Theme Symposium

NEW HORIZONS IN SPINAL SURGERY: SPINE ARTHROPLASTY

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(Presented at the Annual Meeting of Association of Spine Surgeons of India, Bangalore, January 2005)

Background: Degenerative primary osteoarthritis is one of the commonest causes of pain in peripheral joints. This is commonly seen in the knee and hip joints. Replacement of these worn out joints is now the established treatment, which gives stable pain free mobile joints. Arthrodesis or fusion of worn out joints is now rarely performed. Degeneration of the intervertebral disc is a common cause of back as well as neck pain. Fusion of the degenerated and unstable spinal segments is an established procedure to relieve pain. But, at the same time this procedure eliminates motion at the fused level and also accelerates degeneration at the adjacent levels. The replacement of the worn out intervertebral disc with “Artificial Disc” is an emerging technology with the aim to maintain motion in the intervertebral unit and, reduce stress on the adjacent levels and thereby decrease the incidence of degeneration at those levels. The "Artificial Disc" does not simply portray another technique in spine surgery, but rather, is the first practical step in the evolution of motion-retaining spine surgery.
Purpose of the Study: To evaluate early results of total disc replacement in the cervical and lumbar spine.
Materials and Methods: A prospective study has been designed with the strict patient selection criteria. A total of 18 artificial discs have been implanted. The SB Charite’ type III disc was used for lumbar spine (6 patients) and the Bryan disc was used for the cervical spine (ten patients and 12 discs). The follow up ranged from three months to two years. All the patients were assessed by standard scoring systems.
Results: We report excellent to good early results in all our patients at the end of two years. We did not encounter any complications related to the procedure or the implanted disc.
Conclusion: The early results of total disc replacement in cervical and lumbar spine show a promising future to avoid the limitations of spinal fusion. Clearly the long-term results are awaited in comparison to the established spinal fusion procedures.

Key words: Adjacent level disc degeneration, Degenerated Disc Disease (DDD), Spinal Arthroplasty, Spinal Fusion.

INTRODUCTION

Spinal fusion is a widely accepted treatment for the DDD in the cervical as well as in the lumbar spine [1]. The Interbody grafting technique promotes foraminal distraction and restoration of normal alignment. Despite good results, there are certain limitations of the fusion procedures.

Limitation of Spinal Fusion

(*i*) Bone graft site pain.

(*ii*) Prolonged post operative recuperation.

(*iii*) Pseudoarthrosis-failure to fuse.

(*iv*) Varied success rates from 48% to 89%.

(*v*) Causes stiffness and decreased motion of spine.

