

# Long term preservation of motion with artificial cervical disc implants: A comparison between cervical disc replacement and rigid fusion with cage

Rafael Cincu, Francisco de Asis Lorente<sup>1</sup>, Joaquin Gomez<sup>1</sup>, Jose Eiras<sup>1</sup>, Amit Agrawal<sup>2</sup>

Department of Neurosurgery, University General Hospital, Valencia, <sup>1</sup>Miguel Servet University Hospital, Zaragoza, Spain,

<sup>2</sup>Department of Neurosurgery, Narayana Medical College and Hospital, Nellore, Andhra Pradesh, India

## ABSTRACT

**Background:** With the advancement of technologies there is more interest in the maintenance of the spine's biomechanical properties focusing on the preservation of the functional motion segment. In present article we describe our experience with 25 cases managed with artificial cervical discs with 28 Solis cage following cervical discectomy with a mean follow-up period of 7.5 year.

**Materials and Methods:** All surgeries were performed by single surgeon from March 2004 to June 2005 with a follow-up till date. Patients with symptomatic single or multiple level diseases that had no prior cervical surgery were candidates for the study. Cohort demographics were comparable. Standardized clinical outcome measures and radiographic examinations were used at prescribed post-operative intervals to compare the treatment groups. Relief in radicular pain, cervical spine motion, and degenerative changes at follow-up were noted.

**Results:** In a total 53 cases, the mean age in prosthesis group was 47 years (age range: 30-63 years) and mean age in cage group was 44 years (32-62 years). Mean hospital stay was 2.7 days in both the groups. At 4 weeks complete cervical movements could be achieved in 19 cases in artificial disc group. Maintenance of movement after 7.5 years was in 76% of these patients. Lordosis was maintained in all cases till date. There was no mortality or wound infection in our series.

**Conclusions:** We conclude that artificial cervical disc could be an alternative to fixed spinal fusion as it represents the most physiological substitute of disc. However, there is need for further studies to support the use of artificial cervical disc prosthesis.

**Key words:** Arthrodesis, cervical disc herniation, cervical arthroplasty, cervical prosthesis, prosthesis, spondylosis

## Introduction

Anterior cervical decompression and fusion, first described over 50 years ago, has become safe and the most common surgical procedure as an alternative to refractory non-operative therapy in patients with symptomatic degenerative cervical spondylosis.<sup>[1-3]</sup> With the advancement of technologies, there is a great interest in the maintenance of the spine's

biomechanical properties that focuses on the preservation of the functional motion segments.<sup>[4]</sup> Artificial cervical discs are designed to fulfill all these requirements. In present article we describe our experience with 25 cases managed with artificial cervical discs with 28 Solis cage following cervical discectomy with a mean follow-up period of 7.5 year.

## Materials and Methods

This prospective randomized study included a total of 53 patients of cervical disc degenerative disease presented with radicular pain, who without features of myelopathy underwent either placement of artificial cervical disc prosthesis Prestige II (Medtronic Sofamor Danek, Memphis, TN) or cage (anterior cervical discectomy and Solis (Solis, Stryker, Allendale, NJ, USA). All surgeries were performed from March 2004 to June 2005 with a follow-up till March 2012. All surgeries were performed by the single surgeon in the same manner. Patients with symptomatic single or multiple level diseases that had no prior cervical surgery were candidates for the study. Twenty-

### Access this article online

#### Quick Response Code:



#### Website:

www.asianjns.org

#### DOI:

10.4103/1793-5482.146608

### Address for correspondence:

Dr. Rafael Cincu, Department of Neurosurgery, University General Hospital, Valencia, Spain. E-mail: rafael.cincu@gmail.com

five patients were randomized to the Prestige II group and 28 to the arthrodesis (control) group. Cohort demographics were comparable. Standard right anterior cervical approach was used in all cases [Figures 1 and 2]. In three patients two level surgeries were performed and disc was removed, followed by the same size of the prosthesis and similar strategy was followed in six patients with cage group. Standardized clinical outcome measures and radiographic examinations were used at prescribed post-operative intervals to compare the treatment groups. All the patients were evaluated using static and dynamic cervical spine radiographs as well as magnetic resonance imaging as and when necessary. Clinical evaluation included the visual analogue scale neck and arm pain, neck disability index, and SF-36. Also the details of any complications and re-operations were noted.

