Disc Replacement or Fusion: which is best for me?

After anterior discectomy in either the cervical or lumbar region there is a need to replace the removed disc with something and the choice lies between fusion and disc replacement. Posterior surgery preserves all or some of the disc and so does not require reconstruction i.e. there is no need for either disc replacement or fusion.

Here we consider only the issues that lie behind that choice between fusion and disc replacement and assume that the disc has to be fully removed.

There are many factors to weigh up before operating and it is all too easy to become too preoccupied with the details of disc replacement and fusion at the expense of more important issues. The main decisions you have to make are:

1. Is surgery right for you at all?
2. If so, should this be done from the front, (anterior) or from the back, (posterior)?
3. If it is to be anterior which method of reconstruction is best for me, fusion or disc replacement?

In fact the first two are much more important questions than the details of which method of reconstruction is to be used once the disc is removed.

Key Points:

- Only once the decision is made to operate and to operate anteriorly is there a need to consider the relative merits of fusion vs disc replacement.
- There will usually be a correct choice for you and we will hope to steer you there.
- The details of the pathology you have, (ie the precise anatomy of your disc prolapse, osteophyte, instability etc) will determine our recommendation.

Therefore we cover here:

- ❖ **The function of a normal disc**
- ❖ **The design of disc replacements**
- ❖ **Our favoured artificial disc**

The function of a normal disc

The structure and function of the intervertebral discs are remarkable. For the basics, please return to the section on About the Spine which is found on our home page.

How smart are my discs?

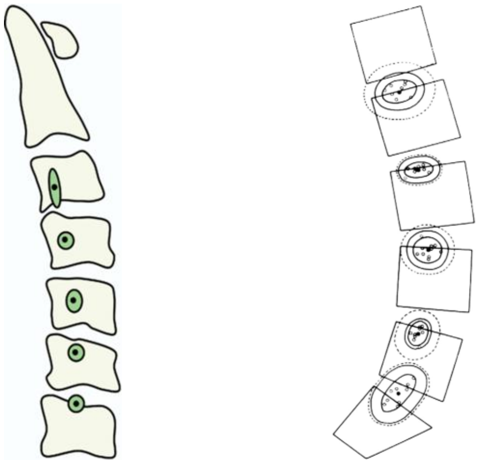
Answer? Very smart indeed. Perhaps, at first glance, a hip joint looks more complex than a simple disc. However, nothing could be further from the truth. In addition to acting as a **hinge** and a **shock absorber,** discs have to hold the bones, (vertebrae), above and below together. Their wedge shape creates the normal curves of the spine that are so crucial to the healthy functioning of the spine as a unit. Within this complex set of curves, how each individual disc operates is also very complex. The hinge function is not just a case of simply bending forwards and backwards. The disc will slide from side to side and front to back in a motion called **translocation**. They can do this in all directions and it is this which underlies moving the head forwards or to one side like and Indian dancer. A disc will also **rotate** it the horizontal plane to allow us to look over either shoulder or shake our heads. Further, it can hinge in any plain, the **point of rotation** differs depending on the plain of movement and the point moves front to back or side to side as each movement progresses. Shock is absorbed at the point of rotation and as these are multiple and constantly shifting so too are the points of pressure. Thus, the load is spread about the disc and no one point wears out. In all these movements **resistance** increases as it progresses so as to progresively resist excessive movement in any direction. Finally, precisely how the adjacent level is angled, how much, how readily and how well it moves in each of the plains, determines the forces the adjacent ones have to cope with and how the vital facet joints perform their function. In this chain, any weak link adversely affects the adjacent ones.