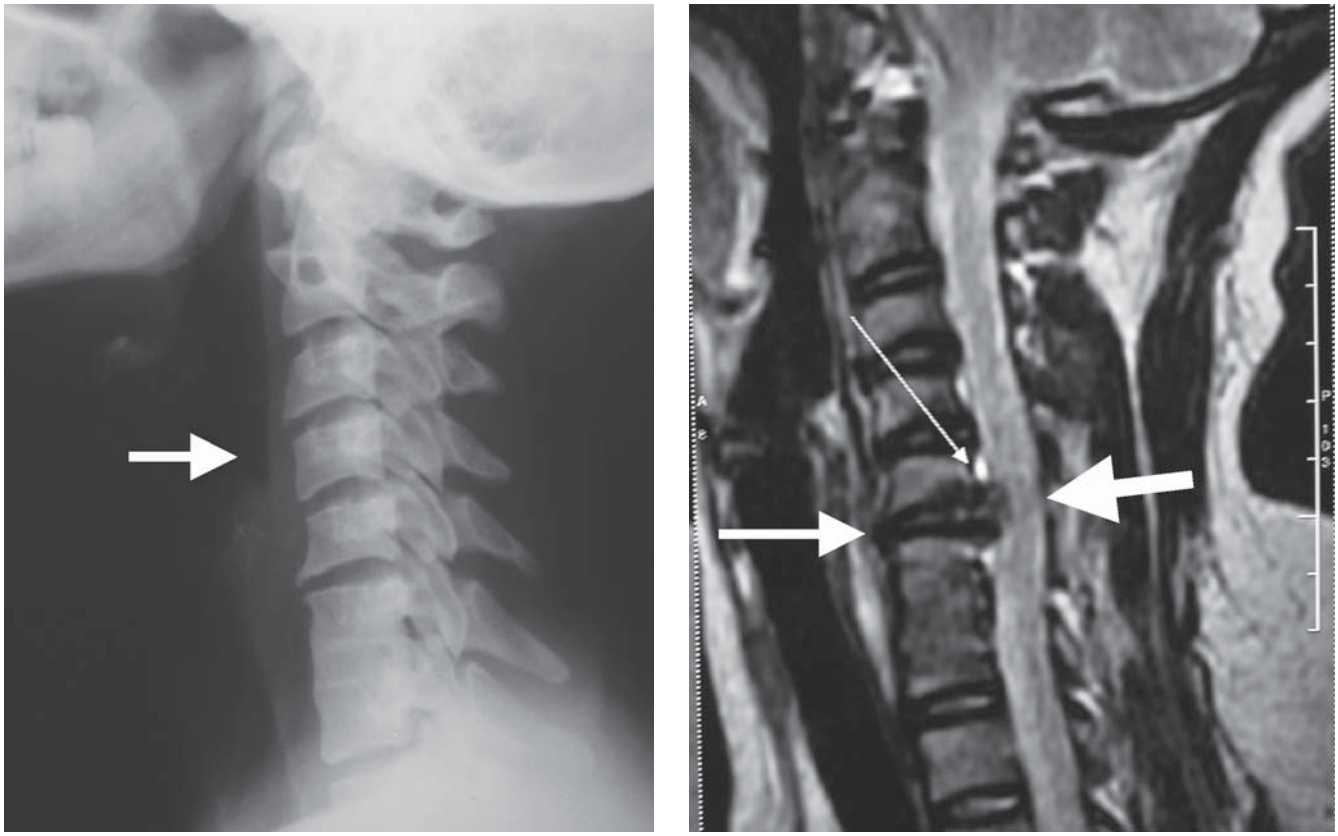
(*vi*) Increase stress to adjacent level which accelerates disc degeneration.

Several biomechanical studies demonstrate significant increase in the shear strain, intradiscal pressure and segmental motion at the adjacent level [2,3] after spinal fusion. Hilibrand, *et al*. reported that symptomatic degeneration with radiculopathy or myelopathy occurs at 26% rate at 10 years follow up [4]. Often these patients require additional procedures to address degeneration of adjacent level (*Fig.* 1). Baba H, *et al* reported long term follow up of 146 patients and concluded that 25% of patients had disc degeneration at adjacent level following spinal fusion [5]. Gore and Sepic reported 14% rate of adjacent level radiculopathy at seven years follow up of 133 patients [6].

Artificial Disc Replacement is the new technology for reconstruction of the degenerated disc, which eliminates many of the limitations of fusion procedures.

Advantages of the ADR

(*i*) Preserve the normal physiological motion.



(*a*) (*b*)

Fig.1*a,b.* Patient had C6-C7 level fusion for degenerated disc with radiculopathy before 5 years. She presented with severe disc degeneration and radiculopathy at C5-C6 level.

(*ii*) Provide segmental stability.

(*iii*) Restore disc height.

(*iV*) Re-establish lordotic alignment.

(*v*) Reduce discogenic pain.

(*vi*) Early return to pre-op occupation.

(*vii*) No external braces.

(*viii*) Decreased hospital stay.

(*ix*) Distributes stress over the spine to reduce adjacent level disc degeneration.

