Curves and Grooves
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Tuesday, May 1, 12
Learning Curve: Fact or Fiction?
Competing Concepts

Volume Argument
The more of something you do, the better you get at doing it.
This process is purely linear driven by exposure and repetition
\[ 1+1=2, \ 2+1=3, \ 3+1=4, \ldots \]
There is an upper limit

Learning Argument
The more of something you do, the better you get at doing it.
Prior experience influences subsequent ability
\[ 1+1=2^z, \ 2^z+1=3^{(z+1)}, \ 3^{(2z+1)}+1=4^{(2z+1)}, \ldots \]
There is an upper limit
Analogy: Pure Volume Effect
Analogy: Learning Effect
Learning Curve: Surgery


- Gained Notoriety 1998 associated with Bristol Enquiry into Intra Operative Infant Mortality: “there should be no learning curve as far as patient safety is concerned”.


Learning Curve: History

• First described by 19th Century German Psychologist Hermann Ebbinghaus.

• Later applied to Unit Cost Vs number of Units produced by T.P. Wright.

• This was termed the experience curve stating that the more often a task is repeated, the lower will be the cost of doing it.
Ebbinghaus Experiment

- Learn a string of nonsensical syllables and determine the variables that influenced one’s ability to recall them.

nad...cag...san...tes...
baz... dat...fac... mog
...nud...puz...teg...sef
Retention as a function of Repetition

- Construct: Repeat sequence X times, measure time to relearn the same sequence 24 hours later, this represents time saved and is an indicator of depth of learning imprintation.

- “The effect of the number of repetitions on their inner fixedness grew at first approximately in proportion to the number of repetitions then that effect diminished gradually.”
Retention as a function of Complexity

- Construct: Increase the length of the meaningless string to be learned, measure the number of repetitions to memorise.

- Result: the time to memorise was directly related to the complexity of the string to be memorised.
Retention as a function of Complexity and Meaning

- Construct: Increase the number of stanzas of Byron Poem to be learned, measure the number of repetitions to memorise.

- Result: Meaningful Strings were easier to learn than meaningless strings.
Retention as a function of Intervening time between events

- Construct: Learn a string and determine time to relearn over a period of subsequent days.

- Result: It became easier to relearn if re-learning occurred regularly.
The Forgetting Curve

• The better the initial learning, the longer the material will be retained.

• Slow learners and fast learners, both forget at the same rate.

• Difficulty of information learned does not appear to affect rate of decline.
Our General View

Training Phase  Application Phase

Learning Curve  Forgetting Curve
Putting them Together

Learning Curve

Training Phase

Forgetting Curve

Application Phase

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"Training" Curve

Maximising Training

- Valid Credible Content
- Engaging Learning Events
- Support for Basic Understanding of Technique
- Support for Decision Making Competence
- Support for Long Term Remembering
- Support for Clinical Application of Learning

Learning Curve

Training Phase
Application Curve

Ability

Case Number

- Able with Difficulty
- Intermittently Able
- Regularly Able
- Consistently Able
- Expert
Determining Skill Level

Procedure Specific Skill Level
Factors Influencing Initial Skill Level

- Tissue Handling
- General Surgical Skills
- Knot Tying & Suturing
- Procedure Specific Skill Level
  - Performing Osteotomies
  - Skills Shared with Novel Procedure
  - Drilling & Screw Insertion
  - Familiarity with Approach
Factors Determining Procedure Skill Level

General Surgical Skills

General and Common Surgeon Skill Level

Skills Shared with Novel Procedure

Procedure Specific Skill Level

Procedure Time

Patient Outcomes
The Duality of Surgical Time

Procedure Time

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The Duality of Surgical Time

“Optimal Time” will both be determined by our personal position on the learning curve and determine our position on the curve!

“Optimal Time” should reflect our experience

“Optimal Time” has both Fixed and Fluid Components.
“Optimal Time” has both Fixed and Fluid Components.

\[ \text{Procedure Time} = \text{Activity Time} + \text{“Gap” Time} \]
“Optimal Time” has both Fixed and Fluid Components.

