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Evidenced-Based Orthodontic Care: A Challenge!

Dr. Kuijpers-Jagtman is Professor of Orthodontics in the Department of Orthodontics and Oral Biology, the University Medical Centre St. Radboud, University of Nijmegen, Nijmegen, The Netherlands. Her research interests are tooth movement and Cleft Lip and Palate.

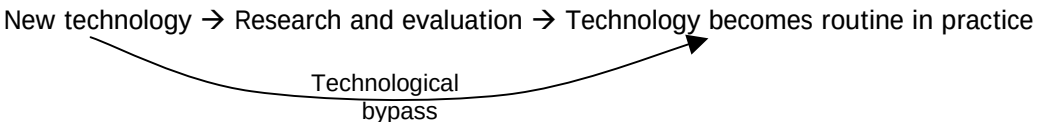
The first portion of her presentation focused on the challenge of incorporating Evidenced-Based Orthodontics into daily orthodontic practice. She presented a case she treated many years ago to emphasize that evidence-based information is not always available for technological advances that are applied to patient care. The case involved a 5 year-old female with a significant facial asymmetry due to a mild hemifacial microsomia. Traditional treatment choices at the time were:

1. Early functional appliance therapy of long duration.
2. Orthognathic surgery after growth had ceased.

However, she chose an early distraction osteogenesis (D.O.) procedure to distract the mandibular ramus vertically on the affected side. The results were very good with improved facial symmetry. Was the treatment evidenced-based?

The quality of evidenced-based information on treatment protocols follows a hierarchy: *Meta-analysis > systematic review > prospective randomized clinical trial > cohort study > case control study > retrospective case study > case report > a famous clinician's opinion.* Due to the fact that she could only rely on case reports for D.O., the quality of evidenced based information she used to apply D.O. as a treatment protocol was low.

She termed this type of situation a "technological bypass", whereby the desirable model to establish proper and efficacious treatment protocols are not followed as shown below:



She gave a historical perspective of the literature to show that even today, evidenced-based information is lacking for D.O. Yet it is a widely used procedure. One of the first articles published was in 1992: McCarthy, JG et al., Lengthening the human mandible by gradual distraction. *Plast Reconstr Surg*. 1992 Jan;89(1):1-8; discussion 9-10.

By 2001 a review article on D.O. was published, citing 109 papers presenting the results of 109 patients treated in one or both jaws and the midface region: Sweennen, G., Craniofacial distraction osteogenesis: a review of the literature: Part 1: clinical studies. *Int J Oral Maxillofac Surg*. 2001 Apr;30(2):89-103.

Currently, there are 1071 journal articles in D.O. However, there are no meta-analyses and only one randomized clinical trial is available. The overwhelming majority of publications are case reports. Therefore, there is insufficient data regarding long term stability and effectiveness of D.O.

Interestingly, the American Association of Oral and Maxillofacial Surgeons website promotes D.O. as a more cost-efficient and effective surgical procedure, yet there is no evidence-based data to support this claim.

Dr. Kuijpers-Jagtman also pointed out that even with the technological advances in orthodontics over the past 40 years, patient improvement from orthodontic treatment, measured by PAR score, has not changed significantly. She cited her retrospective study in which she compared pre-treatment and post-treatment PAR scores for 6 groups of patients treated during different periods, 1965-70, 1971-75, 1976-80, 1981-85, 1985-90, 1991-95, at the University of Nijmegan orthodontic clinic. The table below shows the treatment outcomes and treatment times for these six groups to be similar.

