

Tentative Agenda
Finance Committee
May 3, 2016
6:00 p.m.
Council Chambers Conference Room

Roll Call

DISCUSSION ITEMS

- 1) Stryker Cot
Doug Jonesi, Emergency Medical Services Director
- 2) Ambulance Purchase
Doug Jonesi, Emergency Medical Services Director
- 3) Next Meeting Date – June 7, 2016

ADJOURNMENT

**CITY OF RAYTOWN
Request for Board Action**

Date: 17 May 2016

Resolution No.: R-XXXX-XX

To: Mayor and Board of Aldermen

From: EMS, Doug Jones, Emergency Medical Services Director

Department Head Approval: _____

Finance Director Approval: _____ (only if funding requested)

City Administrator Approval: _____



Action Requested: EMS requests the Board of Aldermen to approve a resolution authorizing the purchase of a Stryker Power-LOAD system, to be installed on the ambulance which is currently to be ordered and delivered later in 2016.

Recommendation: The Department of Emergency Medical Services recommends the purchase and installation of this equipment.

Analysis: The Power-LOAD cot fastener system compliments the Power-PRO ambulance cots we currently have in service. During loading into/unloading from the ambulance, the system supports the full weight of cot and patient, lifts/lowers the cot into/out of the ambulance mechanically, thereby minimizing the potential to drop the cot or patient during these operations, and eliminating the operator spinal loads which can lead to cumulative trauma. Cost includes freight, extended warranty/maintenance package (7-year), and the retrofit of one of our cots to be used with the system.

Alternatives: The alternative would be to not purchase the system.

Budgetary Impact:

- Not Applicable
- Budgeted item with available funds
- Non-Budgeted item with available funds through prioritization
- Non-Budgeted item with additional funds requested

Amount Requested: \$28,608.12
Account Number(s): 205-72-00-100-53250
Fund: Capital Sales Tax
Department: EMS

Additional Reports Attached: Quote from Stryker
Power-LOAD brochure
Sole-source documentation
Additional information on the biomechanics of back injuries



Sales Account Manager

Todd Tibbetts
 Todd.Tibbetts@stryker.com
 Cell: 925-323-8136

Remit to:

P.O. Box 93308
 Chicago, IL 60673-3308

End User Shipping Address

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 RAYTOWN EMS
 10020 E 66TH TERRITORY
 RAYTOWN, MO 64133

Shipping Address

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 RAYTOWN EMS
 10020 E 66TH TERRITORY
 RAYTOWN, MO 64133

Billing Address

1153213
 RAYTOWN EMS
 10020 E 66TH TERRITORY
 RAYTOWN, MO 64133

Customer Contact	Ref Number	Date	PO Number	Reference Field	Quote Type
	4759421	03/09/2016	QUOTE		

Line #	Quantity	Item Description	Part #	Unit Price	Extended Price	Item Comments
1.00	1	PowerLOAD	6390000000	\$20,995.00	\$20,995.00	
		Options				
	1	PowerLOAD	6390000000	\$20,995.00	\$20,995.00	
	1	Standard Comp 6390 Power Load	6390026000			
	1	English Manual	6390600000			
	1	1 year parts, labor & travel	7777881660			
2.00	1	Protect Power-LOAD- 7year	77506001	\$5,804.12	\$5,804.12	
3.00	1	6506 PWRLD COMPAT UPGRADE KIT	6506700001	\$1,499.00	\$1,499.00	
4.00	1	ProCare Upgrade Charge	77100003	\$310.00	\$310.00	

Note:

Product Total	\$28,608.12
Freight	\$0.00
Tax	\$0.00
Total Incl Tax & Freight	\$28,608.12

Signature: _____ Title/Position: _____ Date: _____

Deal Consummation: This is a quote and not a commitment. This quote is subject to final credit, pricing, and documentation approval. Legal documentation must be signed before your equipment can be delivered. Documentation will be provided upon completion of our review process and your selection of a payment schedule.