THE ARTIFICIAL LUMBAR DISC

The SB Charite' Type III Disc

On 19th of September, 1984 the world's first three-component artificial intervertebral disc that preserved mobility and function was implanted in a human. This disc was named the "SB Charite' Modular Type Disc Prosthesis" after its inventors and the clinic where it was developed (*Fig.* 2). Today SB Charite' III prosthesis has had extensive clinical use over 17 years in more than 6,000 patients in 30 countries of the world. The device is composed of two oval cast cobalt-chrome endplates and a UHMWPE (Ultra High Molecular Weight Poly Ethylene) sliding core to allow unconstrained motion.

Fig. 2. The artificial lumbar disc prosthesis "The SB Charite' Type III".

Indications for Lumbar ADR

(*i*) Mono and bisegmental DDD with or without previous surgery with long-term chronic mechanical low back pain (Primary discopathy).

(*ii*) Post-discectomy syndrome (Secondary discopathy).

Contraindications for Lumbar ADR

(*i*) Mechanical instability in form of Lysis, listhesis or resection of the facet joints.

(*ii*) Radiculopathy due to disc prolapse (leg pain much more than back pain).

(*iii*) Facet arthrosis with or without spinal stenosis.

(*iv*) Infection.

(*v*) Osteoporosis.

(*vi*) Adhesive archnoiditis.

(*vii*) Multiple abdominal surgery.

(*viii*) Morbid obesity.

THE ARTIFICIAL CERVICAL DISC

The Bryan disc

Vincent Bryan, an American Neurosurgeon invented the artificial cervical disc, which has been in clinical use since 1997. The Bryan disc (*Fig*.3) is composed of polyurethane polymeric nucleus between two titanium alloy shells with porous coated surfaces for bone ingrowths. The Bryan disc has been utilized for single as well as double level replacement in our institution.

Indication for cervical ADR

Degenerative disc disease associated with radiculopathy or myelopathy from C3-4 to C6-7 levels.

Fig. 3. The artificial cervical disc prosthesis “The Bryan Disc”.

Contraindication for cervical ADR

(*i*) Infection

(*ii*) Osteoporosis

(*iii*) Mechanical instability

MATERIAL AND METHODS

The lumbar artificial disc replacement

We present the results of our patients who underwent lumbar arthroplasty. A total of six patients were operated from October 2004 to May 2005. All patients were between 30-45 years age group. Four patients were female and two male. All patients had single level arthroplasty. Of these, three patients had L4-5 level and three patients had L5-S1 level disc arthroplasty. Five patients had primary discopathy with chronic mechanical low back pain and one patient had previously been operated for disc prolapse with persistent complaint of chronic low back pain.

Pre-operatively, all the patients were evaluated with X-rays and MRI of lumbar spine. Plain X-rays showed disc space reduction (*Fig.* 4). Provocative discography was done in multiple level disc degeneration. Provocation of pain during discography was considered as an important indicator for level selection. Patients were operated in the supine position. By a retroperitoneal approach, adequate anterior decompression and meticulous discectomy was done. The end plates were prepared and SB Charite’ III disc was implanted with specific jig instruments (*Figs.* 5,6)

