North Carolina Spine Society

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MIS single-position anterior interbody fusion and bilateral pedicle screw fixation: Feasibility and perioperative results

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Introduction

- Extreme lumbar interbody fusion (XLIF) is a proven minimally-invasive strategy for anterior lumbar interbody fusion.
- One impediment to wider acceptance of XLIF: need to flip patient to prone position in order to place supplemental posterior fixation
  - Average "flip time" at our institution: 25-30min.
  - Possible risks: inadvertent extubation, pulling lines and graft migration
  - Increased OR costs
- Bilateral pedicle screw fixation is gold standard for supplemental fixation after XLIF (versus unilateral, lateral plate or interspinous fixation.)

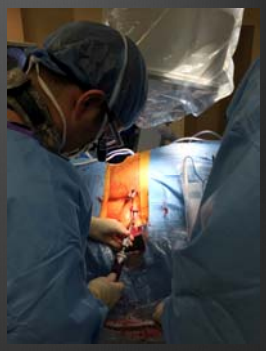
Objectives

- Preliminary study examining feasibility of placement of bilateral pedicle screw fixation (PSF) in lateral decubitus position after XLIF.
- Examine OR and fluoroscopic times for screw placement.
- Examine accuracy of placement of bilateral PSF in lateral decubitus position.

Methods

- Prospective cohort study
- Consecutive series of patients who underwent XLIF with bilateral PSF placed in the lateral decubitus position.
- Case time, screw placement time (total and per screw) and fluoroscopic time (total and per screw) collected.
- Postoperative CT scans performed beginning at 6 months to assess screw placement accuracy and presence of fusion.
  - Added immediate postoperative CT scans and standing films
- Patient outcomes (VAS) assessed.

Methods



Results

- 174 screws placed in lateral decubitus position in 42 consecutive patients after XLIF
- Mean age: 61 years (range 40-81)
- 55% female
- Mean BMI: 29.6 (range 20.5-40.2)
- 38 one-level cases and 4 two-level cases
- 83% of cases involved L4/5
- Spondylolisthesis was most common diagnosis (79%)

Results

- *Total* mean operative time: 84.3 minutes (range 49 – 126).
- Mean total screw time 25.3 minutes (range 17-38); time PER screw: 6.1 minutes (3-9.25).
  - Shin et al, 2015: 3.8 min +/- 4 min per screw
- *Total* mean fluoroscopy time: 126 seconds (range 58 – 270); mean fluoroscopy time for screw placement: 59.2 seconds (range 30-93); fluoroscopy time PER screw: 14 seconds (range 8-23).
  - Mroz et al, 2011: 29s per screw
  - Spitz et al, 2015: 23s per screw
- Mean EBL: 42cc (range 10-100)
- Mean LOS: 1.3 days (range 1-4 days)

- Mroz TE, Abdullah KG, Steinmetz MP, Klinzberg EO, Lieberman IH: Radiation exposure to the surgeon during percutaneous pedicle screw placement. **J Spinal Disord Tech 24**:264–7, 2011.
- Shin M-H, Hur J-W, Ryu K-S, Park C-K: Prospective Comparison Study Between the Fluoroscopy-guided and Navigation Coupled With O-arm-guided Pedicle Screw Placement in the Thoracic and Lumbosacral Spines. **J Spinal Disord Tech 28**:E347–51, 2015.
- Spitz SM, Sandhu FA, Voyadzis J-M: Percutaneous "K-wireless" pedicle screw fixation technique: an evaluation of the initial experience of 100 screws with assessment of accuracy, radiation exposure, and procedure time. **J Neurosurg Spine 22**:1–10, 2015 .

Results

- Postoperative CT available in 22 patients (52%)
  - 6 breaches out of 98 screws (6.1%)
    - 3 medial and 3 lateral
    - All breaches <2mm
    - 5 breaches in first year
    - Shin et al, 2015: 7.8%
    - Wiesner et al, 2000: 6.6%
  - All patients showed evidence of early bony fusion on CT
- There were no infections or screw-related complications.
- No cases were aborted to prone positioning.
- Mean VAS improved from 7.5 preoperatively to 4.0 (47%) at 3-months postoperatively.

- Shin M-H, Hur J-W, Ryu K-S, Park C-K: Prospective Comparison Study Between the Fluoroscopy-guided and Navigation Coupled With O-arm-guided Pedicle Screw Placement in the Thoracic and Lumbosacral Spines. **J Spinal Disord Tech 28**:E347–51, 2015.
- Wiesner L, Kotke R, Schulze KP, Rüther W: Clinical evaluation and computed tomography scan analysis of screw tracts after percutaneous insertion of pedicle screws in the lumbar spine. **Spine (Phila Pa 1976) 25**:615–21, 2000 .

Conclusions

- Bilateral pedicle screws were placed in the lateral decubitus position after XLIF in an average of 6.1 minutes per screw and with only 14 seconds of fluoroscopy per screw.
- Although there is an initial learning curve, a reasonable breach rate and lack of screw-related complications suggests that this technique is safe and reproducible.
- This technique allows for increased efficiency for the surgeon as well as increased cost-savings for the hospital.

Thank You!

Background

- ACDF preferred treatment for cervical radiculopathy and myelopathy.
- Bohlman et al. revision rate 11%.
- Hilibrand et al. 2.9% adjacent segment disease per year over 10 years
  - 19% with adjacent segment disease at final follow-up.
- Few large studies with modern day implants.

Bohlman, JBJS-Am, 1993
Hilibrand, JBJS-Am, 1999

Objective

To determine the rate of revision surgery and the occurrence of adjacent segment disease of patients undergoing ACDF for cervical radiculopathy and myelopathy utilizing modern day instrumentation techniques.

Methods

- IRB approval obtained: PRO12110298
- All patients undergoing ACDF between 2000 and 2010.
- Indication for surgery:
  - Radiculopathy
  - Myelopathy
  - Myeloradiculopathy
- Failed conservative management

Methods – Surgical Technique

- ACDF (Modified from Robinson et al).
- Disc completely removed, partial or complete resection of posterior longitudinal ligament, endplates left intact.
- Tricortical autograft or corticocancellous allograft inserted into disc space.
- Anterior plate, two fixed angle screws at each level.
- Plates with secondary locking mechanism.