Confidentiality Notice: Recipient will not disclose to any third party the terms of this quote or any other information, including any pricing or discounts, offered to be provided by Stryker to Recipient in connection with this quote, without Stryker's prior written approval, except as may be requested by law or by lawful order of any applicable government agency.

Terms: Net 30 Days. FOB origin. A copy of Stryker Medical's standard terms and conditions can be obtained by calling Stryker Medical's Customer Service at 1-800-STRYKER.

Cancellation and Return Policy: In the event of damaged or defective shipments, please notify Stryker within 30 days and we will remedy the situation. Cancellation of orders must be received 30 days prior to the agreed upon delivery date. If the order is cancelled within the 30 day window, a fee of 25% of the total purchase order price and return shipping charges will apply.

Date: April 29, 2013

Re: Power-LOAD Cot Fastener Sole Source Information

To Whom It May Concern:

Stryker Medical certifies that we are the sole manufacturer of the Stryker EMS Power-LOAD (Model 6390). This correspondence is to inform you of the unique characteristics of the Power-LOAD Cot Fastener. These characteristics can be broken down into two primary categories: Independent Qualification, and Ease of Use.

The Stryker EMS Power-LOAD (Model 6390) cot fastening system is mounted within the patient compartment and is intended to aid in the loading/unloading of patients. The Stryker Power-LOAD is the only powered cot fastening system that meets the following:

Independent Qualification

- IPX6: The system is rated to withstand powerful water jets.
- IEC 60601-1 and IEC 60601-1-2: This certification indicates that Power-LOAD conforms to industry standards for mechanical and electrical safety for medical electrical devices, as well as electromagnetic compatibility and immunity.
- BS EN-1789 clause 4.5.9: This is a European dynamic crash test which subjects a 50th percentile dummy to a nominal 10g deceleration for a minimum of 50ms. Following the test there shall be no sharp edges or danger to the safety of persons in the road ambulance.

Ease of Use

- Device must provide a linear guide when loading and unloading the cot
- Device must allow for remote actuation from Power-PRO foot end controls
- Device must engage to the cot during loading and unloading, providing a means of lifting and lowering
- Device must allow for manual back-up operation in the event of power failure or system error
- Device must have a safe working load of 870 lbs and be capable of lifting patients weighing up to 700lbs.
- Device must be mounted inside the patient compartment to prevent environmental exposure and corrosion
- Device must be power washable
- Device must be capable of inductively charging the Stryker SMRT cot battery

Please contact your Stryker Sales Representative for further information.



Power-LOAD™
power-loading
cot fastener system

Power-LOAD

power-loading cot fastener system

Shown with optional accessories.

Reduce the risk of injuries when loading and unloading cots

Power raise and lower for loading and unloading

using your finger, not your back.



Load and unload patients with the touch of a button.

Operator injuries result from repetitive spinal loading. Our innovative Power-LOAD cot fastener system is designed to load and unload a compatible cot with the touch of a button – not your back.