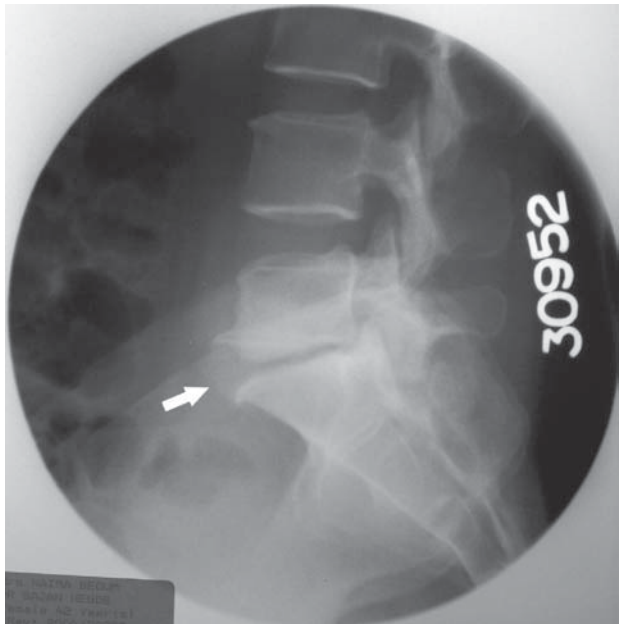


Fig. 4. X-ray showing degenerated disc with space reduction at L5-S1 level (arrow), other levels show normal disc height.

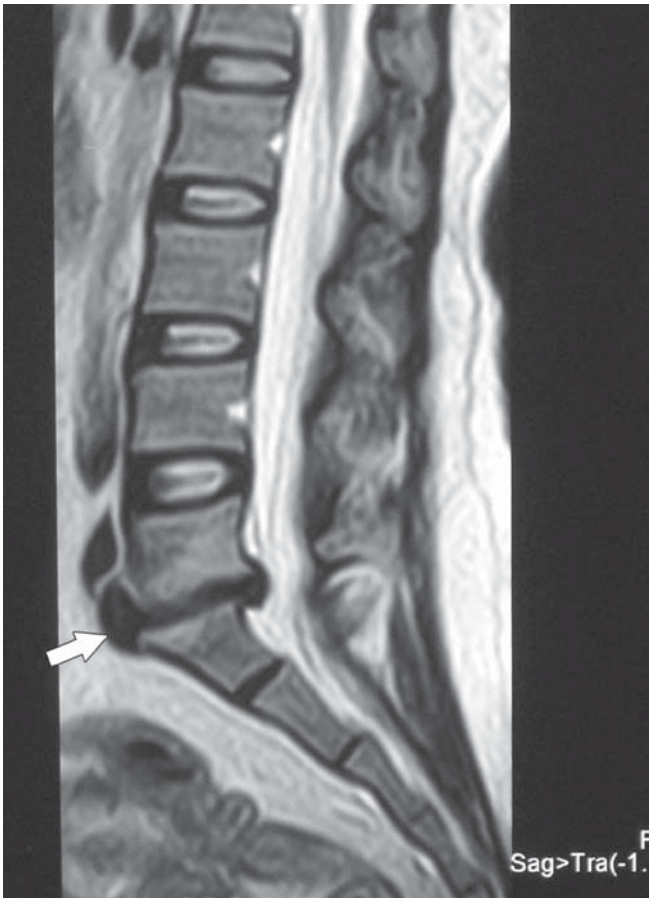


Fig. 5. MRI of degenerated disc (arrow) at L5-S1 level in contrast to normal disc at other levels.

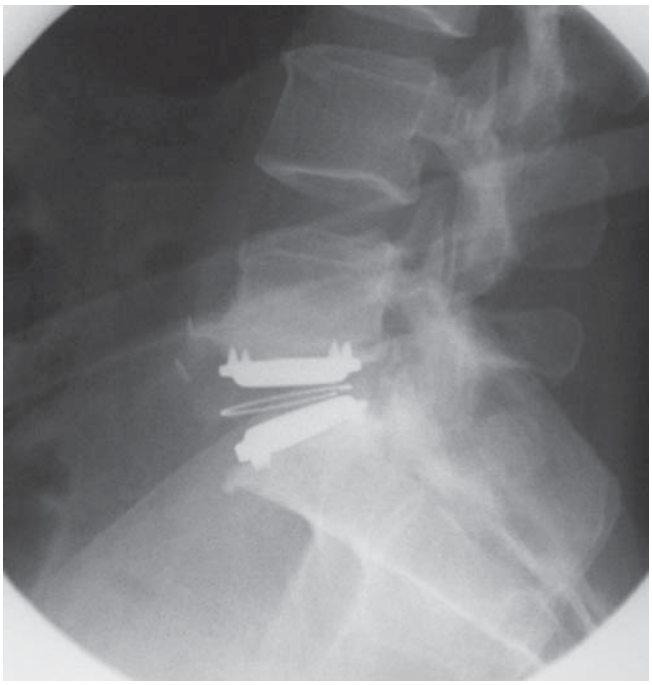


Fig. 6. X-ray showing SB Charite' Type III disc prosthesis at L5-S1 level.