Smith & Robinson, JBJS-Am, 1958
Smith, Kaub, Kang, Inst Course Lec, 2003

Methods - Demographics

- Age
- Sex
- Height
- Weight
- BMI
- Symptoms at presentation (myelopathy vs radiculopathy)
- Number of levels fused
- Graft type
- Smoking status

Methods – Outcomes

- Revision rate.
- Reason for revision surgery.
- Time to revision surgery.
- Plate to disc distance.
- Pseudoarthrosis.
- Presence and grade of adjacent segment degeneration.
- Reporting of symptoms of adjacent segment disease at final follow-up.

Park, JBJS-Am, 2005

Grade Adjacent Segment Degeneration

University of California at Los Angeles Grading Scale for Intervertebral Space Degeneration			
Grade	Disc Space Narrowing	Osteophytes	End Plate Sclerosis
I	-	-	-
II	+	-	-
III	±	+	-
IV	±	±	+

Statistics

- Independent t-test and Chi-squared for differences between subjects who did and those who did not require revision surgery.
- Kaplan Meier survival analysis to determine the predicted yearly incidence of adjacent segment disease.

Results

- 672 patients.
- Average follow-up: 31 months.
- 45% male.
- Age 48 years (19-85).
- BMI 29 ± 7.
- 48% smokers.
- 88.4% radiculopathy, 8.8% myelopathy, 2.8% both.
- 37% 1-level, 58% 2- level, 5% 3- level.
- 95% autograft, 5% allograft.

Results - Revision

- 101 patients (15%) underwent revision surgery.
- Reason for revision surgery:
  - adjacent segment disease in 47 (47.5%)
  - pseudarthrosis in 45 (45.5%)
  - new problem at a non-adjacent level in 7 (7.1%)
- Revision ~ 34 months after the index procedure.

Levels of Pseudoarthrosis / ASD

Most common level for pseudarthrosis and adjacent segment disease		
	Number of times pseudarthrosis occurred (% of total)	Number of times adjacent segment disease occurred (% of total)
C3-4	1 (2%)	10 (11%)
C4-5	2 (3%)	25 (28%)
C5-6	26 (39%)	24 (26%)
C6-7	35 (53%)	25 (28%)
C7-T1	2 (3%)	6 (7%)
	66 (100%)	90 (100%)

Results - Pseudoarthrosis

- Revision for pseudarthrosis ~ 21.5 months.
- Additional 8 patients with radiographic evidence of pseudarthrosis were asymptomatic.

Results- Pseudoarthrosis

- Overall, 7.5% of patients developed symptomatic pseudoarthrosis
  - 3.2% 1 level fusions
  - 9.2% 2 level fusions
  - 3.0% 3 level fusions

Results – Adjacent Segment Disease

- Higher pre-operative grade of radiographic degeneration at the cranial or caudal level did not predispose to revision surgery ($p = 0.691$, $p = 0.158$, respectively).
- The revision rate per number of levels:
  - 1 level 8.0%
  - 2- level 6.7%
  - 3-level 2.9%

Results – Adjacent Segment Disease

- 422 patients (66%) had radiographic degeneration at final follow-up.
- 103 (15.3%) developed symptoms
  - 47 underwent revision surgery
  - 56 treated conservatively
- Kaplan Meier survival analysis: 4%per year.

Results – Risk Factors

- Revision surgery risk was not affected by:
  - Patient age
  - Sex
  - Height, weight, BMI
  - Graft type
  - Smoking status
  - Symptoms at presentation
  - Plate to disc distance

Discussion

- 15% Revision rate unchanged from historical studies.
  - ASD, pseudoarthrosis and new disease included.
- Only 85% of patients with pseudarthrosis were symptomatic.
- No difference between autograft and allograft.
- No effect of age, sex, number of levels fused, smoking status on the risk for revision surgery.

Phillips, Spine, 1997
Samartzis, Spine J, 2003
Jawaha, Spine J, 2010

Discussion

- Plate to disc distance did not increase the risk for symptomatic adjacent segment disease.

Plate to disc (cranial)	**3.5mm**	**3.2mm**	**3.7mm**	**P= 0.090**
Plate to disc (caudal)	5.7mm	5.6mm	5.9mm	P= 0.236

Conclusion

- The revision rate after ACDF is 15%.
- No specific risk factors for revision surgery were identified in this study.
- Limitations:
  - Retrospective chart review study.
  - Average f/u 31 months (ranged to 150 months).
  - Bias: longer follow-up more likely to have problem.

Duke Neurosurgery

An internally randomized controlled trial of radiation exposure using ultra-low radiation imaging (ULRI) versus traditional C-arm fluoroscopy for patients undergoing single- level minimally invasive transforaminal lumbar interbody fusion (TLIF)

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Introduction

- Transforaminal lumbar interbody fusion (TLIF) is a common surgical approach to treatment of spinal instability, spinal canal stenosis, and neuroforaminal stenosis
- Minimally invasive TLIF was first pioneered in last 20 years
  - Advantage: smaller incision, less blood loss, faster recovery, less dependence on opioid analgesics
  - Disadvantage: minimal visualization of anatomy
    - Requires heavy use of c-arm fluoroscope

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Introduction

- **Increased reliance on intraoperative C-arm fluoroscopy → increased radiation exposure**
  - MIS TLIF associated with 2.4x increased radiation compared to open TLIF (Kim et al.)
  - Patients experience 1.4-2.4% increase in lifetime risk of solid tumor per minimally invasive surgery (Presciutti et al.)
  - Spine surgeon performing 140 MIS TLIF /yr will reach occupational radiation hazard limit within 10 years (Haque et al.)

