Rethinking sitting, seating and symptoms: new findings

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Introduction

- I am an Australian physiotherapist
- I have spent the last 12 years addressing statements by important people in the seat design world
- "Ergonomic criteria need to be applied selectively, because many of them are contradictory" (Cranz, 1998, p.93, Professor of Architecture at Berkeley)
- "My early approach to the chair was something between contempt and despair" (Frank Lloyd Wright, 1971, p. 170)





Format of this presentation

- · Brief history of the flexion/extension debate
- And according to current best knowledge the winner is ...
- Brief history of how aesthetic seating has consistently overridden functional seating design from 3000 BC to present day
- Taking ergonomic seating design beyond the office

Brief history of the flexion/extension debate

1700s to c. 1948

- Lordosed seated postures were considered healthier than kyphosed
- · Prevented scoliosis

17/1800s emphasis on child posture

- Subscribed to the popular theory that kyphosed postures caused "poor breathing, pulmonary tuberculosis, venous congestion, constipation, haemorrhoids, etc." (cited in Åkerblom, 1948, p. 32)
- Staffel (1884) preempted Mandal by advising forward tilt seating for school children
- · But settled for this innovative school seating

1800s emphasis on traction and extension exercises

- "the orthopedist of the 19th century was not primarily a surgeon, and his reputation grew in proportion to his ability to effectively utilize mechanical principles" (White & Panjabi, 1990, p.477)
- E.g. traction to maintain lordosis and prevent scoliosis

Institutions to treat or prevent scoliosis

- Based on maintenance of lordosis through exercise and traction 24/7
- Delpech 1825, "made [a] deliberate attempt to apply gymnastics to the deformities of the body" (Coulter, 1932, p.33)

Early 1900s beginning of the confusions re best seated posture

- Overall medical opinion continued to favour some degree of lordosis
- Because some lordosis formed "a shelf to support the floating viscera" (Kellogg, 1932, p.289)
- Although hyperlordosis led to a lack of support for the abdominal contents leading to constipation, indigestion.
- Kyphosed postures compressed the abdominal and pelvic contents

Theories for causes of low back pain abounded

- Lovett (1914) tried to shift emphasis from pelvis and abdominal contents to stress on ligaments and muscles
- Relaxation of the sacroiliac joints leading to sciatica (Meisenbach, 1911)
- Arthritis, posture, balance, leg length & pelvic disorders (Dickson, 1931)
- Dynasty of the disc (Mixter & Barr, 1934)
- Poor sitting posture (Åkerblom , 1948; Williams, 1948; Keegan, 1953)





· Having established that cubist seating did not maintain the natural curve of the low back, the scientific world now divided into 2 camps. Those who thought kyphosed postures maintained spinal health and those who thought lordosed postures were the least damaging.

Williams' recommended posture

"You should always sit in such a fashion that the hollow in the low back is eliminated."

> (Williams, 1974, p. 27)

"The designers of supposedly comfortable lounge chairs have created monstrosities of over stuffed half beds which provide neither a comfortable sitting, nor a comfortable reclining position, permit no change of position, and are impossible to rise from without assistance" (Keegan, 1953, p.589)



Williams became popular worldwide

- · Seated postures recommended by Farnhi, 1966, p. 30 (top)
- And Cailliet, 1981, p.191

By 1970s two schools of thought

- Kyphosed seated postures (Cailliet, 1981, 1988; Williams, 1974; Farnhi & Truemen, 1965; Fahrni 1966, 1975, 1976; Adams & Hutton 1980, 1983, 1985; Adams et al., 1993, 1994, 1995, 1996, 2000; Adams, 1995)
- Lordosed seated postures (Andersson et al., 1974; Hedman & Fernie, 1997; Lotz et al. 1998; McKenzie, 1981, 2006; McGill & Brown, 1992; Solomonow et al., 2003a,b,c,d; Solomonow 2004; 2009)

Akerblom, 1948 recommended all 3 postures

Demise of the Dynasty of the Disc

 Nachemson's disc studies may have been flawed by transducer technology available in the day.



 Today implanted-transducer into nucleus pulposus (Wilke et al., 1999, 2001), and studies of spinal shrinkage and internal fixator loads (Althoff et al., 1992; Lievseth & Drerup, 1997; Rohlmann et al., 2001) infer that similar or marginally greater [intradiscal pressure] IDP is likely in standing than sitting (Claus et al, 2008).