Post-operative complications

No complication related to implant or the procedure was encountered.

All the patients were mobilized from first post-op day with soft lumbosacral brace support. The follow up ranged from two to ten months. Patients were reviewed after six weeks and then at three and six months. During follow up flexion and extension X-rays were taken to document functional movement.

Follow up evaluation was done with

(*i*) Visual analogue score (VAS).

(*ii*) Functional range of movement.

(*iii*) Return to prior work.

Out of six, in five patients the visual analogue score for pain improved from eight to zero while one patient continues to have some low back pain though of much reduced intensity. All patients demonstrated to have average 7º of functional movements on dynamic X-rays. All the patients returned to their prior job within two to seven days of surgery.

The cervical artificial disc replacement

We present an analysis of early clinical outcome of our patients who underwent cervical arthroplasty. Twelve Bryan discs were implanted between 2003-2004. Out of these, eight patients had single level and two patients had double level arthroplasty (*Figs*. 7,8). All patients were between 30-45 years age group with equal gender ratio. Eight patients were from a high professional group (doctors, executives and software specialists). Clinically nine patients had complaints of radiculopathy with neck pain. One patient had compressive cervical myelopathy. The duration of symptoms ranged from 5 to 30 months. The commonest level was C5-C6 disc (8 cases). One patient had previous fusion at the C6-7 level and then she developed disc degeneration and radiculopathy at the adjacent C5-C6 level for which arthroplasty was done.

Pre-operatively all the patients were evaluated with X-ray and MRI of cervical spine. A CT scan was done in all patients to accurately assess the size of the disc. Patients were operated in supine position. Adequate anterior decompression and meticulous discectomy was done, following which the Bryan disc was implanted with specific jig instruments.

Post operative complications

One patient developed hoarseness of voice, which recovered in three weeks. No other complication related to the implant or procedure was encountered.