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Introduction

- Thus, methods to decrease fluoroscopic radiation exposure during during MIS TLIF will provide substantial health benefit to patient, surgeon, and operating room staff
- Problem: decreasing radiation output from C-arm fluoroscope reduces image quality
  - Unsafe
- LessRay (SafeRay Spine, LLC) software is a fluoroscopic adjuvant meant to enhance low-radiation images based on high-quality composite images taken preoperatively
  - Allows enhancement of low radiation imaging to the point where one can visualize pertinent anatomy

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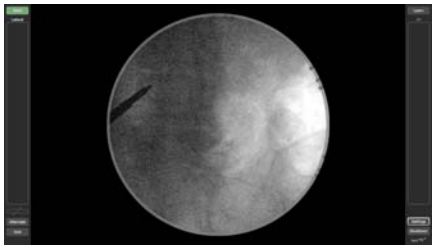
Introduction



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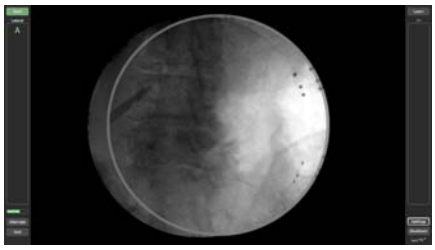
Introduction



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Introduction

- Purpose: randomized control trial comparing radiation exposure between LessRay enhanced ultra-low radiation imaging and conventional C-arm fluoroscopy for patients undergoing MIS-TLIF

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Methods

- Prospective inclusion criteria:
  - Adult
  - Single-level MIS-TLIF
- Procedure divided into 5 intervals:
  - 0) Preoperative imaging
    - (localize spinal level and establish composite)
  - 1) L-sided pedicle cannulation and k-wire placement
  - 2) R-sided pedicle cannulation and k-wire placement
  - 3) Bilateral screw placement
  - 4) Interbody graft and rod placement

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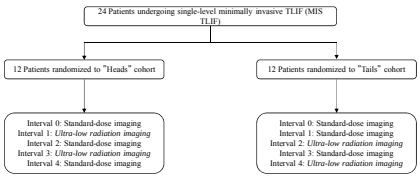
Methods

- Heads:
  - Interval 0: Traditional C-arm
  - Interval 1: ULRI
  - Interval 2: Traditional C-arm
  - Interval 3: ULRI
  - Interval 4: Traditional C-arm
- Tails:
  - Interval 0: Traditional C-arm
  - Interval 1: Traditional C-arm
  - Interval 2: ULRI
  - Interval 3: Traditional C-arm
  - Interval 4: ULRI



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Methods

- Personnel radiation exposure measured via pocket dosimeters:
  - At the end of all intervals
  - For members of the operating room:
    - Surgeon
    - Scrub Nurse
    - Circulator
    - Anesthesiologist
- Total Radiation production was measured by c-arm
- Time recorded for each interval
- Statistical comparison between radiation exposure for traditional C-arm vs. ULRI

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Results (24 total patients)

Table 1: Demographic data for patients undergoing single-level MIS TLIF

	Total	Heads	Tails	p
Age (mean ± SD)	59.4 ± 16.0	61.7 ± 11.3	56.6 ± 20.4	0.45
Male (n)	17	9	8	0.65
BMI (mean ± SD)	29.5 ± 4.1	29.2 ± 4.5	29.9 ± 3.7	0.68
Levels	24	12	12	1.00
L3-4	2	0	2	
L4-5	17	11	6	
L5-S1	5	1	4	
TLIF Side (right)	12	8	4	0.41

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Results

Table 2: Interval comparison of radiation emitted by standard-dose fluoroscopy and ULRI

	Standard-dose (mGy)	Using ULRI (mGy)	% Change	p
Interval 1 and 2 Average	39.15	10.23	-73.9%	<0.001*
Interval 3	39.76	4.26	-89.3%	<0.001*
Interval 4	24.76	10.71	-56.7%	0.019*
Cumulative	143.20	35.02	-75.5%	-

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Results

Table 3a: A comparison of radiation exposure to surgeon and scrub nurse between standard-dose fluoroscopy and ULRI

	Surgeon				Scrub Nurse			
	Standard-dose (mrem)	ULRI (mrem)	% Change	p	Standard-dose (mrem)	ULRI (mrem)	% Change	p
Interval 1 and 2 Average	1.46	0.36	-75.2%	0.001*	0.20	0.03	-83.7%	<0.001*
Interval 3	3.16	0.16	-94.8%	0.002*	0.38	0.05	-88.2%	0.014*
Interval 4	0.56	0.22	-61.8%	0.110	0.25	0.28	16.0%	0.830
Cumulative	6.61	1.09	-83.5%	-	1.04	0.40	-61.6%	-

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Results

Table 3b: A comparison of radiation exposure to circulator and anesthesia personnel between standard-dose fluoroscopy and ULRI

	Circulator				Anesthesia			
	Standard-dose (mrem)	ULRI (mrem)	% Change	p	Standard-dose (mrem)	ULRI (mrem)	% Change	p
Interval 1 and 2 Average	0.11	0.38	-66.7%	<0.001*	0.05	0.01	-84.6%	0.282
Interval 3	0.00	0.01	-	0.287	0.03	0.001	>99.9%	0.046*
Interval 4	0.13	0.04	-69.8%	0.047*	0.05	0.03	-32.3%	0.481
Cumulative	0.35	0.12	-66.3%	-	0.19	0.05	-74.6%	-

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Results

Table 4: Operation time between standard-dose fluoroscopy and ULRI

	Standard-dose fluoroscopy (min)	ULRI (min)	% change	p
Interval 1 and 2 Average	10.6	11.0	3.9%	0.781
Interval 3	11.5	11.38	-1.0%	0.062
Interval 4	56.4	61.4	8.8%	0.438
Cumulative	89.4	107.2	20.0%	-

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Conclusions

- Significant reduction in radiation production seen using ULRI coupled with image enhancement
  - ~75% reduction
- Significant reduction in radiation exposure for surgeon, scrub tech, and circulator
  - 61.6-83.5% reduction
- No incidents of complication, no abandonment
- No statistically significant increase in time
- *This study is the first to demonstrate safe usage of ULRI in any surgical procedure in humans*

The Effect of Iatrogenic Lordosis and Laminectomy Width in the Development of Post-operative C5 Palsy After Posterior Cervical Laminectomy and Fusion

