5 disk suggests a prosthetic ligament tension of about 70 kg (700 Newtons). This is probably an excessive worst-case estimate in sitting.

We would like the ligament to be able to withstand this tension without excessive stretching (elastic not plastic!) but we still want it not to be damaged, or to damage the connection points, if excessive flexion occurs as for instance when landing from a high jump. We do not want the ligament to act as a 'long stop' in such cases. Instead we want it to extend elastically under excessive load and subsequently to recover undamaged.

We must therefore estimate how far the ligament might have to extend in any extreme circumstance. A large angle of hyperflexion at both L4 5 and L5 S would require the ligament to extend to a length of maybe160 millimetres. This is a 30% extension on the unstretched length of Figure 5.

Experiments with various nylon cords gave the following results:

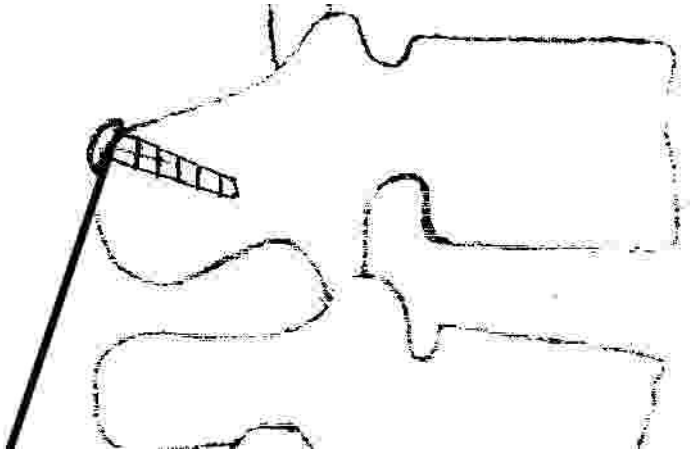
Diameter	*Force for 30%extension*	*Breaking Stress*
1mm	*20kg(200Newton)*	*30kg*
1.6mm	*41kg(410Newton)*	*>60kg*
2.3mm	*85kg(850Newton)*	*unknown*

It appears from this that nylon cord can withstand 30%extension without failure. The 1mm cord seems to give

inadequate tension. On the other hand it is difficult to envisage connection points for the ligament being capable of withstanding a force of 850Newtons, which suggests that the 2.3mm cord is too strong. The 1.6mm cord seems to have characteristics in the right order of magnitude.
Before pursuing this line of thought further it is probably better to examine how the ligament would be attached.

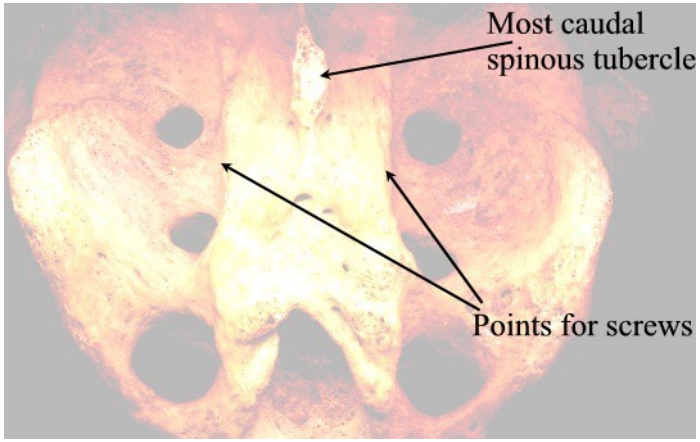
Prosthetic Ligament Attachment Points.
One of the advantages of the connection points suggested earlier is that the prosthetic ligament will be relatively long in comparison with the extension required for the flexion of the two joints. This means that normal materials like nylon will probably be able to stretch elastically without damage. If the ligament went simply between the closest points on the adjacent vertebrae, the percentage extension would be much greater. This is because the extension will be the same although the length would be far less.

Attachment to L4 spinous process.
It is emphasised again that these suggestions are subjects for discussion, as I have no experience in this field.
Connection to L4 could be made by a screw inserted directly into the tip of L4 as shown in Figure 7. (Purely diagrammatic!)



This would have the advantage that the maximum mechanical leverage would be maintained.

