Matsumoto M, Okada E, Toyama Y, et.al. Tandem age-related lumbar and cervical intervertebral disc changes in asymptomatic subjects. European Spine Journal 2013; 22:708-713.

Critique author: Linda Metzger

Design: Observational Study

Objective: To investigate the frequency of tandem lumbar and cervical intervertebral disc degeneration in asymptomatic subjects using magnetic resonance (MR) imaging.

Population /sample size/setting/interventions:

- 129 of the original 497 subjects (262 males, 235 females) volunteered for this follow-up study ranging in age from 10 years to over 60 years of age spread uniformly across genders and the age groups. Most volunteers were known to the investigators. They included office workers, doctors, nurses, medical coworkers, manual workers, students, housewives and retired persons from the Japanese population (Matsumoto, 1998).
- Original subjects were included only if they had no current cervical spine symptoms, such as neck pain or brachialgia, and had no previous history of disease or trauma to the cervical spine or brain which needed medical care. Follow-up study subjects completed a questionnaire about any clinical symptoms related to the cervical spine (neck or back pain), as well as questions related to smoking, sports activities, and occupation. 35 subjects who reported neck, shoulder, or back pain were excluded from the follow-up study. This left 94 asymptomatic subjects for the follow-up study (48 males, 46 females; mean age 48.0$\pm$13.4 years).
- Original participants underwent MRI of the cervical spine between 1993 and 1996. Follow-up study subjects also underwent MRI of both the lumbar and cervical spine.
- The lumbar and cervical spine MR images were evaluated for 5 indicators of intervertebral disc degeneration: 1) decreased disc signal intensity, 2) posterior disc protrusion, 3) anterior compression of the dura, 4) narrowing of the disc space, and 5) spinal canal stenosis.
- In the original study, all the imaging studies were analyzed blindly by one spine surgeon (the primary author). Two other experienced spine surgeons also evaluated 103 MR images blindly and independently to allow evaluation of the reliability of the results. In this follow-up study, all the lumbar spine MR images were read blindly by the primary author only.
- Statistical analyses were conducted using McNemar's test and logistic regression analysis to identify potential associations between degenerative MRI findings in the lumbar spine and the following factors: age (< 40 years or ≥ 40), gender, smoking, sports activities, body mass index (BMI), and the presence of degenerative MRI findings in the cervical spine. A p value of <0.05 was considered statistically significant.

Main outcome measures:

- Since the original study had good inter-observer reliability, inter-observer reliability was not examined in this follow-up study. The kappa values from the original study for the 3 observers varied from moderate to good (0.51 to 0.60) for the various disc abnormalities.

- Degenerative disc changes in the lumbar spine were observed in 84% (79) of the subjects. Decreased disc signal intensity was seen in 74.5% of the subjects, posterior disc protrusion in 78.7%, anterior compression of the dura in 81.9%, disc space narrowing in 21.3%, and spinal canal stenosis in 12.8%. The percentage of degenerative changes increased at more caudal levels and with age for all types of degenerative MRI findings of the lumbar spine.
- The percentage of subjects with positive degenerative MRI findings at one or more discs did not differ significantly between the lumbar and cervical spine.
- When comparing the lumbar and cervical spine, positive degenerative MRI findings were observed in both areas of the spine in 78.7% of the subjects. Decreased disc signal intensity was seen in 64.9% of the subjects, posterior disc protrusion in 66.0%, anterior compression of the dura in 68.1%, disc space narrowing in 10.6%, and spinal canal stenosis in 4.3%.
- Three indicators of disc degeneration in the lumbar spine were significantly associated with an increase in age. They were decreased disc signal intensity (OR = 4.2, (95% CI 1.2-14.9; p=0.024), posterior disc protrusion (OR 7.9, 95% CI 2.0-32.2; p=0.004), and anterior compression of the dura (OR 8.8, 95% CI 2.2-35.4; p=0.002).
- A decrease in disc signal intensity in the lumbar spine was significantly associated with decreased disc signal intensity in the cervical spine (OR 4.9, 95% CI 1.4-17.1; p=0.012).
- Posterior disc protrusion in the lumbar spine was significantly associated with posterior disc protrusion in the cervical spine (OR 9.0, 95% CI 2.3-35.8; p=0.002).
- Anterior compression of the dura in the lumbar spine was significantly associated with female gender (OR 0.16, 95% CI 0.03-0.82; p=0.027).
- No factors were found to be significantly associated with disc space narrowing or with spinal canal stenosis.
- Degenerative disc changes in the cervical and lumbar spine as seen on MR images in asymptomatic subjects are common and increase with increasing age.
- Degenerative disc changes as seen on MR images in asymptomatic subjects affect the cervical and lumbar spine equally, suggesting that disc degeneration occurs in tandem in the lumbar and cervical spine.