## Results

The mean age in prosthesis group was 47 years (age range: 30-63 years) and mean age in cage group was 44 years (32-62 years). Sex distribution is shown in Table 1. In prosthesis group, 21 patients presented with unilateral radicular pain and paresthesia, four patients with bilateral radicular pain or paresthesia, and 10 patients had pre-operative focal motor deficits. Totally, 22 cases had single level disc prolapse on magnetic resonance imaging (MRI) and three patients had two level disc prolapse involving two consecutive levels [Table 2]. Two patients were further investigated pre-operatively with discography to confirm the disc as the pathology for pain. All patients who underwent cage placement presented with radicular pain and paresthesia without motor neurological deficits. MRI showed single level disc prolapse in 22 cases and two level disc prolapse in 6 cases [Table 3]. Mean hospital stay was 2.7 days in both the groups. In artificial cervical disc group, one patient had transient recurrent nerve paralysis that recovered over a period of 3 weeks. At 4 weeks, cervical movements were restored to the pre-operative level in 19 cases in artificial disc group [Figures 3-5]. Three months after the surgery in 21 patients the range of movements was similar to pre-operative period. Totally, 19 cases were able to attend the duties at 2 months follow-up. There were 2 cases in artificial cervical disc group who lost mobility at follow-up: One case at 8 months after the surgery developed anterior osteophytes and another case at 11 months after surgery lost mobility; however, the patients were doing well with good neck movements [Figure 6]. In the 2<sup>nd</sup> year follow-up, 1 case on radiologic study showed the degeneration at upper level disc with refractory pain to conservative treatment in the same dermatome previous to initial surgery and underwent prosthesis removal followed by C4-6 fixation and fusion with bone graft. No differences were found between cases with one level or two levels in this group. Two of three patients who underwent artificial disc placement at multiple levels had more than 80 months follow-up and did well with good

mobility similar to single level prosthesis. In cage group one patient developed immediate worsening of arm pain and neurological deficit probably due to nerve root lesion during surgery that was relieved with analgesics and rehabilitation. One patient had transient recurrent nerve paralysis that recovered over a period of 4 weeks. One patient with double level discectomy (C5-6 and C6-7) developed wound hematoma that needed urgent evacuation. Three patients had recurrence of cervical pain and were needed local infiltration at 3 and 6 months follow-up respectively. One patient underwent selective rhizotomy at 9 months for persistent cervical pain. One year after surgery one patient had removal of a Solis at another center. Decompression and fusion with Smith Robinson at the same level and the subjacent level with screws and plate for subjacent disc involvement was performed but later on the patient lost to follow-up. In one patient who was operated for one level with cage 2½ years after the first surgery was re-operated and circumferential arthrodesis was performed (C5-6 and C6-7) at another center and later on lost to follow-up. One patient with two level cage placements met a car accident 3½ years after surgery and suffered a continuous regional pain syndrome with essentially normal post-operative investigations. During follow-up in cage group, five patients showed radiologic evidence of degeneration at another level of the cervical spine and this change was noted at 4 years follow-up. Two patients in the cage group developed referred cervical pain at 2 years of follow-up and responded to conservative treatment. In one patient with cervical disc prosthesis at 7.5 years follow-up, degenerative changes were noted at another level of cervical spine ( $n = 25$ ) and in eight

**Table 1: Sex distribution**

Sex	Prosthesis (n=25)	Cage (n=28)
Male	9	11
Female	16	17

**Table 2: Number and distribution of patients in artificial disc group**

Level	Prosthesis
C4-5	1
C5-6	9
C6-7	12
C4-5 and C5-6	1
C5-6 and C6-7	2

**Table 3: Number and distribution of patients in cage group**

Level	Cage
C5-6	11
C6-7	11
C4-5 and C5-6	1
C5-6 and C6-7	5

patients with cervical cage ( $n = 28$ ) meant more cases with degeneration in case of cage in comparison with artificial disc [Figure 6]. The use of analgesics was reduced to  $\frac{1}{4}$  after the surgery for cervical pain in patients where artificial cervical disc was used. Lordosis was maintained in all cases till date and movements were preserved in 76% of these patients at 7.5 years. There was no mortality or wound infection in present series.