Demise of the Dynasty of the Disc

- "It can be cautiously concluded that the intradiscal pressure during sitting may in fact be less than that in erect standing" (Wilke et al., 1999)
- Wilke et al., (1999) still found that sitting with maximum flexion caused a higher IDP; 0.83 MPa, than sitting erect but unsupported; 0.46 MPa

Slouched postures still increase IDP

- XR images by Dunk et al., (2009) showed:
- " Each of the lower three intervertebral joints [of the lumbar spine] approached their total flexion angles in the slouched sitting posture" (p. 164)
- Then increased tension from the spinal ligaments could cause increased IDP in slouched sitting (Claus et al., 2008). This includes tension from the iliolumbar ligaments (Snijders et al., 2004)
- Which would explain why sitting flexed causes higher IDP than sitting erect

Demise of the Dynasty of the Disc

 "Current studies indicate that IDP [intradiscal pressure] in sitting is unlikely to pose a threat to non-degenerate discs, and sitting is no worse than standing for disc degeneration or low back pain incidence. If sitting is a greater threat for development of low back pain than standing, the mechanism is unlikely to be raised IDP." (Claus et al, 2008, p. 550)









More recent research shows:

that after 10 minutes of sustained flexion with a load comparable to that which is exerted on the spine in slouched sitting, followed by a 10 minute rest and repeated 6 times, (2 hours all up) laxity occurs in the visco elastic tissues, and multifidus activity is decreased for 3-4 hours after.

(Le et al, 2009; Yusuf et al, 2008, Ben Masaud et al., 2010)

Slouched sitting Erect sitting Inconsistent appearance Ligaments, muscle reflex, joint ٠ stability compromised of compressive peaks of Risk of CTD stress in posterior disc Increases incontinence where degeneration is Increased head & neck flexion prone c/f erect sitting · Facet joint loading Increased activation of neck Increased lumbar spine extensors c/f erect sitting muscle activity in the Beneficial posture for symptoms from canal stenosis absence of a backrest and /or sponylolisthesis Beneficial posture for Caneiro et al., 2010; Mc Kenzie, 2006, those with symptoms Sapsford, 2008; Solomonow, 2006, from disc and facet joints 2009 Adams et al., 1994; Adams et al., 2000; Caneiro et al., 2009; McKenzie,

Is slouched sitting more damaging to the health of the lumbar spine than sitting with some degree of the lumbar lordosis maintained?

YES

So the next research question is how much lordosis is healthy?

- · Varies with each individual.
- Depends on the underlying natural posture, any muscle imbalances causing pain (Claus et al., 2009a,b; Dankaerts et al., 2006; McGill & Karpowicz, 2009; O'Sullivan et al., 2006a, 2010) and disc and joint degeneration (McKenzie, 2006).
- Overall it is that posture that is pain free during and following sitting (including the next morning).

- Is lumbar support necessary? If it reduces pain during sitting and/or following sitting, YES. (Andersson et al, 1979; Snijders et al., 2004; Carcone & Keir, 2007)
- How much lumbar support? That which reduces pain during and/or following sitting. Carcone & Keir (2007) found 3 cm depth most comfortable
- Static or dynamic lumbar support? Increase muscle blood flow and oxygenation with dynamic (Durkin et al., 2006), anterior pelvic tilt during inflation (Aota et al., 2007) but there was no difference in erector spinae activity or subjective comfort (Beach et al., 2005; Aota et al., 2007)

How is lumbar lordosis maintained in sitting?

- By opening the trunk/thigh angle, taking the tension off the hamstrings, and allowing the pelvis to rotate anteriorly (Bennett et al., 1990; Bettany-Saltikov et al, 2008; Link et al., 1990; Shenoy & Aruin, 2007)
- By placing a lumbar support in the backrest. (Carcone & Keir, 2007) especially in the reclined position (Andersson et al, 1979).
- Or by altering the pelvic position (Noro, 2007)



Maintaining lordosis without a backrest

E213).



 "The highest activity levels at multifidus and obliquus internus abdominis muscles occurred in the short lordosis posture [lumbar spine only].



The lowest activity levels were observed at most muscles in the flat posture" (Claus at al., 2009a p.

- Sustaining short lordosis without a backrest may well be beyond the endurance capacity of the majority of people (Claus et al., 2009a)
- To do so requires 16.8% of maximum voluntary contraction (MVC) of the deep and superficial multifidi (Claus et al., 2009a).
- Given that the multifidus can work at 5% of MVC for 30 minutes maximum without depleting oxygen to the muscle (van Dieen et al., 2009) the sustained muscle work required to maintain lordosis without a backrest is not feasible.