Neutral

flexion

extension

Movement in a Disc

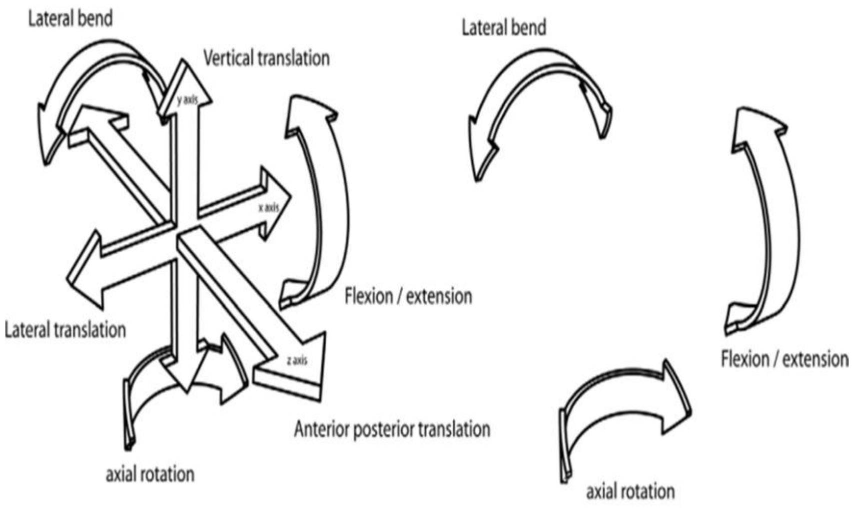


Cervical **Lumbar**

Even the way a disc acts as a hinge is not simple. The point of rotation moves throughout the range of movement in healthy cervical and lumbar discs. The axis point moves from front to back and side to side as we move our heads about.

Bogduk and Mercer. Clin Biomech 15:633-648, 2000

Directions of Movement in Normal Discs



Each direction of movement in an object is descrided in Kinematics, the study of motion, as a "degree of freedom". An intervertebral disc has the maximum – six. Stunningly for each one of these degrees of freedom there is a separate centre of rotation and each centre moves with head or body position. Many artificial discs have only two degrees of freedom with a single and fixed point of rotation – not the partner their adjacent discs or indeed their facet joints were designed for!

Translocation

This is a vital part of a disc's function if it is to work with its facet joints properly. As the neck flexes the disc must hinge. However, in addition the facet joint slides forwards and so too must the disc if the facet joint is not to be damaged.

Cervical Disc replacement or Fusion: Which is best for me?

Fusing a disc inevitably transfers work to the adjacent discs. So, unless there is a good reason to fuse the spine, the usual course is to utilise a disc replacement as this offers to restore lost curves or preserve movement at the affected level.

Disc replacement is now more common than fusion after disc removal though the evidence that it is actually better is not as tight as you might think. Both operations are good. Your big decision is whether to have surgery or not. If you have spent more time thinking about replacement vs fusion your mind has been focused on the wrong issue - though this is an important decision too. Often the choice is clear.

- **Fusion is needed if there is significant instability at the operated level e.g. in spondylolisthesis or if there is a fracture as well as a prolapse.**

- **Fusion is also used**

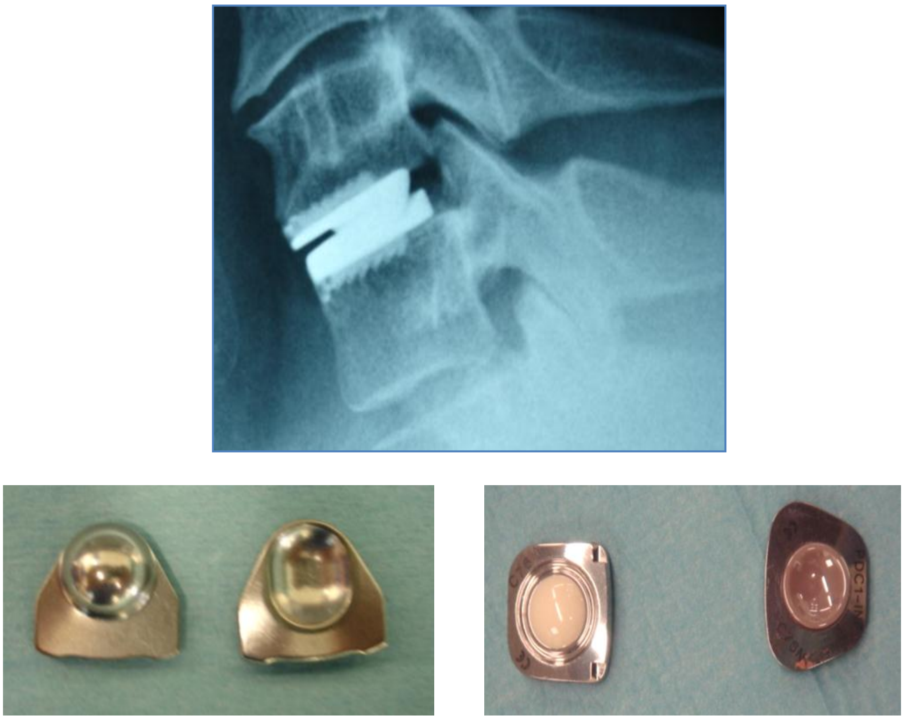
    - **If the disc space is already very narrow when the movement has already been lost.**
    - **If the facet joints are also worn and painful as disc replacement can make facet pain worse by increasing their movement.**
    - **If there are a lot of ostephytes that have to be drilled away at surgery this bone work can cause the two vertebrae to fuse around the replacement – this happens more often with some artificial discs than others and may occur as many as one in ten times.**