### Discussion

The intervertebral disc is a complex cartilaginous interface joint uniting the adjacent vertebral endplates.<sup>[5]</sup> Increased motion and elevated intra-discal pressures cumulatively translated into increased stress on the adjacent non-operated discs, which could accelerate the rate of disc degeneration.<sup>[6-8]</sup> It has been shown in several biomechanical studies in a

human cadaveric model that intra-discal pressure increases in adjacent disc segments following fusion.<sup>[6,9,10]</sup> This hypothesis for adjacent level degeneration is somewhat confounded, however, several studies state that clinical symptoms correlate poorly with the degree of degenerative disc changes which were radiographically observed.<sup>[11-13]</sup> As the cervical spinal fusion is designed to eliminate the normal motion of one or more vertebral segments, it is successful in many cases because the motion itself can cause irritation and pain due to the inability of the degenerative vertebral segment to support the weight of the body comfortably.<sup>[14,15]</sup> However, solid fusion of the vertebrae eliminates the intervertebral motion and its normal physiological function.<sup>[15-18]</sup> It has also been noted that many osteophytes at the level of the fusion spontaneously regress once a stable fusion has been achieved and this also has been interpreted as a desirable event.<sup>[19]</sup> In many studies



Figure 1: Intra-operative photograph showing cage placement

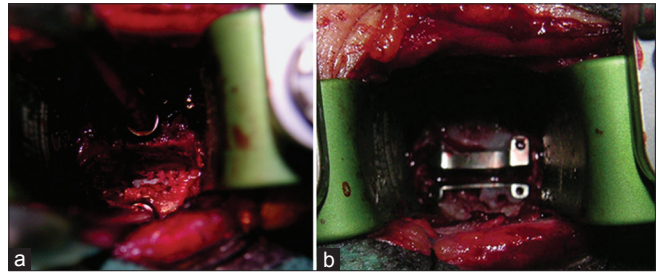


Figure 2: Intra-operative photograph showing disc space after disc removal (a) and artificial disc in place (b)

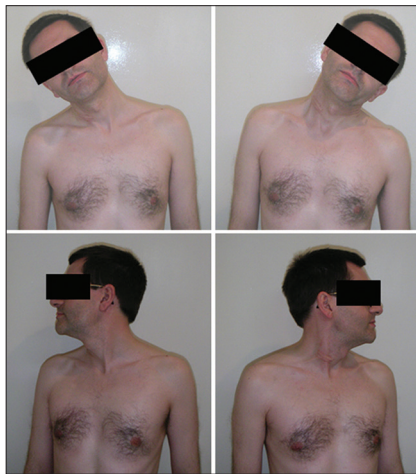


Figure 3: Follow up photograph showing range of neck movements in a case of artificial cervical disc

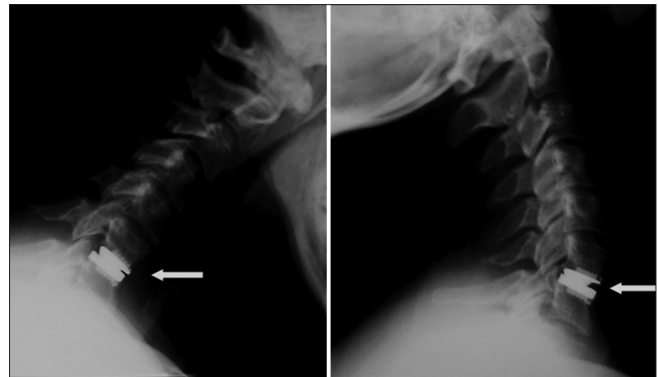


Figure 4: X-ray cervical showing movements of artificial cervical disc

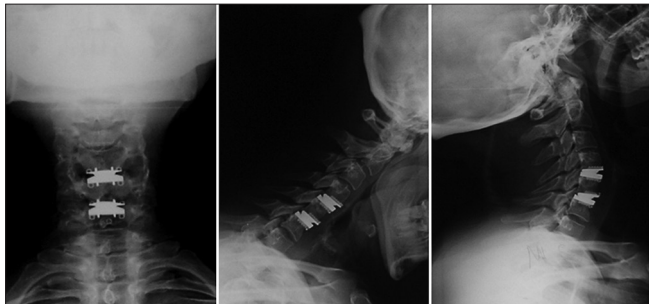


Figure 5: X-ray cervical showing movements of artificial cervical disc in a patient with two level diseases