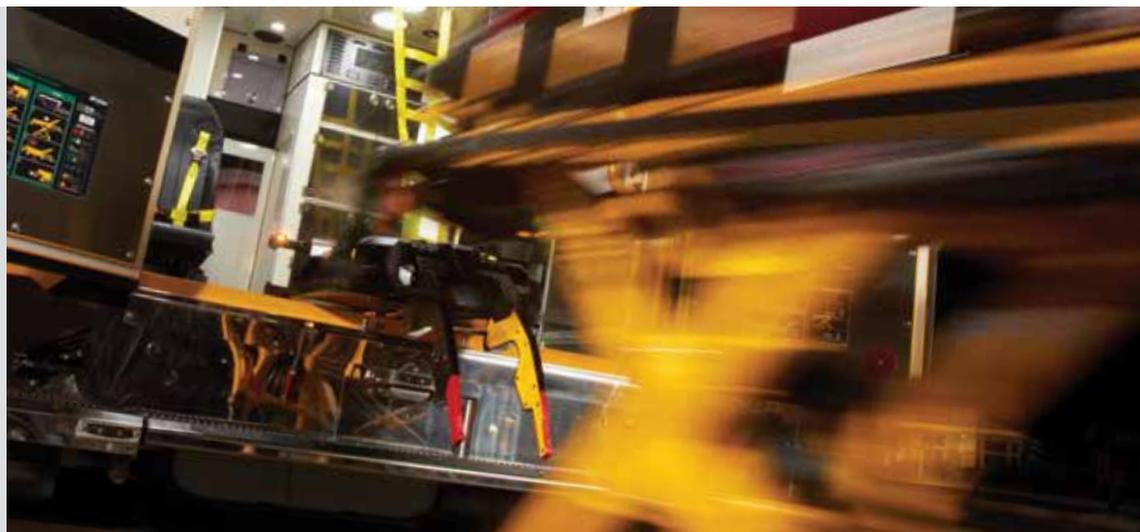
Save yourself from injury. Save your career with Power-LOAD.

Ergonomically designed to reduce operator and patient injuries, Power-LOAD hydraulically lifts patients weighing up to 700 lbs.

Lifts and lowers the cot into and out of the ambulance, reducing spinal loads and the risk of cumulative trauma injuries.

The Power-LOAD cot fastener system improves operator and patient safety by supporting the cot throughout the loading and unloading process. The reduction in spinal load helps prevent cumulative trauma injuries. Power-LOAD wirelessly communicates with Power-PRO™ cots for ease of operation and maximum operator convenience.

- **Eliminates the need to steer the cot into and out of the ambulance.**
- **Minimizes patient drops by supporting the cot until the wheels are on the ground.**
- **Meets dynamic crash test standards for maximized occupant safety.**
- **Features an easy-to-use manual back-up system, allowing complete operation in the event of power loss.**
- **Lifts or lowers the cot into and out of the ambulance, eliminating spinal loads that can result in cumulative trauma injuries.**



Cot Release Handles

Red release handles allow the cot to be disengaged from the Power-LOAD system when unloading.



Duplicate LED Indicator

Displays Power-LOAD status at the head end for added operator convenience.



Manual Trolley Release

Allows trolley to be released when locked at the head end.

Inductive Charging

Power-LOAD automatically charges the cot SMRT battery and Power-LOAD battery when in transport position (no cable or connectors required).

Head-end LED Indicators

Keeps operator informed of position status. Solid green when in position or ready to transport; flashing amber when not in position or not ready to transport.

Trolley

Secures the cot into the Power-LOAD system.

Lifting Arms

Battery-powered hydraulic lift system supports the cot and patient during loading and unloading.

Linear Transfer System

Supports and guides the cot during loading and unloading.

Control Panel

Allows complete operation for manual cots as well as the operation of powered cots in the event of a power loss.



Foot-end Release

Allows the cot to be disengaged from the patient compartment.



Battery Indicator

If the Power-LOAD system is in transport position, the battery LED will flash green, indicating the battery is being charged. If the battery is low, the caution LED will flash amber.

Safety Hook

Assures handling confidence when loading and unloading in the event of power loss.

700lb
capacity

Features

1 Lifting Arms

Battery-powered hydraulic lift system supports the cot and patient during loading and unloading.

2 Head-end LED Indicators

Keeps operator informed of position status. Solid green when in position or ready to transport, flashing amber when not in position or not ready to transport.

3 Control Panel

Allows complete operation for manual cots as well as the operation of powered cots in the event of a power loss.

4 Cot Release Handles

Red release handles allow the cot to be disengaged from the Power-LOAD system when unloading.

5 Linear Transfer System

Supports and guides the cot during loading and unloading.

6 Inductive Charging

Power-LOAD automatically charges the cot SMRT battery and Power-LOAD battery when in transport position (no cable or connectors required).