Connection to the Sacrum
The most caudal sacral spinous tubercle was suggested previously for the caudal connection of the prosthetic ligament. Any more cranial connection would reduce the ligament length.
However a simple connection like that shown above cannot be used because of the spinal canal. It would seem likely that some metal plate will be necessary to spread the load. Figure 8 is of this area of a sacral bone showing the points where screws could be inserted through the full depth of the sacrum. This sacrum is 15mm thick at this point.



For this very preliminary document that is probably enough detail of the suggested implementation. We need however to look at the possible problems.

Possible Problems.

1. Selection of material for ligament. As I have no experience there is no point in trying to discuss this here. Nylon cord has only been mentioned because I was able to measure the characteristics of various thicknesses of cord.
2. Possible development of inflammation and pain around the connection points. Once again I have no experience in this field.
3. The prosthetic ligament will tend to flex the sacrum within the pelvis. I.e. to flex the sacro-iliac joints. I have argued elsewhere that the lack of this flexion force, which would normally be provided by natural squatting, is the main reason for most sacro iliac problems. I therefore believe that this will not prove to be a disadvantage but will in fact be advantageous.
4. The effect of the ligament crossing the two joints might be that one joint loses all its mobility while the other still flexes too far. This seems to be what has happened in the example chosen where most of the lordosis is confined to L5 S. while L4 5 flexes too far. To solve this we would need an extra, though less strong, ligament between the spinous processes of L4 and L5. This would need to be much more elastic than the main ligament as it would have to extend by the same amount although much shorter. I can't really see the solution to this at the moment but I will not pursue it in this preliminary document.

Notes/ Comments.

1. The range of mobility of the L4-5 joint after insertion of the prosthetic ligament will be within the naturally evolved range and will not even overlap with the range beforehand. This is why it is suggested that the ‘shape warning pain’ will be ‘switched off’ solving this persons back pain.

2. On rereading this after a few months I can already see some errors and inconsistencies in the calculations on prosthetic ligament strength. Obviously these will have to be based on good data and carefully calculated before implementation so I will not try to improve these figures now.

Testing

This would I believe be a totally new procedure with many unknowns. We need to evaluate many things such as:
-- pain, healing etc around the connection points.
-- reduction in flexion achieved.
-- possible damage to ligament in energetic activities. For instance falls in skiing!

John Gorman 2004

The following was added in early 2017

Despite writing innumerable letters and emails before and after 2005, I have failed to interest any orthopaedic surgeons. I have therefore no more experience to add to the above document but I have obviously thought frequently about how implementation might be done. The following is just some of these thoughts, in no particular order!

1) If normal sitting habits persist after implementation, it is likely that flexion will become excessive at L3/4. Maybe the prosthetic ligament must extend to joints further up the spine as well as to L4/5 and L5/S. If pelvic supports are used in driving and working postures this is probably unnecessary. Probably!

2) Back pain when sleeping, (or not sleeping!) and in the morning, is one of the "pains" of the back sufferer. We want the sufferer, post op, to be as pain free as poss. Although the pain will be switched off when the shape is near extended, the painful lower joint will not return to totally natural quickly. It will probably still be achy when flexed even though it is now limited to a natural flexion angle by the prosthetic ligament. At least for a time, and it may be months or years, a natural angle of flexion will still result in ache if not pain.

Maybe the best solution to this is to choose the length of the prosthetic ligament such that it just comes tight at the correct standing shape of the lowest two joints of the spine. This will be a wedge shape of around 15° for L4/5 and around 20° for L5/S. This should however not be a solid limit to flexion. The prosthetic ligament should be elastic so that sitting and bending can flex these joints through somewhere near the natural angle of flexion. Say10° for each of the two joints. This will still leave a wedge angle of about 5° for L5/S and 10° for L5/S in full flexion.

I can think of several plusses for this idea;
-The elastic ligament will be less liable to rupture in energetic activities.
-in the event of overdoing it, say an excessive lift, the elastic ligament will "perform" a continuous McKenzie Extension even if the sufferer retires to bed!
- in normal daily life, the extended shape when sleeping will allow the quickest return to natural for the ligaments and disks. Probably!

More soon. Jan 19th 2017
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*For Markwalder references see my answer to question 10 from the front page of this website;
http://www.naturaljointmobility.info/answerq10.htm