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Disclosures

- None

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Collaborators

- **Christopher R. Brown, MD**
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Background

- **Posterior cervical laminectomy and fusion (PCLF) established treatment for spondylotic myelopathy**
  - Reliable improvement in myelopathic symptoms
  - Direct decompression
  - High rates of fusion
- **Known complications with PCLF[1-4]**
  - Junctional kyphosis
  - Post-laminectomy instability
  - Neurologic deterioration
  - Post-op infection
  - C5 Palsy

[1]Anderson et al. Spine 2009 [2]Cunningham et al. Spine 2010. [3]Kineberg et al. Orthop Clin North Am
[4]Van Geest et al. Eur Spine 2013

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Post-operative C5 Palsy

- **Estimated incidence of 6.7% (range: 0-30%)[1]**
  - Rates vary by technique and definition
  - Transient palsy >> permanent deficit
- **Can occur after anterior or posterior approach**
- **Undetermined etiology of palsy development**
  - Posterior drift back of the cord[2-4]
    - Traction on anatomically shorter C5 roots
  - Iatrogenic direct nerve injury
    - Heat from burr
    - Compression/traction
  - Foraminal stenosis
  - Spinal cord ischemia

[1]Nassr, A., et al. Spine (2012) [4]Bydon M, et al. *The Spine Journal (2014)*
[2]Nakashima H, et al. JNS: Spine (2012)
[3]Radcliff KE, et al. JSD&T (2014)

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Predicting and/or Prevention of Post-operative C5 Palsy

- **Radcliff et al. JSD&T 2014**
  - Higher rates of palsy with larger/wide decompression → greater opportunity for posterior cord drift
  - Recommended reducing laminectomy width
    - No prospective data
- **Lubelski et al. The Spine Journal 2015**
  - Assessed anterior-posterior diameter (APD), foraminal diameter (FD), and cord-lamina angle (CLA) to predict C5-Palsy
  - Proposed 3-part model
    - Every 1mm ↑ of APD → 69% decrease in palsy rate
    - Every 1mm ↑ of FD → 98% decrease in palsy rate
    - Every 1° ↑ of CLA → 43% increase in palsy rate
    - $\text{logit}(p) = -0.81 - 1.16(\text{APD}) - 4.00(\text{FD}) + 0.35(\text{CLA})$
    - No prostpective data

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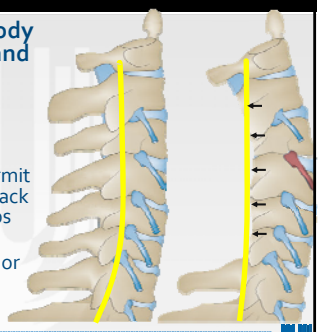
Potential Role of Lordosis

- Posterior vertebral body is fulcrum of flexion and extension in spine
- Increased cervical lordosis
  - Would theoretically permit further posterior drift back of cord as slack develops after laminectomy
  - Could compress posterior elements → foraminal stenosis



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Purpose

- Assess cervical lordosis and laminectomy width as predictors of post-operative C5-palsy development
  - Confirm findings of Radcliff et al. using post-operative CT (vs. MRI)

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Materials & Methods: Lordosis

- Retrospective case-control study: 54 patients
  - ICD-9 for cervical spondylotic myelopathy and CPT for multilevel cervical laminectomy with fusion (no foraminotomies)
  - Charts reviewed for post-operative decrease in motor strength of deltoid or biceps of at least 2 motor grades vs. pre-op
  - 13 palsies (24%)
    - All but 1 resolved
    - Avg. duration: 6mo. – 1yr.

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Materials & Methods: Lordosis

- **Radiographic measures**
  - **MRI (pre-op):** anteroposterior diameter (APD), foraminal diameter (FD), cord-lamina angle (CLA)
  - **XR (pre- & post-op):**

$$= \frac{\sum a_1 + a_2 + a_3 + a_4}{L} \times 100$$

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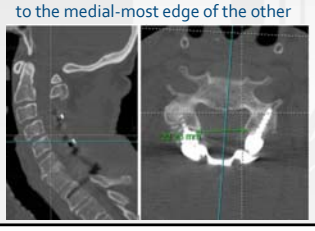
Materials & Methods: Laminectomy Width

- **Laminectomy width measured at each surgical level on postoperative axial CT scans**
  - Measured at middle of the posterior vertebral body of the level in question on the sagittal image and the corresponding line placed through the middle of the vertebral body on the axial image
  - Measured smallest distance from the medial-most edge of one lamina to the medial-most edge of the other



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Results

Time point	Variable	No palsy	C5 Palsy	p value
Preoperative	Right FD	3.93 ± 4.99	2.09 ± 1.01	0.04
	Left FD	3.91 ± 4.84	2.53 ± .80	0.10
	Minimum FD	3.66 ± 4.87	1.97 ± .75	**0.05**
	APD	9.58 ± 3.76	7.32 ± 1.67	**0.006**
	Right CLA	33.43 ± 10.59	37.58 ± 8.73	0.19
	Left CLA	32.17 ± 7.43	36.61 ± 6.69	0.07
	Neutral	11.48 ± 14.77	12.37 ± 9.59	0.82
	Flexion ROM	14.77 ± 12.16	13.59 ± 11.61	0.78
	Extension ROM	-22.68 ± 15.15	-25.57 ± 11.66	0.53
	Ishihara Index	8.12 ± 25.03	2.54 ± 13.71	0.42
	Cervical Spine Angle	8.07 ± 15.41	12.08 ± 12.77	0.36
	Segmental Lordosis	0.17 ± 5.01	1.64 ± 8.06	0.54
Postoperative	Ishihara Index	-2.05 ± 6.45	3.63 ± 10.83	0.15
	Cervical Spine Angle	7.82 ± 13.12	12.07 ± 13.91	0.34
	Segmental Lordosis	-0.09 ± 5.22	2.45 ± 2.77	**0.03**