Inductive Charging

Power-LOAD automatically charges the SMRT battery when in transport position (no cable or connectors required).



Power Controls

The Power-PRO cot controls the Power-LOAD system during loading and unloading for ease of operation and maximum convenience.



Low Electrical Demand

Power-LOAD is self-powered, drawing minimal amperage from the vehicle (during charging process).



Operation Guide

Power-LOAD operation labels are provided and intended to be placed on the inside of the rear doors of the ambulance as a quick reference guide for Power-LOAD operation.



Control Panel

Allows complete operation for manual cots as well as the operation of powered cots in the event of a power loss.



Marine Grade Hydraulic System

Provides reliable operation in harsh conditions.

Warranty

- One-year parts, labor, and travel or two-year parts only
- Lifetime on all welds*

Extended warranties available.

*7-year service life

Certifications:

IPX6 IEC 60601-1
 AS/NZS 4535:1999 BS EN 1789:2007





Power-LOAD Cot Compatibility

The Power-LOAD compatibility option is available for the Power-PRO XT, Power-PRO IT, and Performance-PRO. This system meets dynamic crash test standards for maximized occupant safety¹ and will automatically charge the Power-PRO XT and Power-PRO IT SMRT battery.



Power-PRO XT Ambulance Cot



Power-PRO IT Ambulance Cot



Performance-PRO XT Ambulance Cot

Optional Features



Wheel Guide

Required for applications when the Power-LOAD system is mounted near the wall. Keeps the wheels straight when loading and unloading.



Mass Casualty Floor Mount Assembly

Provides cot compatibility for non-upgraded Stryker X-frame cots. Assembly equipped with quick release mechanism for ease of operation.



Mass Casualty Wall Mount Assembly

Provides cot compatibility for non-upgraded Stryker X-frame cots. Assembly equipped with quick release mechanism for ease of operation.

Power-LOAD Specifications

Model Number	6390
Length	
Overall Length	95 in (241 cm)
Minimum Length	89.5 in (228 cm)
Width	
	24.5 in (62 cm)
Weight	
Total Weight	211.5 lb (96.5 kg)
Floor Plate Assembly	16.5 lb (7.5 kg)
Anchor Assembly	23 lb (10.5 kg)
Transfer Assembly	67 lb (30.5 kg)
Trolley Assembly	105 lb (48 kg)
Maximum Weight Capacity*	700 lb (318 kg)
Minimum Operator Required	
Occupied Cot	2
Unoccupied Cot	1
Recommended Loading Height	22 in to 36 in (56 cm to 91 cm)
Battery	12V, 5 Ah Lead Acid Battery (6390-001-468)

* Maximum weight capacity represents patient weight. Safe working load of 870 lb (395 kg) represents the sum of the cot total weight and patient.

† Meets dynamic crash standards for Power-PRO XT (AS/NZS-4535 and BS EN-1789) and Performance-PRO XT (BS EN-1789).

Stryker reserves the right to change specifications without notice.

Specifications are rounded to the nearest whole number. Conversions are calculated before rounding.

The Power-LOAD cot fastener system is designed to conform to the Federal Specification for the Star-of-Life Ambulance KKK-A-1822.

Patents pending.