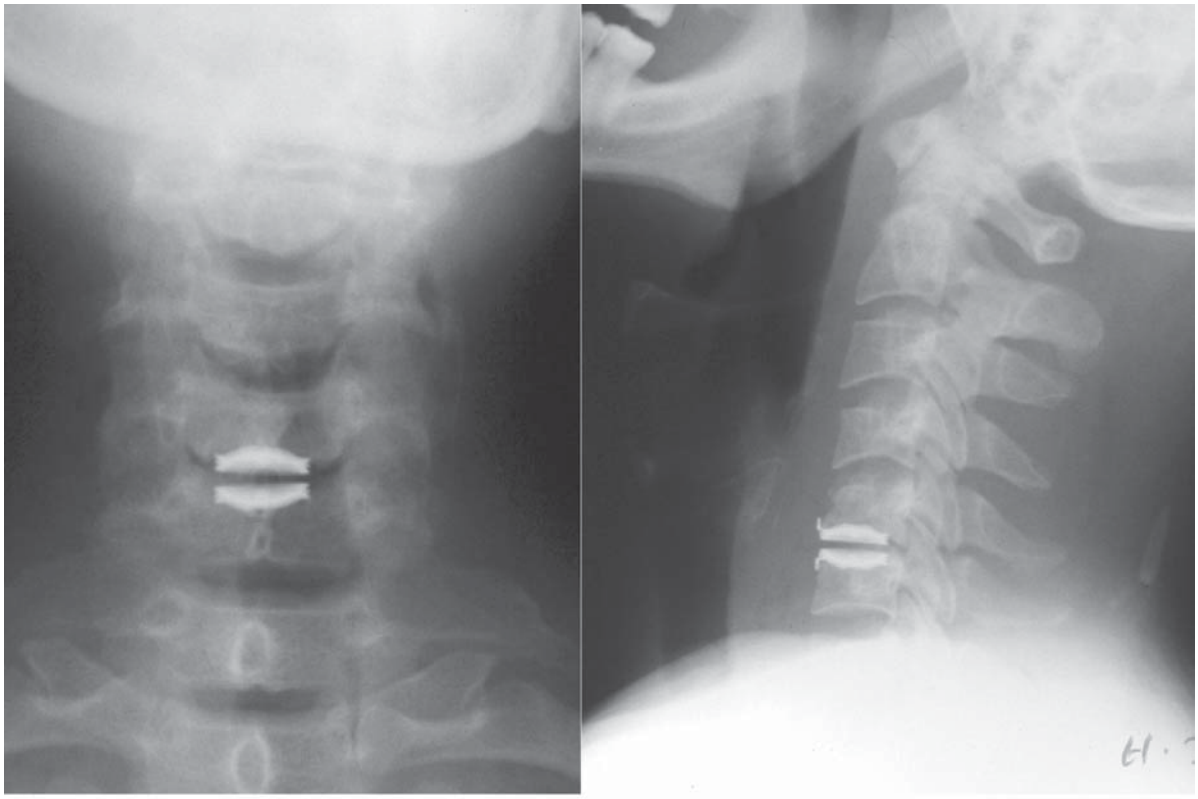


Fig. 7. X-rays showing single level Bryan disc prosthesis at C5-C6 level.