Activity Time

Fixed Time

This is “Doing Time”, some of which will be determined by the interaction of bone and High Speed equipment. Too fast may lead to thermal necrosis, non union and/or implant failure.

“Gap” Time

Fluid Time

This will be influenced by:
• Accuracy and Specificity of Planning (influence on “thinking time”).
• Institutional Aspects
• Personal Organisation
• Random Intra Operative Events
Defeating Progress: Focussing on Time

Inexperienced + Speed = Disaster

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Factors Determining Procedure Skill Level

- General Surgical Skills
- General and Common Surgeon Skill Level
- Skills Shared with Novel Procedure
- Procedure Specific Skill Level
- Procedure Time
- Patient Outcomes

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Factors Determining Procedure Skill Level

- Procedure’s Ability to resolve Pathology
- Execution Accuracy
- Mistake
- Planning Accuracy
- Error
- Planning Method Validity
- Complication Rate
- Patient Outcomes
Factors Determining Procedure Skill Level

\[ \text{Outcome} = 1 - \left\{ \left[ \sum (\text{Errors})_{\text{plan}} + \sum (\text{compounding Errors})_{\text{surgery}} - \sum (\text{negating Errors})_{\text{surgery}} \right] + \sum (\text{Errors})_{\text{surgery}} \right\} \]

Where optimal outcome = 1 and optimal planning can produce optimal outcome.
Determining Skill Level

- General Surgical Skills
- Procedure Specific Skill Level
- Skills Shared with Novel Procedure
- Procedure Time
- Planning Method Validity
- Planning Accuracy
- Execution Accuracy
- Patient Outcome
- Complication Rate
- Procedure’s Ability to resolve Pathology
Misnomer: Steep Curve

- Able with Difficulty
- Intermittently Able
- Regularly Able
- Consistently Able
- Expert

Smaller Case Number to achieve Expert Level!

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Misnomer: Steep Curve

Long Flat Curve

Case Number

Ability

Able with Difficulty
Intermittently Able
Regularly Able
Consistently Able
Expert

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Accelerating the Curve: By Repetition

**Participant:**
Repeatedly recall and revisit course material immediately before cases and between cases.

**Course Provider:**
Provide materials that permit meaningful revision of Planning and Technique.
Accelerating the Curve: By Repetition

Training Course Effect

Time Saved

Repetitions

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Accelerating the Curve: By Repetition

Try to schedule a few cases in a short period of time after the initial Training Sessions.

Repetition: Repeating the same thing again and again: DO NOT DEVIATE FROM DESCRIBED TECHNIQUE.

Repetition should be engrained individually and institutionally.
Accelerating the Curve: By Simplification

**Participant:**
Chunk procedure. Try to relate steps to skills already possessed.

**Course Provider:**
Provide “least complex” Instruction. Identify processes that could be simplified and make them simpler.

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**Graph Details:**
- **Title:** Complexity Vs Repetitions
- **Y-Axis:** No Repetitions
  - 0
  - 15
  - 30
  - 45
  - 60
- **X-Axis:** String Length
  - 0
  - 7
  - 12
  - 16
  - 24
  - 39

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Tuesday, May 1, 12
Accelerating the Curve: By Increasing Meaningfulness

**Participant:**
Understand “Why” and not just “How”. This will improve meaningfulness.

**Course Provider:**
Ensure that the rationale is well explained. Relate steps and decision making to skills that the attendees already possess.
Accelerating the Curve: By Increasing “Saving”

**Participant:**
- Revisit Materials
- Attend Master Classes
- Use reliable, online education resources.

**Course Provider:**
- Provide Material specifically aimed at rapid recall.
- Provide secondary and tertiary training courses.
Without a perfect plan, perfect surgery is not possible.

Without perfect surgery, our patients will not realise the full benefits of surgery.

You can train in planning before and between recruiting patients for the procedure.
Self Monitoring

Plan
Execution

Outcome
What is an Expert?

• “A novice practices until he gets it right. An expert practices until he cannot get it wrong”.

• Experts have highly organised knowledge structure.