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Trauma & Extremities
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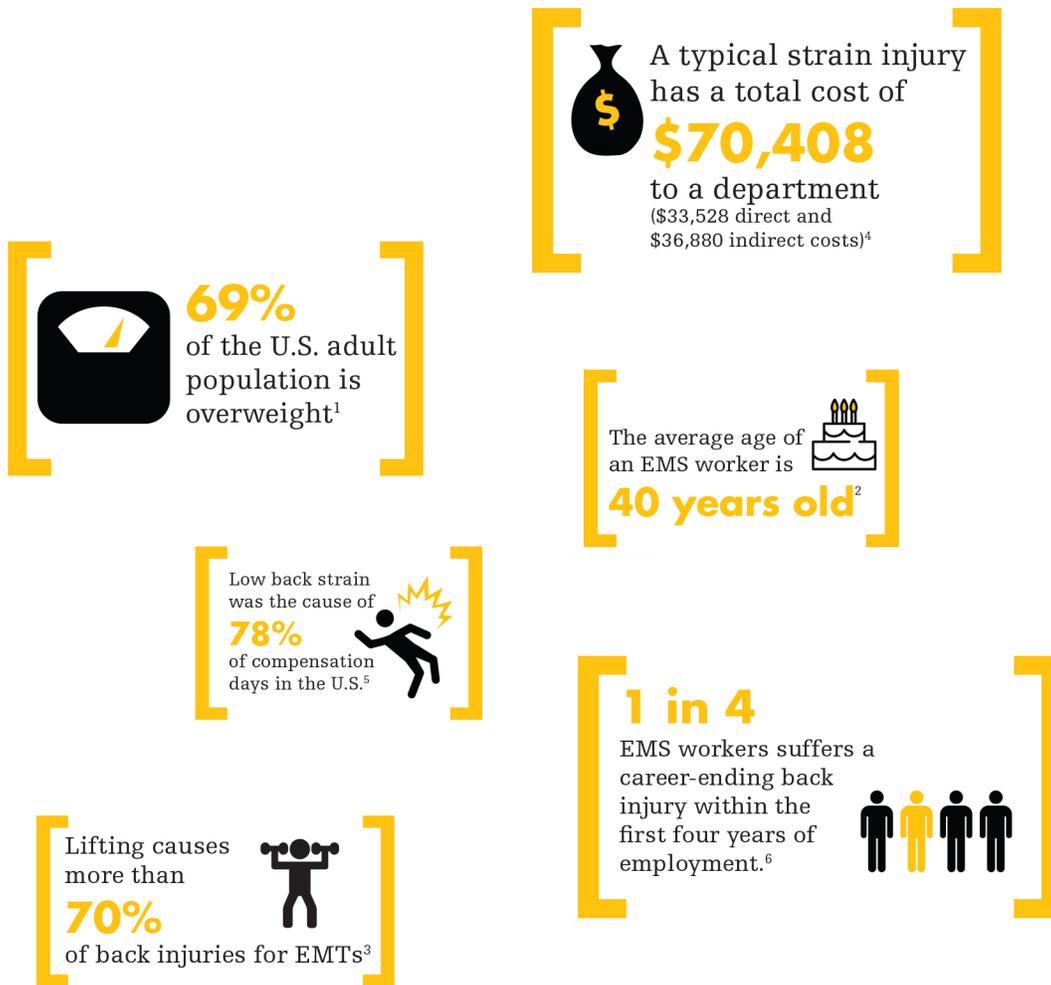
www.ems.stryker.com

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References

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3. http://www.emsworld.com/press_release/11360397/firefighter-invents-product-to-reduce-back-injuries
4. <https://www.osha.gov/dcspp/smallbusiness/safetypays/estimator.html>
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6. Sanders, Mick J. (2011) Mosby's Paramedic Textbook (4th ed., p. 36)
7. <http://ems.stryker.com/> Stryker's Powered System shown to reduce back related injuries.

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ISB KEYNOTE LECTURE

THE BIOMECHANICS OF LOW BACK INJURY: IMPLICATIONS ON CURRENT PRACTICE IN INDUSTRY AND THE CLINIC

Stuart M. McGill

Occupational Biomechanics and Safety Laboratories, Department of Kinesiology, Faculty of Applied Health Sciences, University of Waterloo, Waterloo, Ontario, Canada N2L 3G1

Abstract—The purpose of this paper is to introduce some concepts of low back injury for use towards developing better injury risk reduction strategies and advancing rehabilitation of the injured spine. Selected issues in low back injury are briefly reviewed and discussed, specifically, the types of tissue loads that cause low back injury, methods to investigate tissue loading, and issues which are important considerations when formulating injury avoidance strategies such as spine posture, and prolonged loading of tissues over time. Finally, some thoughts on current practice are expressed to stimulate discussion on directions for injury reduction efforts in the future, particularly, the way in which injuries are reported, the use of simple indices of risk such as load magnitude, assessment of the injury and development of injury avoidance strategies. This paper was written for a general biomechanics audience and not specifically for those who are spine specialists. © 1997 Elsevier Science Ltd. All rights reserved.