Table 4
Comparison of the mean PAR at the pretreatment (PARpre) and posttreatment (PARpost) stages, relative improvement in the PAR, and the treatment duration for the whole sample according to treatment period

Years	N	PARpre Mean SD	PARpost Mean SD	% change Mean SD	Duration Mean SD
65-70	51	29.5 ±11.5	6.3 ± 6.5	76.1 ± 23.0	2.8 ± 1.4
71-75	140	28.6 ± 9.6	8.2 ± 6.9	68.4 ± 27.8	3.1 ± 1.6
76-80	238	29.1 ±10.3	9.3 ± 7.6	65.0 ± 28.8	2.8 ± 1.4
81-85	460	27.8 ±10.4	8.1 ± 5.6	67.4 ± 25.5	3.1 ± 1.5
86-90	559	27.0 ± 9.6	7.1 ± 5.5	70.5 ± 24.7	2.9 ± 1.4
91-95	422	26.7 ± 9.7	7.2 ± 5.7	70.0 ± 26.4	3.2 ± 1.4
p-value		0.018	0.000	0.019	0.002

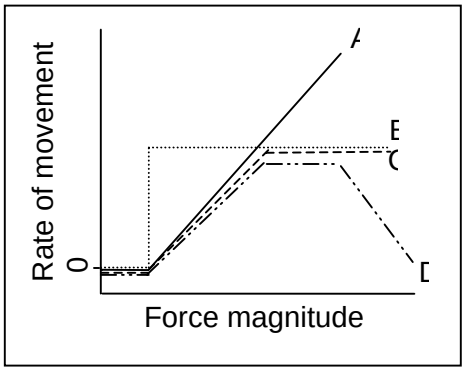
p-value = one way ANOVA

Al Yami, EA, Kuijpers-Jagtman, AM, Van't Hof, MA, Occlusal Outcome of Orthodontic Treatment, *The Angle Orthodontist*: Vol. 68, No. 5, pp. 439–444.

A major problem with interpreting research on the lower portion of the evidenced-based hierarch (cohort studies, case control studies, retrospective case studies) is that bias is often found in these types of studies. She outlined 5 types of bias in clinical research:

1. Selection bias: This occurs when the subjects chosen for the study are not selected randomly.
2. Follow-up bias: This occurs when subjects that provide data for the first measurements have dropped from the study by the final measurements. (e.g. 100 pre-treatment records are measured and 50 post-treatment records are measured)
3. Exclusion bias: This occurs when subjects are excluded for reasons such as non-compliance.
4. Evaluation bias: Evaluators of subjective criteria must be independent of the investigators.
5. Reporting bias: Results that show a positive improvement are move likely to be published, cited and presented than results that show negative or no improvement.

The second portion of her presentation dealt with the evidence available for the very important clinical question: *How much force should be applied to move a tooth?* She cited a 1985 article that proposed 4 mathematical models for how the rate of tooth movement is affected by the magnitude of the force applied:



Quinn RS, Yosikawa, KA, reassessment of force magnitude in orthodontics. *Am J Orthod*. 1985;88:252-260

In 2001 she asked whether or not there was evidenced-based information to support any of the above models of tooth movement. She began at the Cochrane website (www.cochrane.org) and found no meta-analyses or systematic reviews had been published. She then searched PubMed, limiting her search to any studies other than case reports, and found 333 human studies and 93 animal studies on tooth movement, but no systematic reviews. She then outlined the procedure for performing her own systematic review of these 426 articles:

1. Set inclusion criteria for acceptable studies to be included in the systematic review. These included the range of applied forces, the type of tooth movement measured, and for animal studies the species of animal tested.
2. Query the 426 articles on these inclusion criteria to select studies for meta-analysis (a pooling of data from similar studies to increase statistical power and significance).

However, she found only 17 animal studies and 12 human studies that fit the inclusion criteria and these were not applicable to meta-analysis: Ren, Y, Maltha, JC, Kuijpers-Jagtman, AM, Optimum Force Magnitude for Orthodontic Tooth Movement: A Systematic Literature Review, *Angle Orthod*. 2003;73:86-92.