Variable	No palsy	C5 Palsy	p value
NDI	4.05 ± 10.03	-2.45 ± 8.8	0.07
Maximum VAS arm	1 ± 2.75	-1.71 ± 2.93	0.06
Ishihara Index	-8.74 ± 25.2	1.09 ± 13.4	0.17
Cervical Spine Angle	0.24 ± 10.11	0.02 ± 13.93	0.96
Segmental Lordosis	-1.73 ± 4.13	0.44 ± 5.74	0.30
JOA	-2.38 ± 1.41	-2.33 ± 0.5	0.92
SF-12M	-4.24 ± 12.82	-2.16 ± 4.03	0.50
SF-12P	-5.8 ± 8.92	-3.31 ± 11.05	0.53
VAS neck	0.75 ± 3.89	0.88 ± 2.23	0.92

	Cut-off	AUC	+ LR	Probability of C5 palsy
Minimum FD	2.4	0.80 (.64-.95)	3.9	0.55
APD	7.6	0.79 (.63-.95)	6.1	0.66

Number of positive results (below cut-off)	Sensitivity	Specificity	+ LR	Probability of palsy
1 or more	0.92	0.68	2.8	0.48
2	0.50	0.97	18.5	0.86

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Width of Laminectomy Trough

Level	Control width (mm)	C5 palsy width (mm)	p Value
C3	21.85±2.72	21.20±2.91	.557
C4	23.27±2.39	23.40±2.34	.885
C5	23.35±2.56	23.11±2.20	.782
C6	23.24±2.20	21.53±2.56	.073
C7	18.56±2.16	18.41±2.93	.898
Overall average	22.25±1.65	21.76±2.15	.507

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Conclusions

- **APD, FD, and increased segmental lordosis is correlated with post-operative C5 palsy**
  - Iatrogenic foraminal stenosis
  - Posterior drift back of cord
- **Combining cut-offs for APD and FD:**
  - **1 positive: 92%** sensitivity, **68%** specificity
  - **2 positive: 50%** sensitivity, **97%** specificity
  - Identify patients at increased risk
- **Intra-operative XR can be used to assess changes segmental lordosis**
  - Limit degree of sagittal correction
  - Potential role of foraminotomy when greater correction desired
- **Laminectomy width not associated with higher rates of C5 palsy**

Duke Orthopaedics

Thank You

Initial Surgical Management of Subaxial Cervical Spine Septic Facet Arthritis: A Report of Two Cases

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Disclosures

- I have no relevant financial relationships with the manufacturers of any commercial products and/or providers of commercial services discussed in this CME activity.
- I do not intend to discuss any unapproved or investigative use of commercial products or devices.

Background

- Septic cervical facet arthritis is a rare entity with only 7 cases reported to date
  - » 4 involved the alanto-axial joint
    - 2 (50%) underwent operative management
  - » 3 involved the subaxial spine
    - 1 (33%) underwent operative management
- Most common presenting symptoms are neck pain and fever
  - » Diagnosis is often delayed given vague symptoms
- All reported cases had an elevation in either ESR or CRP

Non-Operatively Treated

Reference	Diagnosis	Immobilization	Outcomes	Follow up
Sasaki et al. J Spinal Disord Tech 2006 [1]	Left C1/2	Halo for 15 weeks	Resolution of infection	1 year
Michel-Batot et al. Joint Bone Spine 2008 [2]	Left C4/5	Bedrest for 1 month followed by cervical collar for 2 months	"Favorable Outcome"	No follow up reported
Stetch et al. Iowa Orthop J 2010 [3]	Left C5/6	No immobilization reported	Resolution of infection	6 months
Jones et. al Am J Emerg Med 2012 [4]	Right C1/2	No immobilization reported	Improving symptoms	No follow up reported

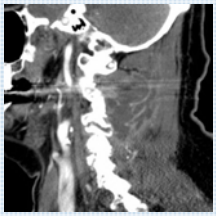
Operatively Treated

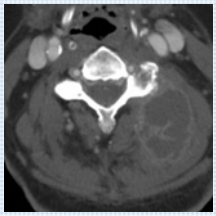
Reference	Diagnosis	Indication for Surgery	Surgery	Outcomes	Follow up
Halla et al. Arthritis Rheum 1991 [5]	Right C1/2	Failure of IV antibiotics with hemiparesis	Transoral debridement, odontoidectomy, and Halo placement for 6 months	Resolution of infection	2 years
Michel-Batot et al. Joint Bone Spine 2008 [2]	Bilateral C3/4 and C4/5	Epidural abscess with tetraparesis	Details not reported	Mortality due to multi system organ failure	Mortality
Compes et al. Eur Spine J 2015 [6]	Left C1/2	Failure of IV antibiotics with persistent pain and fevers	Debridement, C1/2 left laminectomy C1-3 instrumented fusion	Resolution of infection.	1 year

Case 1

- 71 year old male with diabetes, hypertension, and coronary artery disease who presented to his PCP with axial neck pain after painting his house.
- Initially treated conservatively by PCP until 1 month later when he developed low grade fevers with continued pain and presented to the ED.
  - » Temp: 99.2 ^{o}F
  - » WBC 22.3K, ESR 40mm/hr
  - » Neurologically intact

Case 1





Case 1

- Ultrasound guided aspiration:
  - » 7ml frank purulence
  - » Gram stain: Gram positive cocci in pairs and chains
- Taken to the operating room the following day

Case 1

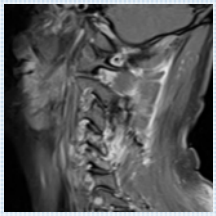
Post-Operative Course

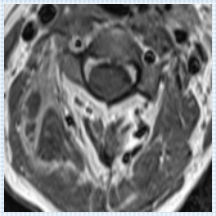
- Discharged home on POD 5
- No collar or other immobilization used
- Microbiology:
  - » Streptococcal Viridans – no clear etiology
  - » 6 weeks IV Ceftriaxone
  - » 2 months of oral antibiotics
- 1 year follow up
  - » Resolution of neck pain with mild persistent stiffness
  - » Normalization of ESR/CRP