Disc replacement is not a guarantee of no more trouble nor does it prevent all disease in the adjacent levels and indeed why should it? Patients wear out their first disc without having had a fusion and so may spontaneously wear others too. That said, our philosophy is to preserve and restore function where possible.

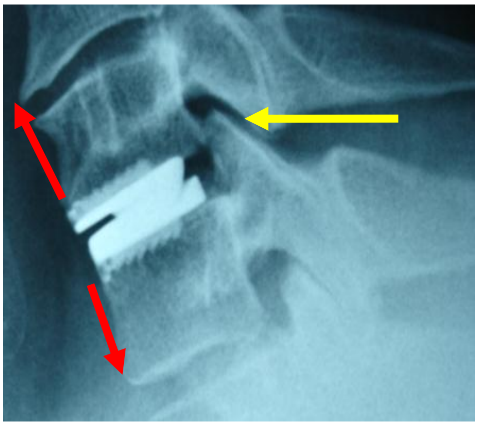
Is there good evidence to prove disc replacement is better? No, at least not in the form of randomised controlled trials, the gold standard of “evidence based medicine”. Such trials are actually very difficult to do well, they have all been flawed and to some degree inconclusive. In our view, this reflects the difficulty of doing this kind of study. For most patients, a logical choice can be made and where there is doubt we would opt for disc replacement – you can always fuse after disc replacement if it does not work but you *can never reverse a fusion*.

The design of disc replacments

Currently, there are some eight disc replacements on the market and their designs have, and will continue, to change. Most offer nothing like the complex function of a healthy disc, as described above. Of the available artificial discs, most come in two separate halves with one sticking to the under surface of the vertebra above and the other to the upper surface of the vertebra below the disc to be replaced. In general, they provide simple ball and socket joint articulation which is rather like putting a hip replacement in your neck. Others have small saucers of nylon which sit between two cups. All these designs provide a type of motion which is a long way from the complex mechanics of a healthy disc but it is only by mimicking all the functions of a healthy disc that you can expect to prevent damage to the adjacent levels. They are made of tough metals, nylons and even ceramics but these materials offer almost no shock absorbance. In addition, in most, the two halves are completely unconnected. This potentially leaves the spine weak, especialy in extension - if the head were to be forced back. If you suffer a whiplash or play high level sport or ski this represents a potential risk.



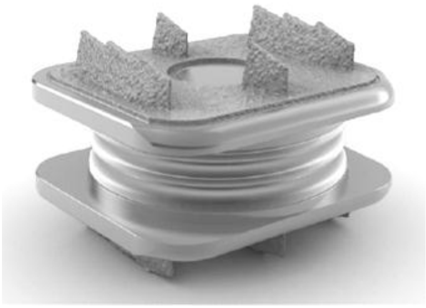
An early design of artificial discs. Two separate halves made of titanium metal and in one case also ceramic consist of a ball and socket type design. In one design the groove offers translocation but only in one plain. Neither offers shock absorbance.