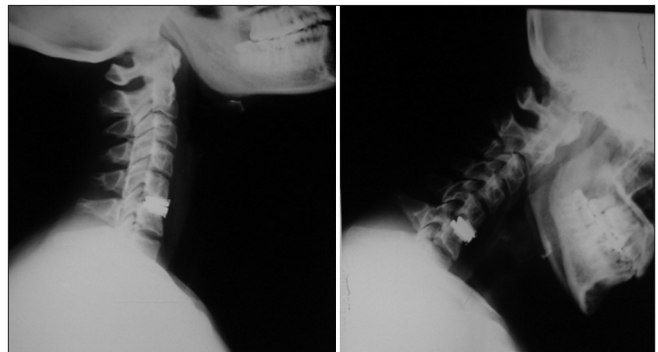


Figure 6: In the follow-up, number of patients show that cage group had 7 times more recurrence of pain than artificial disc group

it has been clearly shown that there is an acceleration of degenerative change in the discs and vertebrae adjacent to a fusion both in the lumbar and cervical spine following fixed arthrodesis.<sup>[8,13,20-24]</sup> All these studies support that after fixed arthrodesis motion is not the only measured outcome that may be adversely affected.<sup>[6,9,10]</sup> Because of these facts there continues to be much controversy regarding spinal fusion versus preservation of inter-segmental motion with a continuous search for a better option for cervical fixation that can provide the spinal stability and at the same time can preserve the function of the spine particularly, motion without hastening the degenerative process adjacent to the fused level. Taking all these facts into consideration, the artificial vertebral disc implants were developed and used with good results.<sup>[15-18]</sup> Our study supports that the artificial disc prosthesis can preserve the good mobility of the cervical spine in all directions with good relief of radicular symptoms in patients with less incidence of increase in degenerative changes in comparison to cage group where the spine mobility is restricted. The issue of accelerated degeneration is much complicated and it has been suggested that adjacent segment disease though a common problem, however, it may reflect the natural history of the underlying cervical spondylosis instead of the effect of the cervical fusion.<sup>[8,22]</sup> But preservation of spinal mobility in our series with artificial disc has shown less incidence of such degenerative changes. Though we see the degenerative changes on follow-up images the patients may not be symptomatic for these changes as there is no clear correlation between changes seen radiographically and the clinical condition of patients.<sup>[25]</sup> For the cervical spine, there is little clinical data regarding patients in whom segmental motion has been preserved<sup>[26]</sup> but there are growing concerns for the development of adjacent segment disease and a search for a comprehensive solution that provides the benefits of neural decompression without the drawback of placing adjacent motion segments at risk.<sup>[18,27]</sup> Another issue is restoration or maintenance of a normal cervical lordotic curvature that is very essential, and the ideal cervical spinal arthroplasty device and procedure would restore normal lordotic sagittal alignment as well as maintain segmental mobility.<sup>[8,28,29]</sup> We believe that an artificial cervical disc can be a good alternative for this purpose with good functional outcome as it preserves of the motion at the operated level, provides biomechanical stability, and maintain neck mobility. Many facts are well supported in our study also and include with artificial vertebral disc implantation abnormal motion can be corrected, the intervertebral space height will be restored, physiological curvature and the instantaneous axis of rotation will be normalized, the corrected normal intervertebral motion will be maintained over time, and patients will experience pain relief and return to function<sup>[14,16,17]</sup> with a decreased incidence of kyphotic deformity.<sup>[30,31]</sup> Mobility of the cervical spine though may not be affected much in single level fusion but may adversely be affected when multi-level treatments are

necessary and can be very detrimental to the remaining motion segments.<sup>[32]</sup> We see very good results in all our 3 cases where we used artificial cervical disc at two levels, and out of these, two patients are doing well at follow-up. In cases of fusion, all structures capable of nociception are fixed, which is not so in arthroplasty;<sup>[33,34]</sup> however; as in present series and also in the literature, the success rate of arthroplasties is comparable with that of fusions.<sup>[35-37]</sup> It is well known that anterior cervical approach for discectomy and fusion can lead to complications and these include recurrent laryngeal nerve injury, injury to neck vessels and other neck structures, post-operative dysphagia, hematoma, pseudo-arthrosis, collapse of inter-body graft, and potential hardware problems.<sup>[38, 39]</sup> We also saw few complications in our series but could be managed successfully with good and complete recovery.

## Conclusion

The implantation of artificial intervertebral discs represents a contradicting philosophy when compared with spinal fusion as the purpose of implantation of artificial disc is motion preservation, whereas spinal fusion is motion elimination.<sup>[15-18]</sup> We concluded that artificial cervical disc could be an alternative to fixed spinal fusion as it represents the physiological substitute of disc with less than 1/7 degenerative events after the surgery in comparison with Solis cages. However, there is need of further studies to support the use of artificial cervical disc prosthesis.