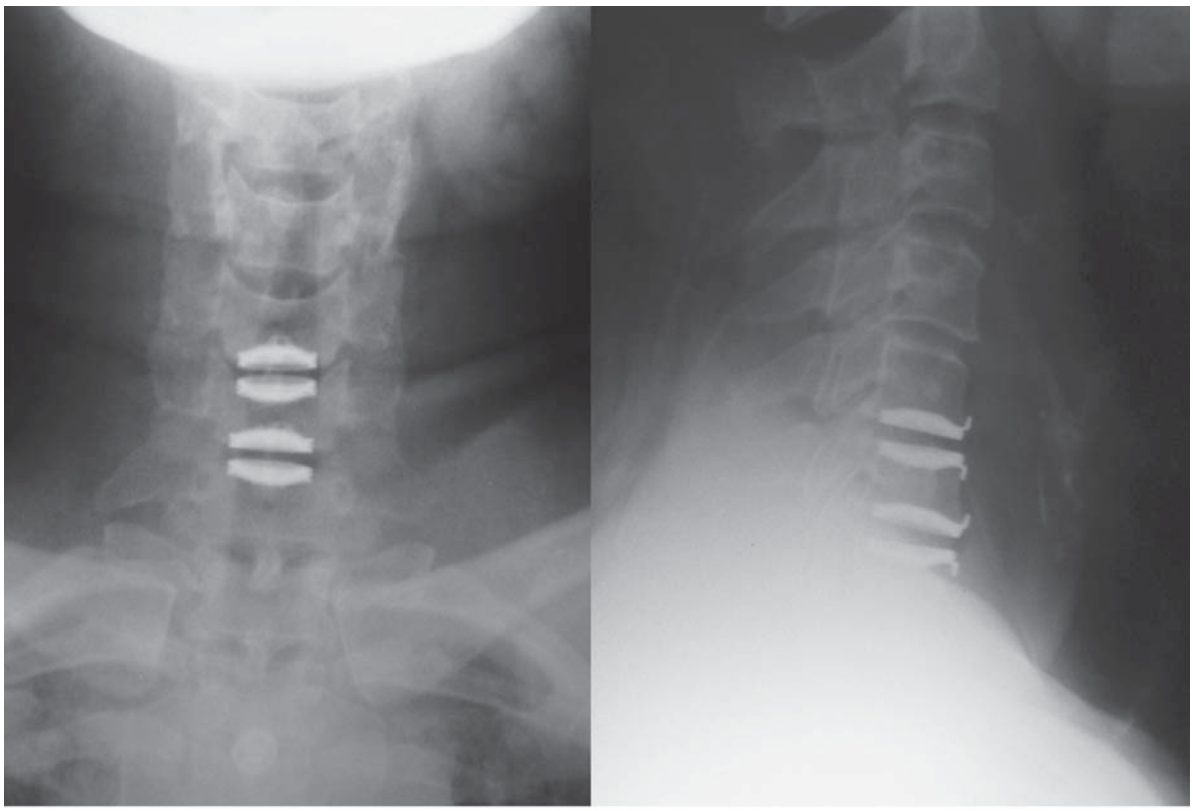


Fig. 8. X-rays showing double level Bryan disc prosthesis at C5-6 and C6-7 level.

All the patients were mobilized from first post-op day without brace support. Neck movements were encouraged from second post-op day. The follow up ranged from six months to 1½ years. Patients were reviewed at six weeks and then seen at three and six months. During follow up flexion and extension X-rays were taken to document range of movement.

Follow up evaluation was done with

(*i*) Visual analogue score

(*ii*) Range of movement

(*iii*) Return to prior work

RESULTS

Patients were assessed according to the modified Odom's criteria. At the end of one year excellent results were reported in 90% of cases with good results in remaining 10% of cases.

Wear Analysis

The failure of total joint replacement has been largely attributed to wear debris from polymer-bearing surfaces. Wear debris induces an intense cellular inflammatory reaction, which results in then production of cytokines that cause resorption of bone. This process known as aseptic loosening, leads to destabilization and mechanical failure of the joint. The possibility of the similar process occurring with polymer nucleus of both the variety of disc prostheses has been studied.

The Lumbar SB Charite' disc [7]

The clinical evaluation of users of the SB Charite' discs have shown that the wear debris develop only by abrasion of the polymer surface. These abrasions donot occur when parallel positioning of properly sized endplates has been achieved. The abrasion occurs only when the load is concentrated on a small region of the core due to incorrect positioning or too small size of implant. It is interesting to note that no signs of "polyethylene disease" or periprosthetic osteolysis from such abrasion have been detected in the tissues surrounding the artificial disc, even where particles of polyethylene were found. This is most probably due to the absence of synovia in the area where the prosthesis is positioned [8].

The Cervical Bryan Disc

Anderson, *et al.* [9] have published a pivotal study on the wear characteristic of the Bryan disc *in vitro* in a cervical spine simulator and *in vivo* biologic response in goat and chimpanzee models. The authors concluded that the wear rate is low *in vitro* and they did not find any inflammatory response *in vivo* models. This is an extremely important observation predicts satisfactory long-term performance.

Limitations of artificial disc Replacement

As a new technology the ADR requires long term follow up. Selection of the patient is of paramount importance for the success of the procedure. The implantation of this prosthesis requires a thorough understanding of the biomechanics and training in the techniques. The high cost of implant is comparable with the cost of the other total joint implants for knee and hip joints.

CONCLUSION

The long-term results of lumbar disc replacement gives a possibility to offer a motion retaining spinal surgery and a possibility of being able to minimize adjacent level disc degeneration. However, intermediate and long-term results are required for cervical arthroplasty before we can safely say that spinal arthroplasty is the procedure of choice in degenerative disc disease. The biomechanical studies have demonstrated that disc replacement creates less strain on the adjacent level than fusion. Wear studies suggest that there may be less potential for aseptic loosening than large joint arthroplasty. Obviously the jury is still out on this technology, but early reports suggest the verdict may be promising in carefully selected cases.

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