• Experts perceive large meaningful patterns.

• Experts engage in self monitoring.
My Experience with Trochlear Groove

• Goal: Resolve discomfort and mechanical incompetence of End stage Patellofemoral DJD secondary to Patellar luxation by replacing the Pathological Trochlea with a Diamond Coated Prosthetic Groove.
Rationale

• Pain and Lameness in these cases is the result of exposure of subchondral bone as a result of cartilage loss and subsequent high friction leading to heat production.

• Diamond Like Coating has an extremely low coefficient of friction and this would reduce heat production and thus pain.

• The Prosthetic Groove depth would resolve tendency to luxate.
Surgical Planning

- Planning Foil with width and height of each of the ten sized prostheses.

- Hatched, mediolateral to establish depth of bone to remove.

- Need to use 1:1 of using Digital Radiography or scaled measurement.
Surgical Planning: Initial Variables

- Mediolateral width of the distal femur versus mediolateral width of template.
- Proximal and Distal extents of the anatomic trochlea versus the prosthesis.
Surgical Planning: Initial Variables

Too Long and Deep

Femur Fracture Risk

Too Shallow

Change orientation of Prosthesis
Craniocaudal Templating

- Width and height of prosthesis compared with likely osteotomy surface area.
- Also consider patellar width.
- This would be checked in theatre with Trial Prostheses.
Surgical Procedure: Arthrotomy Stage

- Lateral Parapatellar Arthrotomy.
- Inspect Retro Patellar Surface (Record Pathology).
- Inspect Trochlea (Record Pathology).
- Inspect Cruciate Ligaments.
Surgical Procedure: Trochlear Resection Stage

- Stifle in Flexion.
- Retract Capsule.
- Identify origin of Long Digital Extensor.
- Mark Osteotomy Line.
- Began procedure making osteotomy from Distal to proximal.
- Resect Trochlea.
Surgical Procedure: Prosthesis Phase.

- Medial Retinacular Release.
- Place trial prosthesis and flex stifle until centred.
- Replace with similarly positioned base plate and screw in position.
- Press fit the Trochlear Prosthesis.
- Cover with swab and hammer into position.
Completion

- Establish whether the Tibial Tuberosity needed to be transposed...If so, transpose.
- Lateral Capsular Imbrication.
- Loose medial capsular closure.
Post Operative Evaluation

- Mediolateral and Craniocaudal Radiographs post surgery.
- Four weeks lead activity (first two, house and garden only).
- Review weeks 2, 4 and 6.
- Re radiograph at week 8.

Case 1
Early Thoughts

Critique
Prostheses looked oversized
Did we need to perform Tibial Tuberosity Transposition?

Outcome
Both cases did very well with complete resolution of lameness, pain and subpatellar crepitation.
Early Changes

Critique
Prostheses looked oversized
Did we need to perform Tibial Tuberosity Transposition?

It was clear that both issues were manifestations of the same problem: Large Prostheses could only occupy a central position, smaller prostheses could be moved into alignment with the Tuberosity
Shift in Position

No Tibial Tuberosity Needed
Magnetic resonance measurements of the deviation of the angle of force generated by contraction of the quadriceps muscle in dogs with congenital patellar luxation.

Kaiser S, Cornely D, Golder W, Garner M, Waibl H, Brunnberg L.

Source
Department of Small Animals, Clinic Benjamin Franklin, Free University of Berlin, Germany.
Q Angle

Pre Op 33 degrees

Post Op 6.4 degrees
Technique: Resolving Rotation by angled

- In two cases have used the prosthesis seated on an oblique cut surface to counter femoral torsion.
Data Summary

- Stifles Treated = 18.
- Patients = 17
- 12 have over one year follow up.
- One patient Sepsis (concurrent TTA). Successfully revised back to prosthesis
- Two patients with residual audible click for variable period.
- All dogs restored to soundness by week 8 post surgery (except septic patient 16 weeks post revision 1/10 lame)
Thank You

- Curve was reasonably short and the main component of change has been in terms of extending its use.

- We need to show bony ingrowth into the base plate.