Case 2

- 48 year old male with schizophrenia and rheumatoid arthritis on chronic prednisone and etanercept who presented to the emergency department with sepsis and altered mental status
  - » Temp: 103.8°F
  - » WBC: 12.5K
  - » No ESR/CRP done pre-op
  - » Neurologically intact
- During his workup for possible meningitis an MRI of the entire spine was obtained

Case 2

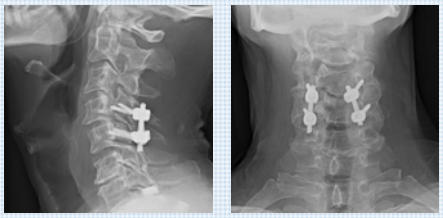




Case 2

- Ultrasound guided aspiration was deferred given sepsis
- Taken urgently to the operating room

Case 2



Post-Operative Course

- Complicated by an abscess associated with an infected total hip arthroplasty discovered on POD 1
  - » Required I&D of hip
- Discharged POD 8 to Acute Inpatient Rehabilitation
- No collar or other immobilization used
- Microbiology:
  - » Methicillin Resistant Staph Aureus – Primary infection possibly infected total hip arthroplasty
  - » 8 weeks IV Vancomycin followed by doxycycline suppression for peri-prosthetic infection

Post-Operative Course

- ESR/CRP did not normalize during our follow up period due to multiple recurrent infections at distant sites
  - » Improving in the initial post-operative period
- 8 month follow up:
  - » Neck pain had returned to baseline
  - » No signs of symptoms of recurrent infection
  - » Continued on suppressive antibiotics for peri-prosthetic infection
  - » Currently being treated for pneumonia

Conclusions

- Cervical spine septic facet arthritis is a rare and likely under-reported entity
- High index of suspicion in patients with neck pain and reported fevers
- While not all patients may require surgical intervention, we believe those with large abscesses and bacterial burden may benefit from early surgical intervention
- Successful experience in both of our patients with early surgical intervention without prolonged immobilization

References

[1] Sasaki K, Nabeshima Y, Ozaki A, et al. Septic arthritis of the atlantoaxial joint: case report. *J Spinal Disord Tech.* 2006;19(8):612-615.

[2] Michel-Batot C, Dintinger H, Blum A, et al. A particular form of septic arthritis: septic arthritis of facet joint. *Joint Bone Spine.* 2008;75(1):78-83.

[3] Stecher JM, El-Khoury GY, Hitchon PW. Cervical facet joint septic arthritis: a case report. *Iowa Orthop J.* 2010;30:182-187.

[4] Jones JL, Ernst AA. Unusual cause of neck pain: septic arthritis of a cervical facet. *Am J Emerg Med.* 2012;30(9):2094 e2091-2094.

[5] Halla JT, Bliznak J, Hardin JG, Finn S. Septic arthritis of the C1-C2 lateral facet joint and torticollis: pseudo-Grisel's syndrome. *Arthritis Rheum.* 1991;34(1):84-88.

[6] Compes P, Rakotozanany P, Dufour H, Fuentes S. Spontaneous atlantoaxial pyogenic arthritis surgically managed. *Eur Spine J.* 2015;24 Suppl 4:S461-464.

WAKE ORTHOPAEDICS

Questions/Comments

UNC SCHOOL OF MEDICINE

Patients as ~~Consumers~~ Customers of Healthcare

MSOC HEALTH Empowering the business of medicine™

con·sum·er ***n.***

One that consumes, especially one that acquires goods or services for direct use or ownership rather than for resale or use in production and manufacturing

MSOC HEALTH

What's happening to healthcare …

What is moving us along this paradigm…

MSOC HEALTH

Government intervention …

Patient Protection and Affordable Care Act (PPACA)

- Decrease the number of uninsureds
- Reduce the cost of healthcare
- Cover all applicants
- Offer same rates regardless of gender or pre-existing conditions

MACRA and Value-Based Care

- CMS modifications and shift to value based care
- MIPS and APM
- Bundled Payment Arrangements
- ACO's and Clinically Integrated Networks

Health Insurance Exchange

- Primarily what the health insurance exchange will do is bring together private health insurance companies along with a government health insurance option to compete for business among individuals and small businesses. To be in the health insurance exchange the health insurance policies offered cannot exclude someone for pre-existing conditions.

"The Marketplace will offer much more than any health insurance website you've used before," HHS Secretary Kathleen Sebelius wrote in a blog post.

"Insurers will compete for your business on a level playing field, with no hidden costs or misleading fine print."