Authors' conclusions:

- Decreased disc signal intensity, posterior disc protrusion, and anterior compression of the dura are very common MRI findings of the lumbar spine in asymptomatic individuals. Disc space narrowing and spinal canal stenosis were less commonly found in asymptomatic subjects.
- Positive MRI findings of disc degeneration at one or more intervertebral levels in the lumbar spine were found in 84% of asymptomatic subjects (mean age = 48 years). There were more degenerative MRI findings in the lumbar spine in older subjects.
- Decreased disc signal intensity and posterior disc protrusion were significantly associated with increased age and with the presence of corresponding MRI findings in the cervical spine.
- Anterior compression of the dura was significantly associated with age and with female gender.
- No significant association was found between lumbar disc degeneration and BMI or smoking.

- In 78.7% of the subjects, at least one type of degenerative MRI finding was observed in both the lumbar and cervical spine. These results suggest that disc degeneration occurs concurrently in the lumbar and cervical spine in asymptomatic subjects.
- Thus, asymptomatic subjects with degenerative disc changes in the lumbar spine were likely to have those changes in the cervical spine as well.
- One limitation of the study was that only T2 sagittal images were obtained for the lumbar spine due to limitations of imaging time and costs. The lack of T2 axial images might limit the diagnostic accuracy of the MR images in detecting degenerative changes especially for spinal canal stenosis.

Comments:

- Interobserver reliability/variability between the three radiologists in the original study was acceptable. All the lumbar spine MR images were read by the primary author in this follow-up study. He was obviously not blinded to the fact that all subjects were asymptomatic for low back pain and he knew the study's hypothesis. This knowledge could have introduced some risk of bias, but it's difficult to estimate the direction the bias may have influenced the results.
- Because T2 axial MR images were not obtained for the lumbar spine, an underestimation of spinal canal stenosis in the lumbar spine may have occurred.
- Table 5 shows that the neck and back are equally susceptible to degenerative changes based on McNemar's test. Age related disc changes do occur throughout the spine, and cervical and lumbar spine changes do indeed occur in tandem. When you see degenerative changes in the neck, you also see it in the lumbar spine.
- In the original study, cervical spine MR images were read without any knowledge or influence from the lumbar spine MR images, simply because no lumbar images were conducted. In this follow-up study, the primary author read all of the lumbar spine images blindly unaware of the previous original cervical spine MRI findings. However, the methodology is unclear as to whether or not the author read the second cervical spine MR images in the follow-up study blinded to the lumbar spine MR images. If the author was influenced by the lumbar results when reading the cervical spine images, this could possibly lead to an overestimation of the tandem correlation between the lumbar and cervical disc changes, and even worse undermine the study's conclusion.
- Most participants in the study were known to the authors and were selected based on their age and occupation. This convenience sample is not a random sample. This may have introduced selection bias into the study population in terms of age distribution and occupation, and may not be representative of the general population. It is unknown whether or not this type of bias would have influenced the conclusions.
- In addition, most of the participants were working and thus healthier than the general population. This healthy worker effect may also introduce selection bias, but it is unlikely to inflate the prevalence of cervical and lumbar spine abnormalities, since these disc changes would likely be less common in a healthy population.
- The study did provide separate analyses and results for males and females which helped its interpretability. Anterior compression of the dura in the lumbar spine was found to be more significantly associated with females than males.
- The classifications for disc degeneration in the lumbar spine are somewhat confusing. Since the vast majority of those patients who have anterior compression of the dura also

have a posterior disc protrusion, there is some overlap of these two categories. The presentation of data using these overlapping categories lacks clarity and is confusing to the reader.

- There appears to be a typographical error in Table 6 under posterior disc protrusion for BMI <25. It presently reads 5 patients and should probably read 51 patients.
- Anterior compression of the dura was significantly associated with female gender and the reported odds ratio (OR) was 0.16. This reported OR was actually for male gender and it would have been more clearly presented if the author had reported the OR for females (crude OR= 4.59), since females were more likely to present with anterior compression of the dura.

Assessment:

- This study is adequate for some evidence that asymptomatic subjects of all ages frequently show common degenerative changes in the cervical and lumbar spine as seen on MR images, and these changes are more common with increasing age, and the cervical and lumbar spine are equally affected, suggesting that disc degeneration occurs in tandem in the lumbar and cervical spine.

Reference:

Matsumoto M, Fujimura Y, et al. MRI of cervical intervertebral discs in asymptomatic subjects. J Bone Joint Surg Br 1993; 80-B: 19-24.