However maintaining a flat L/S may be sustainable (Claus et al., 2009a)



And Yet

- Increased erector spinae activity sitting on a posture ball c/f sitting in an office chair (Kingma & Dieen, 2009: Gregory et al, 2006)
- Significant fatigue-related EMG changes were found as low as 2% of maximum voluntary contraction (MVC) sustained for 30 minutes
- "The results suggest that motor tasks requiring low-level activity of trunk extensor muscles could lead to fatigue development, resulting in impaired function and discomfort or pain" (van Dieen et al., 2009, p.405)
- So even working with a flat lumbar spine where the spinal extensors are less active than when actively maintaining lordosis (Claus et al., 2009a), fatigue will ensue and the sitter will.... slouch



Studies of sitting on a posture ball without backrest show :

- Decreased pelvic tilt i.e. slouching, with increased discomfort c/f office chair (Gregory et al., 2006)
- Increased creep (indicating slouch) c/f office chair (Kingma & van Dieen, 2009)
- No improvement in posture or spinal activity when c/f sitting on a stable surface (McGill et al., 2006; O'Sullivan et al., 2006b)

Are seats without backrests beneficial to spinal health?

Constant activation of spinal extensor muscles as is required when sitting without backrest is detrimental to spinal postural health.

Is a backrest necessary to maintain lumbar lordosis in sustained sitting? YES





Importance of movement during seated postures

- Movement can be divided into that which the seated person performs – pause exercises in sitting and standing
- That which the chair assists



Movement by exercising from slouch to erect is important

"constantly



changing position is important to promote flow of fluid (nutrition) to the disc" (Wilke, 1999)



(From Pynt, 1998, p.25)



Dynamic chairs and movement

- Less lumbar spine creep on a dynamic chair (van Dieen et al., 2001)
- "when sitting on the dynamic chair the average spinal length increased in comparison to the spinal length in the static chair, where average spinal length decreased. It was concluded that there is spinal distress relief due to the passive motion of the chair" (van Deursen et al., 2000 p. 95)

The best posture is the next posture

 Providing the working posture maintains some degree of the lordosis

Optimal posturally healthy seating:

- Maintains some degree of the natural curve of the low back
- Assists in task performance
- Allows movement
- · Affords stability
- Aesthetically pleasing providing function is not subordinated



The next frontier: taking ergonomic seating beyond the office

- Approximately 87% of Australians over the age of 15 watch television for an average of just over 3 h/day (Australian Bureau of Statistics, 2007).
- "Consideration of leisure hour seating as a cause of back pain is therefore important. The question arises: can the manner in which a person sits in leisure hours affect the health of the spine in office hours?" (Pynt et al., 2008, p.36)

If we consider that sustained slouched sitting causes a "creep hangover" then YES



Neuromuscular abnormalities occur in multifidus over next 24 hours
After 20 minutes, back is unstable for up to 7 hours
Preset for injury the following day
Inflammation, cumulative trauma and degeneration
Creep continues to develop over next 7 hours & may not be resolved over 24 hours
(Ben-Masaud et al., 2009; LaBry et al., 2004; Sbricolli et al., 2004; Solomonow, 2009)

• We need to educate people that poor leisure seat design and use can preset tomorrow's back pain

As can design icons such as the cantilever chair

 "designed so that by the time the main course arrived, at least one guest had pitched face forward into the lobster bisque"
(Thomas Wolfe, From our House to Baubaus 1982)





We need to educate designers about research findings

 "I am often told that the furniture is not comfortable, and in that not functional... The furniture is comfortable to me...A straight chair is best for eating or writing"
(Judd, 1993, p.21)



Judd's **Office** Chair

And dissuade the critics from applauding art over function

• "I find this a rather uncomfortable chair as the back rung cuts painfully across the spine, but it is undoubtedly a beautiful chair" (Meadmore, 1974, p. 119)

And what about the poor sods who have to live with it?

• "I have been black and blue in some spot, somewhere, almost all my life from too intimate contacts with my own furniture." (Frank Lloyd Wright, 1960, p. 49)



As furniture historian Caplan observed:

 "Designers who pride themselves on a disciplined focus upon understanding and forming materials, often neglect such materials as flesh and blood – although the flesh is weak and the flow of blood has been greatly impeded by a number of prize-winning chairs"(1978, p. 15).



The next frontier

Recreational seating that considers spinal postural health by facilitating: • lumbar lordosis,

•tasks such as dining, TV watching

•movement

AND considers aesthetics



Opsvik's Gravity balans (above) Pendulum seating (left), Actulum seating (right)