## References

1. Cloward RB. The anterior approach for removal of ruptured cervical disks. *J Neurosurg* 1958;15:602-17.
2. Cloward RB. The treatment of ruptured lumbar intervertebral disc by vertebral body fusion. III. Method of use of banked bone. *Ann Surg* 1952;136:987-92.
3. Smith GW, Robinson RA. The treatment of certain cervical-spine disorders by anterior removal of the intervertebral disc and interbody fusion. *J Bone Joint Surg Am* 1958;40:607-24.
4. Pracyk JB, Traynelis VC. Treatment of the painful motion segment: Cervical arthroplasty. *Spine (Phila Pa 1976)* 2005;30:S23-32.
5. Gosh P. The biology of the intervertebral disc. Boca Raton, FL: CRC Press; 1988.
6. Pospiech J, Stolke D, Wilke HJ, Claes LE. Intradiscal pressure recordings in the cervical spine. *Neurosurgery* 1999;44:379-84.
7. Baba H, Furusawa N, Imura S, Kawahara N, Tsuchiya H, Tomita K. Late radiographic findings after anterior cervical fusion for spondylosis myeloradiculopathy. *Spine (Phila Pa 1976)* 1993;18:2167-73.
8. Hilibrand AS, Carlson GD, Palumbo MA, Jones PK, Bohlman HH. Radiculopathy and myelopathy at segments adjacent to the site of a previous anterior cervical arthrodesis. *J Bone Joint Surg Am* 1999;81:519-28.
9. Weinhoffer SL, Guyer RD, Herbert M, Griffith SL. Intradiscal pressure measurements above an instrumented fusion. A cadaveric study. *Spine (Phila Pa 1976)* 1995;20:526-31.
10. Eck JC, Humphreys SC, Lim TH, Jeong ST, Kim JG, Hodges SD, *et al.* Biomechanical study on the effect of cervical spine fusion on adjacent-level intradiscal pressure and segmental motion. *Spine (Phila Pa 1976)* 2002;27:2431-4.
11. Cherubino P, Benazzo F, Borromeo U, Perle S. Degenerative arthritis of the adjacent spinal joints following anterior cervical spinal fusion: Clinicoradiologic and statistical correlations. *Ital J Orthop Traumatol* 1990;16:533-43.

