Motion preservation in cervical prosthesis surgery: Implications for adjacent segment degeneration

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Chapter 12

Summary

Cervical motion preservation prostheses are considered a developing technology, with widespread clinical use beginning in the early 2000s. They are developed to reduce adjacent segment degeneration (ASD) in the postsurgical follow-up by maintaining range of motion (ROM). However, it is still a controversial issue. The main objective of this thesis was to uncover the relationship between preserved motion and radiological ASD in patients with single-level cervical radiculopathy. Other factors which may be correlated to ASD were studied as well.

The basis of this study was the NECK and PROCON trial: two prospective randomized controlled trials among patients with single-level cervical radiculopathy. Anterior cervical discectomy with prosthesis (ACDA) was compared to a conventional approach with (ACDF) or without an interbody cage (ACD). No significant differences in clinical outcomes after two-year follow-up were demonstrated. The current thesis considers the radiological outcome data.

Chapter 1 gives an introduction and an history of surgical treatment of cervical radiculopathy. At present, ACDF is defined as the gold standard for cervical disc herniation surgery since clinical researchers have demonstrated excellent clinical outcome with low complication rates in long term follow-up. Subsequently, the concept of ASD was proposed since arthrodesis of a motion segment was documented to lead to increased mechanical load and stress at the levels adjacent to the fusion site. Cervical prosthesis was developed to prevent ASD and thereby avoid neck pain and disability in postoperative follow-up by motion preservation. However, the benefits of implanting a cervical prosthesis remain controversial and the basis of preventing ASD by maintaining ROM has not been confirmed.

Chapter 2 describes the results of a systematic review on radiological follow-up after implanting cervical disc prosthesis in anterior discectomy. Radiological signs of ASD were present at baseline in 50% of patients, and there is a low-level evidence that this increased more (10%–20%) in the fusion group at long-term follow-up. However, this was only studied in the mixed study population, which is degenerative by diagnosis.

Chapter 3 reports on the correlation between the size of the disc herniation and the clinical condition, as well as the prognostic value of MRI findings in relation to clinical outcome in patients with cervical radiculopathy. At baseline, the patients in the mild herniation group had a comparable neck disability index (NDI) and 36-Item Short Form Health Survey (SF-36) to the patients in the severe herniation group. Likewise, both disabling arm pain and disabling neck pain were comparable in the mild and severe herniation group. At two years after surgery, no difference was found in any of the clinical parameters between the two groups. Therefore, in patients suffering from cervical radiculopathy, the size of disc herniation does not correlate to the severity of clinical symptoms at baseline and does not allow to predict clinical outcome after surgical treatment at two-year follow-up.

Chapter 4 reports on the incidence of radiological ASD comparing cervical prosthesis surgery to cervical arthrodesis surgery. ASD was present in 34% of patients at baseline and in-

creased to 59% at two-year follow-up in the arthrodesis groups (ACD and ACDF combined), and to 56% in the arthroplasty group. Progression of ASD was present in 29% of patients in the arthrodesis group and in 31% of patients in the arthroplasty group at two-year follow-up. It was demonstrated that radiological ASD occurs in similarly in patients that were subjected to arthrodesis in cervical radiculopathy and in patients that received arthroplasty to maintain motion.

Chapter 5 reports on the relationship between ROM of the cervical spine (both at the target level and of the global cervical spine) and the presence of radiological ASD after cervical discectomy. In the prosthesis group, 63% patients with a preserved ROM (> 4 degrees at the target level) did not show a significantly lower incidence of ASD or less positive ASD progression than patients with an immobile cervical segment. In the analysis irrespective of surgical methods, no correlation was demonstrated between ROM and ASD, and neither for neck disability. Therefore, the advantage of a cervical motion preserving device to reduce accelerated degeneration at the adjacent levels is not confirmed in the present chapter.

Chapter 6 reports on the relationship between sagittal alignment and the presence of radiological ASD in the cervical spine. It was demonstrated that the cervical sagittal alignment parameters were comparable between the three treatment groups, both at baseline and at two-year follow-up. Irrespective of the surgical method used, C2-C7 lordosis was found to increase from 11 to 13 degrees, but the other parameters remained stable during follow-up. Only the occipito-cervical inclination (OCI) with higher degrees (108 to 113 degrees) was demonstrated to be associated with the presence and positive progression of radiological ASD, both at baseline and at two-year follow-up. Clinical outcome was demonstrated not to be correlated to cervical sagittal alignment. Likewise, a correlation to the value or change of the OCI was absent.

Chapter 7 describes the results of a systematic review of literature regarding the correlation between Modic changes (MCs) and clinical condition as well as cervical disc degeneration. The prevalence of MCs in cervical spine varied from 5 to 40% and type II was predominant. Patients with MCs were reported to experience more neck pain and neck disability. Cervical disc degeneration was detected more frequently in patients with MCs.

Chapter 8 reports on MCs findings, changes of MCs findings over time and the correlation between MCs findings and neck pain as well as disc degeneration in the cervical spine in our own study cohort. The prevalence of MCs was found to be 18% at baseline and increased to 28% at one year after surgery. Both at baseline and at one-year follow-up, the percentage of patients with and without MCs reporting neck pain was comparable. Likewise, both at baseline and at one-year follow-up, the percentage of patients with and without MCs reporting disabling arm pain was comparable. The patients with MCs demonstrated more radiological degeneration than those without MCs at baseline, but this difference disappeared at one year after surgery. Therefore, in disagreement with literature, we demonstrated only a tendency for

a correlation between the presence of MCs and radiological degeneration, but no correlation to neck pain or disability.

Chapter 9 reports on the occurrence and progression of heterotopic ossification (HO) in patients treated by ACDA, as well as the clinical relevance of HO. The occurrence of HO was 60% at one year, and it increased to 76% at two-year follow-up. 31% of patients was scored as high grade HO at one-year follow-up, and this percentage increased to 50% at two-year follow-up. Clinical outcome does not correlate to HO grade, and no risk factor for high grade HO could be identified. The ROM at the index level was significantly higher in low grade HO group than those patients with high grade HO, but the grade of HO does not consistently correspond to ROM. The McAfee-Mehren classification should be combined with ROM evaluation to properly study HO.

Chapter 10 reports on the occurrence of HO between the two cervical disc prostheses from the NECK and PROCON trial. At two-year follow-up, the occurrence of HO was 68% in patients treated with the activC prosthesis (severe HO 55%), which was comparable with 85% in patients with the Bryan disc (severe HO 44%). The HO progression was similar between the two groups. Clinically, the patients had comparable NDI, physical component summary and mental component summary of SF-36 at two years after surgery, and comparable improvement of clinical outcomes. The ROM of the total cervical spine in the Bryan group (56.4 ± 10.8 degrees) was significantly higher than that in the activC group (49.5 ± 14.0 degrees) at two years after surgery. Therefore, we conclude that the development of HO is independent on the architecture of the cervical disc prosthesis.