Outcomes of anterior cervical spine surgery

Chapter 14

Valérization

The primary focus of this thesis is to evaluate the outcomes of anterior cervical spine surgery for degenerative diseases. Key findings underscore the importance of using clear, uniform definitions, and standardizing outcome measures to create a solid foundation for research in spine surgery, particularly in terms of cost-effectiveness. This is significant for future researchers to be able to undertake similar investigations and to compare outcomes effectively.

How will the findings of this thesis impact future research?

Given the significant burden of disease of cervical spinal degenerative pathology and its substantial economic implications - primarily due to absenteeism in the working-age population - reliable research findings are essential. Currently, anterior cervical discectomy with arthroplasty (ACDA) is not reimbursed in the Netherlands. Implant costs are higher, and short-term clinical outcomes are similar to the standard treatment, anterior cervical discectomy with fusion (ACDF). However, in the long term, a decreased incidence of adjacent segment pathology (ASP) is expected due to the preservation of motion after ACDA. Studies investigating the incidence of ASP employ different definitions, including reoperations at the same or adjacent segments or radiologic changes on adjacent segments. This results in varying reported ASP rates and prevents us from evaluating the actual difference, and therefore also the cost-effectiveness, between the two techniques. By employing a clear definition of ASP, insight into the actual incidence can be gained, and the techniques can be compared. The aim of the CACES RCT described in *Chapter 12* is to compare the incidence of ASP between ACDA and ACDF resulting in level 1 evidence.

When looking at factors influencing ASP, both motion and cervical sagittal balance are thought to play a role. It is remarkable that although cervical sagittal balance is considered an important factor influencing outcomes of cervical spine surgery, barely any studies pay attention to patient positioning when acquiring X-rays. Literature shows that patient positioning significantly influences cervical sagittal balance measurements, which leads us to believe that conclusions cannot be drawn on non-standardized imaging. This is especially relevant when comparing results from different centers or studies. The correlation between spinal sagittal balance and ASP should therefore be studied in standardized X-rays.

Currently, motion is mainly investigated in static X-rays, which is contradictory. Therefore, we propose and validate a new way to look at motion by investigating dynamic fluoroscopic recordings. An artificial intelligence-assisted algorithm is currently being developed to make this method routinely accessible. When the labor- and time-intensiveness of this type of analysis can be decreased by artificial intelligence (AI), bigger amounts of data can be analyzed. It is of interest to gather data from large groups of individuals, including subgroups of different ages, pathologies, or implants. This will permit us to define normative motion patterns not only for (sub)groups, but on an individual level. Only then will it be possible to study whether certain operation techniques restore normal physiology.

When considering cost-effectiveness, the heterogeneity in performed research is evident. When systematically reviewing the methodology of all economic evaluations in spine surgery, it becomes apparent that not even two studies could be compared. Therefore, we conclude that there is no actual insight into the cost-effectiveness of spine surgery. The development of a disease-specific guideline aims to establish uniformity in future cost-effectiveness research and therefore comparability. The CACES trial will provide the first level 1 evidence concerning the cost-effectiveness of ACDA and ACDF, adhering to the previously mentioned guideline, employing clearly defined outcomes, as mentioned in this thesis.

As the results of cost-effectiveness studies become more comparable, we will gain greater insight into the actual cost-effectiveness of certain surgical techniques. It is quite possible that a specific intervention may be cost-effective in one country but not in another due to differing national costs and reimbursement systems. When cost-effectiveness is considered in surgical decision-making, healthcare costs can ultimately be limited.

What potential influence might these findings have on future practice?

The target audience for the findings presented in this thesis primarily includes fellow researchers engaged in similar studies. The aim is to perform research in this field with standardized methods and outcomes to validate and compare findings against established data. When gathering more data according to the proposed definitions and outcome measures, we can work towards defining normative data. At this point, if previous literature is not uniform, and therefore not comparable, normal values cannot be defined. We encounter this problem for the incidence of ASP, the outcomes of anterior surgery for cervical myelopathy, the measurement of cervical sagittal balance parameters, motion parameters, motion patterns, and cost-effectiveness research methodology. Ideally, by gathering more data with clearly used definitions and correlating these to clinical outcomes, we can define outliers and extremes or abnormal data. Remaining data could be considered to be in the 'normal' spectrum. Probably, not a single outcome measure can be defined as normal, but we can work towards defining the optimal outcome measure for an individual. In this, AI can aid in recognizing patterns and correlations in the data that is gathered. For example, depending on the individual, a certain cervical sagittal balance will be optimal for a specific patient. Factors such as age, body mass index (BMI), sagittal balance of the entire spine, degeneration, etc., possibly influence the optimal values for this patient. The same will apply to implants; probably, there is no 'one size fits all', but one optimal for a specific individual. When we are able to determine these values, we can tailor surgical approaches based on data gathered on the individual. For example, by defining normative motion patterns for specific individual variables, we could revolutionize preoperative planning in spine surgery. By conducting dynamic recordings preoperatively and predicting the influence of a specific surgery or implant on these patterns, we might be able to predict how patients would benefit optimally. Achieving individualized care, wherein the most suitable treatment can be

determined for each patient, will enhance both the quality of care and its cost-effectiveness. Therefore, the results of this thesis are pertinent for medical practitioners and policymakers within the healthcare sector. By advocating for standardization in diagnostics and striving for individualized care based on validated data, this research can pave the way for cost-effective treatment strategies tailored to individual patient needs.