Based on this, she determined that an evidenced-based answer to the question lies in performing a controlled clinical trial. The results of her experiment showed:

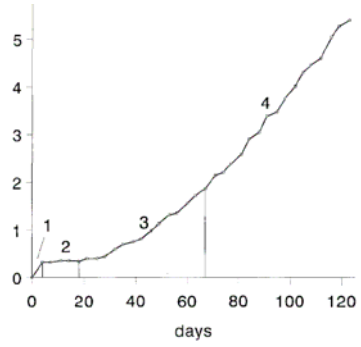


Fig. 3. Example of tooth-displacement curve divided into four phases. Phase 1 = initial tooth movement, phase 2 = arrest of tooth movement, phase 3 = acceleration of tooth movement, and phase 4 = constant linear tooth movement.

1. *Phase 1* can be interpreted as the initial movement of a tooth in its socket.
2. *Phase 2* can be considered as a period of arrest of tooth movement and is probably associated with hyalinization in the periodontal ligaments.
3. *Phase 3 is* characterized by a continuous tooth movement with an increasing rate. This acceleration phase may be interpreted as a period in which biologic processes involved in remodeling of the periodontal ligament and alveolar bone reach their maximum capacity. This may also explain why, subsequently, constant tooth movement is observed in *phase 4.*
4. These results are in contrast to human studies that show a blending of phases 3 and 4 to give 3 phases of human tooth movement.
   Pilon, JJ, Kuijpers-Jagtman, AM, Maltha, JC. The Magnitude of orthodontic force and rate of bodily tooth movement, an experimental study in beagle dogs. *Am J Orthod Dentofacial Orthop.* 1996;107:16-23.

Additional studies (in progress) indicate:

1. The rate of tooth movement is unchanged in response to a variety of applied force levels.

2. Different animals show different rates of tooth movement when the same force is applied. This suggests there may be "slow movers" and "fast movers" based on an individuals bone metabolism.
3. 0.27 mm/week is, on average, the maximum rate of tooth movement. Extrapolation to human studies gives an estimate of 0.29 mm/week as a maximum for human tooth movement, with a range of 0.1 mm/week (slow movers) to 0.4 mm/week (fast movers).
4. The optimal force range for tooth movement is between 104-454 centi-newtons. Extrapolation to human studies gives an estimate of 132-462 centi-newtons for human tooth movement.
5. The most appropriate mathematical model for tooth movement is "D" (see above).

Ren, Y, Maltha, JC, Van't Hof, MA, Kuijpers-Jagtman, AM, Optimal Force Magnitude for Orthodontic Tooth Movement: A Mathematical Model, *Am J Orthod Dentofacial Orthop*. 2004;125:71-77.

The third portion of her presentation focused on retention and orthodontic relapse. She summarized the findings of her retrospective case study in which patients were retained for one year with upper Hawley and lower fixed 3-3 retainers. Then post-retention records were taken at 2, 5, and 10 years to measure orthodontic relapse based on PAR score.

1. 67% of orthodontic improvements were maintained at 10 years post-retention.
2. 50% of relapse seen at 10 years occurred by 2 years post-retention.
3. 28% of relapse seen at 10 years occurred between 2 and 5 years post-retention.
4. 12% of relapse seen at 10 years occurred between 5 and 10 years post-retention.

Ren, Y, Kuijpers-Jagtman, AM, Van't Hof, MA, Stability of orthodontic treatment outcome: follow-up until 10 years postretention, *Am J Orthod Dentofacial Orthop.* 1999 Mar;115(3):300-4.

Given the lack of randomized clinical trials regarding retention and relapse, Dr. Kuijpers-Jagtman is performing experiments to provide more information. Her studies in progress suggest:

1. 35-40% of tooth movement relapses toward the original tooth position within 4 months if no retention is applied.
2. If retention is applied for 4 months and then released, 10% of the tooth movement relapses over the following 4 month period.
3. The total amount of relapse for tooth movement of short distance is similar whether or not retention is applied.
4. The total amount of relapse for tooth movement of long distance is less if retention is applied for a period of time compared with retention not being applied.
5. We cannot provide evidence-based data on retention protocol until we understand the etiology of relapse.