12. Gore DR. Roentgenographic findings in the cervical spine in asymptomatic persons: A ten-year follow-up. *Spine (Phila Pa 1976)* 2001;26:2463-6.
13. Kulkarni V, Rajshekhar V, Raghuram L. Accelerated spondylotic changes adjacent to the fused segment following central cervical corpectomy: Magnetic resonance imaging study evidence. *J Neurosurg* 2004;100:2-6.
14. Geisler FH, Blumenthal SL, Guyer RD, McAfee PC, Regan JJ, Johnson JP, *et al.* Neurological complications of lumbar artificial disc replacement and comparison of clinical results with those related to lumbar arthrodesis in the literature: Results of a multicenter, prospective, randomized investigational device exemption study of Charité intervertebral disc. Invited submission from the Joint Section Meeting on Disorders of the Spine and Peripheral Nerves, March 2004. *J Neurosurg Spine* 2004;1:143-54.
15. Boden SD, Balderston RA, Heller JG, Hanley EN Jr, Zigler JE. An AOA critical issue. Disc replacements: This time will we really cure low-back and neck pain? *J Bone Joint Surg Am* 2004;86-A:411-22.
16. Gunzburg R, Mayer HM, Szpalski M, Aebi M. Arthroplasty of the spine: The long quest for mobility. Introduction. *Eur Spine J* 2002;11:S63-4.
17. Szpalski M, Gunzburg R, Mayer M. Spine arthroplasty: A historical review. *Eur Spine J* 2002;11:S65-84.
18. Le H, Thongtrangan I, Kim DH. Historical review of cervical arthroplasty. *Neurosurg Focus* 2004;17:1-9.
19. Robinson R, Smith G. Anterolateral cervical disc removal and interbody fusion for cervical disc syndrome. *Bull John Hopkins Hosp* 1955;96:223-4.
20. Aota Y, Kumano K, Hirabayashi S. Postfusion instability at the adjacent segments after rigid pedicle screw fixation for degenerative lumbar spinal disorders. *J Spinal Disord* 1995;8:464-73.
21. Hilibrand AS, Yoo JU, Carlson GD, Bohlman HH. The success of anterior cervical arthrodesis adjacent to a previous fusion. *Spine (Phila Pa 1976)* 1997;22:1574-9.
22. Hilibrand AS, Robbins M. Adjacent segment degeneration and adjacent segment disease: The consequences of spinal fusion? *Spine J* 2004;4:S190-4.
23. Gillet P. The fate of the adjacent motion segments after lumbar fusion. *J Spinal Disord Tech* 2003;16:338-45.
24. Ishihara H, Kanamori M, Kawaguchi Y, Nakamura H, Kimura T. Adjacent segment disease after anterior cervical interbody fusion. *Spine J* 2004;4:624-8.
25. Gore DR, Sepic SB, Gardner GM. Roentgenographic findings of the cervical spine in asymptomatic people. *Spine (Phila Pa 1976)* 1986;11:521-4.
26. Phillips FM, Carlson G, Emery SE, Bohlman HH. Anterior cervical pseudarthrosis. Natural history and treatment. *Spine (Phila Pa 1976)* 1997;22:1585-9.
27. Grundy P, Nelson R. The long-term outcome of anterior cervical decompression and fusion. London: British Cervical Spine Society; 1998.
28. Rajshekhar V, Arunkumar MJ, Kumar SS. Changes in cervical spine curvature after uninstrumented one- and two-level corpectomy in patients with spondylotic myelopathy. *Neurosurgery* 2003;52:799-804.
29. Wigfield CC, Skrzypiec D, Jackowski A, Adams MA. Internal stress distribution in cervical intervertebral discs: The influence of an artificial cervical joint and simulated anterior interbody fusion. *J Spinal Disord Tech* 2003;16:441-9.
30. Cummins BH, Robertson JT, Gill SS. Surgical experience with an implanted artificial cervical joint. *J Neurosurg* 1998;88:943-8.
31. Pointillart V. Cervical disc prosthesis in humans: First failure. *Spine (Phila Pa 1976)* 2001;26:E90-2.
32. DiAngelo DJ, Roberston JT, Metcalf NH, McVay BJ, Davis RC. Biomechanical testing of an artificial cervical joint and an anterior cervical plate. *J Spinal Disord Tech* 2003;16:314-23.
34. Frymoyer JW, Hanley EN, Howe J, Kuhlman D, Matteri RW. A comparison of radiographic findings in fusion and non fusion patients ten or more years following lumbar disc surgery. *Spine* 1978;3:1-6.
35. Hanley EN Jr, Levy JA. Surgical treatment of isthmic lumbosacral spondylolisthesis. Analysis of variables influencing results. *Spine (Phila Pa 1976)* 1989;14:48-50.
36. Wiltse LL, Rocchio PD. Preoperative psychological tests as predictors of success of chemonucleolysis in the treatment of the low-back syndrome. *J Bone Joint Surg Am* 1975;57:478-83.
37. Szpalski M, Gunzburg R. The role of surgery in the management of low back pain. *Baillieres Clin Rheumatol* 1998;12:141-59.
38. Puckett TA. Treatment options for failure of anterior cervical discectomy and fusion. *Semin Neurosurgery* 2003;14:61-6.
39. Albert TJ, Eichenbaum MD. Goals of cervical disc replacement. *Spine J* 2004;4:292-293S.

**How to cite this article:** Cincu R, Lorente Fd, Gomez J, Eiras J, Agrawal A. Long term preservation of motion with artificial cervical disc implants: A comparison between cervical disc replacement and rigid fusion with cage. *Asian J Neurosurg* 2014;9:213-7.

**Source of Support:** Nil, **Conflict of Interest:** None declared.

## Staying in touch with the journal

### 1) Table of Contents (TOC) email alert

Receive an email alert containing the TOC when a new complete issue of the journal is made available online. To register for TOC alerts go to [www.asianjns.org/signup.asp](http://www.asianjns.org/signup.asp).

### 2) RSS feeds

Really Simple Syndication (RSS) helps you to get alerts on new publication right on your desktop without going to the journal's website. You need a software (e.g. RSSReader, Feed Demon, FeedReader, My Yahoo!, NewsGator and NewzCrawler) to get advantage of this tool. RSS feeds can also be read through FireFox or Microsoft Outlook 2007. Once any of these small (and mostly free) software is installed, add [www.asianjns.org/rssfeed.asp](http://www.asianjns.org/rssfeed.asp) as one of the feeds.