Keywords: Low back injury; Lumbar spine; Injury; Low back pain.

INTRODUCTION

What really causes low back injury? Why may only one individual become injured among a group of workers performing an identical job? How is it that a worker can perform a physically demanding job all day and then 'throw their back out' at night picking up a pencil? How does low back injury occur in people who perform seated-sedentary jobs? It is better to stoop or squat when lifting? Is compression that most important loading variable when considering injury? We have all experienced injury of various sorts throughout our lives, but why do we become injured at all? While it is currently popular to state that psychosocial components factor heavily in several aspects of occupational low back pain, there is no dispute that injury must result from excessive mechanical loading of a particular tissue, thereafter psychosocial aspects affect injury reporting, pain perception, etc. In fact, it is the characteristics of the load itself (load rate, mode of load compression, bending, torsion, shear, etc.) and properties of the tissue which determine the type and extent of tissue damage. Loads on individual tissues can be surprisingly high, in fact, given the magnitude of tissue loads during the performance of quite ordinary daily tasks, our enjoyment of lengthy periods free from injury fosters an appreciation for the magnificent strength and durability of the low back.

The purpose of this review paper is to introduce, and discuss in a limited way, some selected issues associated with low back injury. It is the opinion of this author that failure to recognize the intricacies of the biomechanics of low back injury is a serious impediment to the further development of strategies for significant reduction in occupationally related low back injury and also hinders major advances in rehabilitation of the injured spine. Combining biomechanical modelling techniques to ob-

tain tissue loads with studies of tissue mechanics and structural architecture is a powerful approach for analysing injury mechanisms, assessing the injury risk, and preparing injury avoidance strategies.

THE INJURY PROCESS

While a generic scenario for injury is presented in this section, references for injury from repeated and prolonged loading to specific tissue is provided in the next section. The purpose here is to motivate consideration of the many factors which modulate the risk of tissue failure, and generate hypotheses to probe injury etiology.

Injury, or failure of a tissue, occurs when the applied load exceeds the failure tolerance or strength of the tissue. Injury shall be defined, for the purposes of this paper, as the full continuum from the most minor of tissue irritation (but micro-trauma nonetheless) through to the grossest of tissue failure, for example, vertebral fracture or ligament avulsion. Obviously, a load that exceeds the failure tolerance of the tissue, applied once, produces injury (the Canadian snowmobiler, airborne, and about to experience an axial impact with the spine fully flexed is at risk of, in this case, posterior disc herniation upon landing). This injury process is depicted in Fig. 1, where a margin of safety is observed in the first cycle of sub-failure load. In the second loading cycle, the applied load increases in magnitude, simultaneously decreasing the margin of safety to zero and injury occurs. While this description of low back injury is common, particularly amongst the medical community who are required to identify an event when completing injury reporting forms, it is the contention of this author that relatively few low back injuries occur in this manner. (More detail or the types of loads which create injury are noted in the next section).

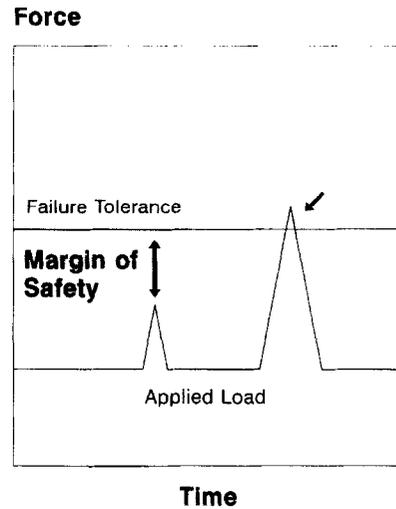


Fig. 1. The Canadian snowmobile driver (the author in this case who should know better) is about to experience an axial compressive impact load to a fully flexed spine—one-time application of load can reduce the margin of safety to zero as the applied load exceeds the strength or failure tolerance of the supporting tissues (shown with the small arrow).