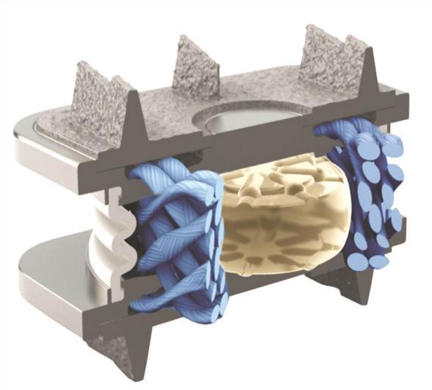
 

In an extension injury, many designs will offer no resistance and tend to open around the fulcrum of the facet joint behind. Some do and this influences our choice.

Our favoured disc

Currently our usual recommendation is for the M6-C disc as it has been designed to replicate the normal motion and mechanical behaviour of a human disc as completely as possible. It is “an almost true physiological copy of a young disc” and achieves this though a cunning design strucutre.





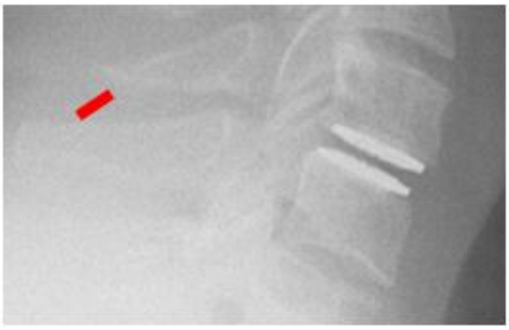
M6C and M6L Artificial Cervical and Lumbar Disc

- ✓ Replicates the anatomic structure and biomechanical performance
- ✓ Controls range of motion in all 6 degrees of freedom
- ✓ Compressible viscoelastic polymer nucleus simulates native nucleus
- ✓ Surrounding multi-layer high tensile strength WPE annulus
- ✓ Simulates progressive resistance to motion of capsule
- ✓ Physiologically almost an exact match for a young disc
- ✓ More robustness

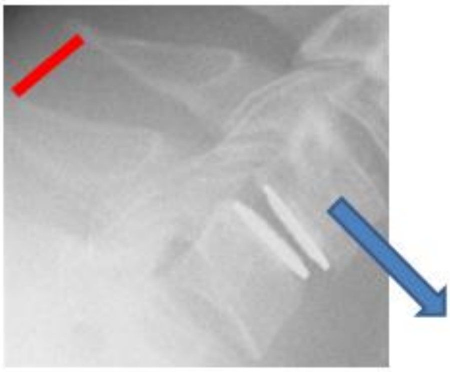
The M6 artificial discs have a nucleus and an annulus, that replicate the normal function of the nucleus pulposus and annulus fibrosus. They allow both compression and translation whilst controlling and progressively limiting movement in all directions.

There is an artificial disc for the cervical and the lumbar spine – **The M6C and M6 L.**

The design of the M6 discs allow for the restoration of full movement. The sizes available are design to completely cover the end plates of the vertebrae so as to prevent the bones fusing around the disc



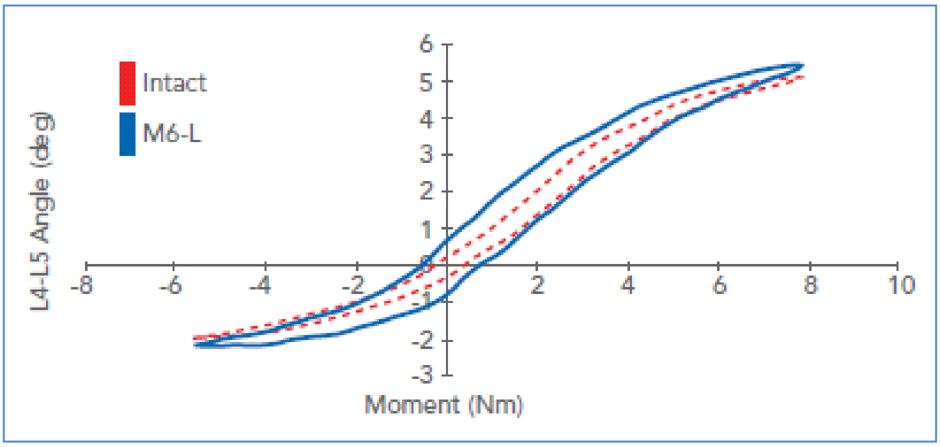
Extension



Extension

The M6c is seen here providing normal hinge function as well as forward translocation in flexion movement.