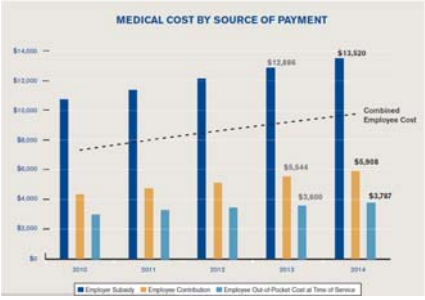
Get Ready, Get Set …

Capitalism at its finest …

Insurance is changing …

Medical Plan Analysis
October 1, 2015 Renewal

		Current	Renewal	Option 1	Option 2	
		Blue Cross & Blue Shield of NC Blue Options #6000006	Blue Cross & Blue Shield of NC Blue Options #6000713	Blue Cross & Blue Shield of NC Blue Options Gold 1500-E	Blue Cross & Blue Shield of NC Blue Options HSA #G0001A - Opt. A	Blue Cross & Blue Shield of NC Blue Options #G0001A - Opt. B
Rates	Counts			Age Band	Age Band	Age Band
Employee Only	11	$549.16	$630.04	$0.00	11 $0.00	0 $0.00
Employee + Spouse	3	$1,252.07	$1,163.14	$0.00	3 $0.00	0 $0.00
Employee + Child(ren)	0	$1,045.31	$1,283.51	$0.00	0 $0.00	0 $0.00
Family	2	$1,615.15	$1,615.05	$0.00	2 $0.00	0 $0.00
Estimated Monthly Premium		$12,273.24	$13,113.58	$175,613.04	$12,273.24	
Estimated Annual Premium		$147,277.88	$157,113.58	$175,613.04	$146,727.88	
Percentage Change From Current		0%	14.3%	7.1%	-12.7%	
Annual Dollar Change From Current		$0.00	$21,445.10	$11,564.50	($17,455.91)	
Benefits						
Office Visit						
Primary Care		$25 Copay	$25 Copay	$25 Copay	Deductible then 20%	$25 Copay
Preventive Care		100% Covered (no deductible)	100% Covered (no deductible)	100% Covered (no deductible)	100% Covered (no deductible)	100% Covered (no deductible)
Specialists		$50 Copay	$50 Copay	$50 Copay	Deductible then 20%	$45 Copay
Routine Vision Exam		100% Covered (1 per 12 months)	100% Covered (1 per 12 months)	100% Covered (1 per 12 months)	100% Covered (1 per 12 months)	100% Covered (1 per 12 months)
Lab and X-Ray						
In Office		$25/ $50 Copay	$25 / $50 Copay	$25 / $50 Copay	Deductible then 20%	$25 / $45 Copay
Out of Office		Deductible then 20%	Deductible then 20%	Deductible then 20%	Deductible then 20%	Deductible then 20%
MRI, CAT & PET		Deductible then 20%	Deductible then 20%	Deductible then 20%	Deductible then 20%	Deductible then 20%
Prescription Drugs						
Retail Non Specialty		$4 / $40 / $55	$4 / $40 / $55	$10 / $35 / $55	Deductible then 20%	$4 / $35 / $55
Retail Specialty						
Mail Order/Specialty		20%	20%	20%	Deductible then 20%	20%
In-Network						
Embedded / Non-Embedded		Embedded	Embedded	Embedded	Non-Embedded	Embedded
Annual Deductible (Ind / Fam)		$1,000 - $2,000 (FY)	$1,000 - $2,000 (FY)	$1,000 - $2,000 (FY)	$2,000 - $4,000	$1,750 - $3,500 (FY)
Coinsurance Max (Ind / Fam)		$2,000 - $4,000	$2,000 - $4,000	$1,000 - $3,000	$2,000 - $4,000	$1,750 - $3,500
Coinsurance Percentage		Deductible then 20%	Deductible then 20%	Deductible then 20%	Deductible then 20%	Deductible then 20%
Out-of-Pocket Max (Ind / Fam)		$3,000 - $6,000	$3,000 - $6,000	$3,000 - $6,000	$4,000 - $8,000	$3,000 - $7,000
Lifetime Maximum		Unlimited	Unlimited	Unlimited	Unlimited	Unlimited
Inpatient Services						
Physician		Deductible then 20%	Deductible then 20%	Deductible then 20%	Deductible then 20%	Deductible then 20%
Hospital		Deductible then 20%	Deductible then 20%	Deductible then 20%	Deductible then 20%	Deductible then 20%
Outpatient Services						
Physician		Deductible then 20%	Deductible then 20%	Deductible then 20%	Deductible then 20%	Deductible then 20%
Hospital		Deductible then 20%	Deductible then 20%	Deductible then 20%	Deductible then 20%	Deductible then 20%
Other Services						
Emergency Room Services		$500 Copay	$500 Copay	$300 Copay	Deductible then 20%	$150 Copay
Urgent Care Copay		$50 Copay	$50 Copay	$75 Copay	Deductible then 20%	$60 Copay
Chiropractic Services		$40 Copay / 30 visits / FY	$40 Copay / 30 visits / FY	$40 Copay / 30 visits / FY	Deductible then 20% / 30 visits / FY	$40 Copay / 30 visits / FY
Out of Network						
Annual Deductible (Ind / Fam)		$2,000 - $4,000	$2,000 - $4,000	$3,000 - $6,000	$4,000 - $8,000	$3,000 - $7,000
Coinsurance Max (Ind / Fam)		$4,000 - $8,000	$4,000 - $8,000	$3,000 - $6,000	$4,000 - $8,000	$3,000 - $7,000
Coinsurance Percentage		Deductible then 30%	Deductible then 30%	Deductible then 30%	Deductible then 50%	Deductible then 50%
Out of Pocket Max (Ind / Fam)		$6,000 - $12,000	$6,000 - $12,000	$6,000 - $12,000	$8,000 - $16,000	$7,000 - $14,000
Notes						



http://us.milliman.com/uploadedFiles/insight/Periodicals/mmi/pdfs/2014-mmi.pdf

Movement is occurring…

FIGURE 4
Sharp increase in offerings of consumer-directed health plans
Percent of employers offering/likely to offer CDHP, by employer size

Number of employees	2010	2011	2012	2013	2014	Very likely to offer in 2017
All employers (10+ employees)	17%	20%	22%	23%	27%	36%
All large employers (500+ employees)	23%	32%	36%	39%	48%	66%
Jumbo employers (20,000 + employees)	51%	48%	59%	63%	72%	88%

Source: http://www.mercer.com/newsroom/modest-health-benefit-cost-growth-continues-as-consumerism-kicks-into-high-gear.html#5

Movement is occurring …

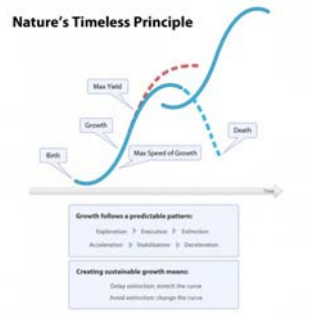
- Consumerism taking hold as enrollment in CDHPs jumps to 23%
- High deductibles are meant to give employees a financial incentive to shop more carefully for health services
- Cigna Spokesperson Joseph Mondy told Workforce. "Why? Because they work. CDHPs will cost you less as an employee and as an employer, but you'll see improvements in health outcomes. We have seven years of data to support that."

Thinking inside the big box

- "UnitedHealth means to capitalize on the fact that retail is a "significant portion of individuals' lives" by creating new retail partnerships to make it easier for the consumer to access all aspects of the insurance industry."
- "Insurers could, say, team up with grocery stores to help increase health awareness and wellness purchasing among their consumers. Or they could partner with technology companies to help inform consumers' wellness goals, including walking, weight management and diet."

Source: June 19, 2013, http://www.fiercehealthpayer.com/story/unitedhealth-retail-partnerships-bring-more-holistic-experience-consumers/2013-06-19?utm_medium=nl&utm_source=internal

Jumping the curve …



Definition of a Customer

cus·tom·er *noun* \'kəs-tə-mər\

Definition of *CUSTOMER*

1: one that purchases a *commodity* or service

2: an individual usually having some specified distinctive trait <a real tough *customer*>

Examples of *CUSTOMER*

She is one of our best *customers*.

She's a pretty cool *customer*.

Origin of *CUSTOMER*

Middle English *custumer,* from *custume* First Known Use: 15th century

*http://www.merriam-webster.com/dictionary/customer

What is a customer?

- Advocate
- Apathetic
- Assassin

*Satisfaction: How Every Great Company Listens to the Voice of the Customer, 2006, Chris Denove and James D. Power IV

Why are customers important?

- It costs 5 times as much to attract a new customer than to keep an existing one. (Source: seohosting.com)
- 68% leave because they are upset with the treatment they've received. (Source: U.S. Small Business Administration)
- On average, loyal customers are worth up to 10 times as much as their first purchase. (Source: White House Office of Consumer Affairs)
- 48% of customers who had a negative experience told 10 or more others. (Source: Harvard Business Review)

Why are customers important?

- 64% of customers cited shared values as the primary reason for a strong brand relationship.
  - Source: Corporate Executive Board
- 68% quit because of the attitude of indifference toward the customer by the owner, manager or some employee.
  - Source: Michael LeBoeuf, "*How to Win Customers and Keep them for Life*"
- 3 in 5 Americans (59%) would try a new brand or company for a better service experience.
  - Source: American Express
- 89% of consumers began doing business with a competitor following a poor customer experience.
  - Source: RightNow

Most important reason …

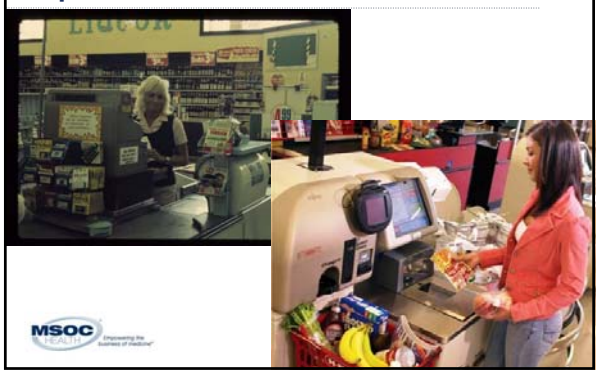
- I believe that the customer pathway will drive quality and value at a faster pace than the government or employers can.
- Let's explore my basis for this…

Let's look at things differently …

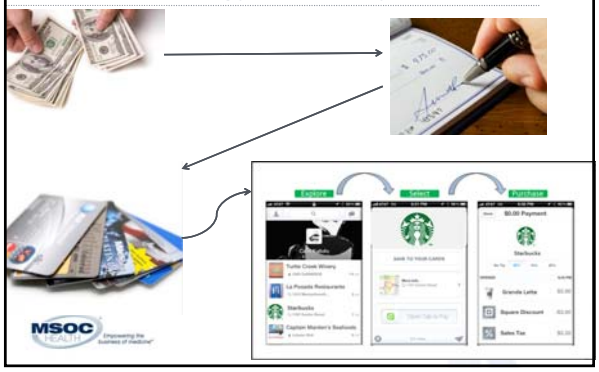
What do customers want?

- A novel question asked by other industries … does healthcare ask that question?

Speed and Convenience



Use Technology Efficiently …



Who has an iPhone?

Knowing I can be in and out of the store in three minutes flat, purchase in hand, is a major incentive to buy more stuff.

Speed and convenience … but still some service

Still want to be involved …

Are patients ready for different …

PERCENTAGE OF CONSUMERS WHO WOULD CONSIDER RECEIVING SPECIFIC FORMS OF CARE, BY LOCATION

	PHYSICAL EXAMINATION	ROUTINE CARE	MINOR EPISODES	DIET/ NUTRITION	FITNESS/ WELLBEING	CHRONIC MANAGEMENT
Interested in receiving care in at least one alternative location	44%	64%	79%	66%	64%	50%
Grocery store (such as Kroger, Publix, Safeway)	10%	17%	20%	22%	21%	11%
Discount retail store (such as Wal-Mart, Target)	13%	20%	24%	25%	25%	13%
Pharmacy (such as Walgreen's, CVS, Rite Aid)	15%	26%	26%	25%	23%	19%
Walk-in clinic or urgent care center	25%	46%	61%	30%	30%	25%
Remotely via phone, voice chat, or video chat	4%	11%	13%	12%	13%	16%

<10% 10-24% 25-49% 50%+

Source: 2013 Oliver Wyman Consumer survey

http://www.oliverwyman.com/insights/publications/2014/apr/are-consumers-ready-for-retail-healthcare-.html#.VcKdPU174qQ

What do customers want?

- A novel question asked by other industries … does healthcare ask that question?

And yet, healthcare is lagging.

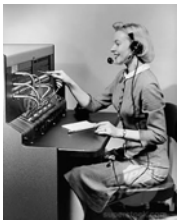
Patients are demanding more convenient access to care.

Urgent Care Providers	Retail Health Clinics	Virtual Acute Care Providers
9,000 urgent care centers	1,743 retail health clinics	>20 virtual acute care companies

This portion of our program prefers interaction …

Is there a wait?

Did you know that I text?



Do I have to come to your office?

Rethinking your front desk …

Why do all of this …

The landscape is changing fast! We have to keep up …

Keep it simple …

Ideas for Retention …
Why do you keep … ?

- Why do you bank at…?
- Why do you eat at…?
- Why do you get your teeth cleaned at…?
- Why do you buy your groceries at…?
- Why do buy your books online? At a bookstore? What happened to the library?
- Where do you go for your mammogram?
- Where do you take your kids for a check up?
- Who does your hair?
- What church do you attend? Why?

Thank you for your time!

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