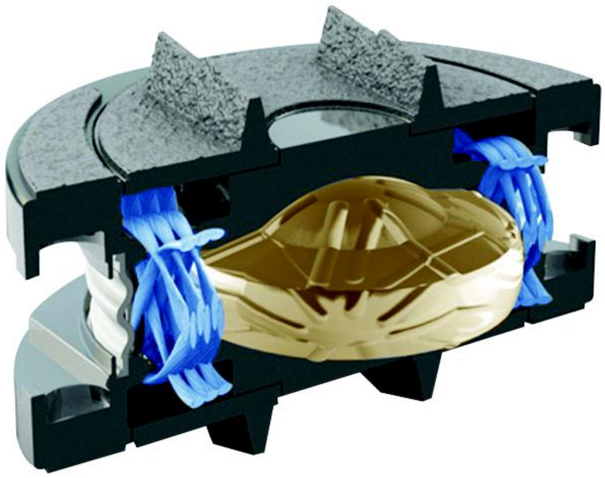
The M6L
To insert a lumbar disc replacement access has to made via the abdomen



This graph shows the resistance to movement throughout the normal range of an intact healthy disc vs the M6C. Not quite perfect but the other designs offer virtuall no resistance at any point and do not change at all as the movement builds.

Like all all artificial discs currently available, the M6c has a metal end plates made of titanium. This is a hypoallergenic metal which is *MRI scan compatible* ie you can safely have MRI scans afterwards should you need them. The M6c causes virtually no disturbance of the images so clear pictures of the operated level can be obtained following surgery.

The surface of these metal endplates have micro-pores like a spongey surface into which the bone of the vertebrae grows. After some months, the bond is very strong. Even heavy contact sport like rugby can usually be resumed at six months post surgery – should you wish and, in our opinion, providing you have been given the correct one!.The plates often have fins, as in the M6c, which help secure the device in the early days and enhance this bond.



The vertebra facing surface of a disc replacement is designed with micropores into which the bone grows so as to fix the device in place.

The fins seen here on the M6L assist in early fixation and strengthen the bond between the bone and disc replacement

How long will my disc last?

The truthful answer is that we do not know. We have patchy long term follow-up on some of the older designs. These designs have been improved on and so inevitably the newer devices have not been used for the many decades that it needed to see if they actually live up to our expectations. They are tested in laboratories on rigs that simulate strains hugely in excess of that of normal life and for considerably longer than a normal life time. There are large margins of safety built in. However, a normal disc must have some capacity to heal which an inert implant has not. Our experience of all implants is that they wear out and may need replacing. The options then are to convert to a fusion or exchange the old disc for a new one. Disc replacements have been around for many years and we have yet to see large swathes of folk coming back with worn out prosthetics. Your great grandchildren may be able to tell you more certainly than us. What would we do? I think we have already answered that!

Table 1: Results of the Static Characterization of the M6-C

Testing Mode	Cervical Physiologic Load or Torque to Failure	M6-C Average Load or Torque to Mech. Failure*	Safety Factor
Compression	3200[3]	> 24,694 ± 460 N	> 7.5x
Compression Shear	845[4]	6714 ± 113 N	8x
Torsion	6Nm[3]	> 10.4 ± 1.4 Nm**	1.7x

Which disc should I have?

There are few good comparative trials and even the simple long term follow up studies are flawed. In addition, their results drive change and the newer discs are always only supported by shorter term data. Countries vary as to which discs are available. The process of getting a disc to market is much slower, and some might say safer, in the USA than for example Europe. Indeed the people of the USA where the M6 disc was developed have been coming to Europe to get it! We have given you our current view. Other reputable groups are using some of the alternatives. Certainly in years to come we will all probably be making different recommendations. The Spine Surgery London will continue to independently assess which one or ones in our opinion offer the better current option. Our surgeons have used all the ones you have seen and some others besides. We do not own shares in any of them and perhaps you can see why! Be you a patient or a manufacturer we are always open to your suggestions as we are to the proponents of fusion over disc replacement. If you think we have missed anything out which is material to this debate, please tell us as we want to know and would like to tell our patients.

Extension

Flexion

Mr X. – "Years of severe Chronic Low Back Pain gone."