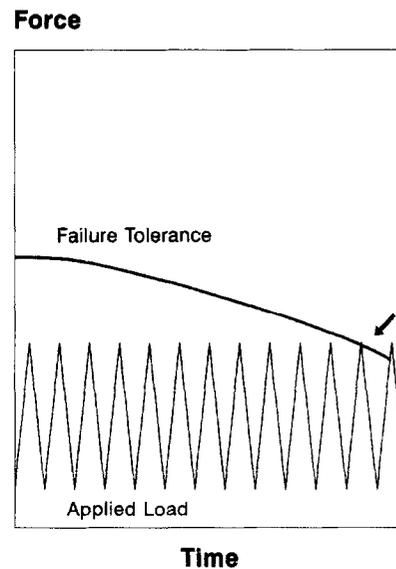


Fig. 2. Repeated sub-failure loads lead to tissue fatigue and failure on the N th repetition of load (or box lift in this example).

There are more likely scenarios which result in injury, when considering occupational and athletic endeavours, which involve cumulative trauma from sub-failure magnitude loads. In such cases, injury is the result of accumulated trauma produced by either the repeated application of relatively low load or the application of a sustained load for a long duration (as in sitting for example). An individual is shown loading boxes on a pallet, repeatedly loading the tissues of the low back (several tissues could be at risk) to a sub-failure level (Fig. 2) causing a slow degradation of their failure tolerance (e.g. vertebrae—Brinckmann *et al.* (1989); disc—Adams and Hutton (1985)). As the margin of safety approaches zero, this individual will experience low back injury. Obviously, the accumulation of trauma is more rapid with higher loads (Carter and Hayes (1977) noted that, at least with

bone, fatigue failure occurs with fewer repetitions when the applied load is closer to the yield strength).

Yet another way to produce injury with a sub-failure load is to induce stresses over a sustained period of time. The rodmen (shown in Fig. 3), with their spines fully flexed for a prolonged period of time are loading the posterior passive tissues and initiating changes in disc mechanics. The sustained load causes a progressive reduction in the margin of safety where injury is associated with the n th% of tissue strain. However, analysis of injury is further complicated by the interaction between the various tissues in the low back. For example, the prolonged—stooped posture loads the posterior ligaments of the spine and posterior fibres of the intervertebral disc causing creep deformation, possibly to the point of micro-failure (e.g. Adams *et al.*, 1980; McGill

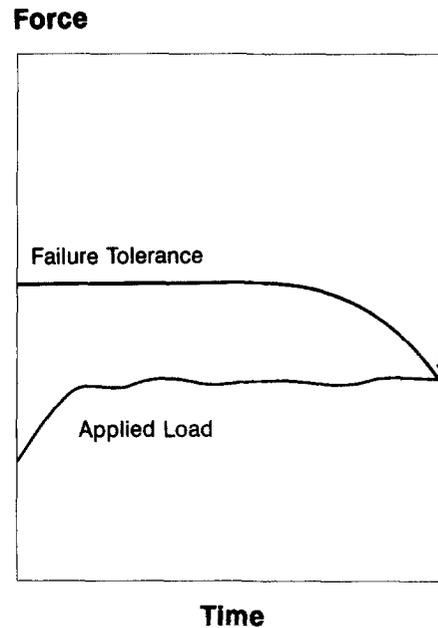


Fig. 3. These 'rodmen' are loading posterior passive tissues for a long duration which fail at the N th% of tissue strain. Strain progresses with time—steadily reducing the margin of safety.

and Brown, 1992). Quite possibly, the following chain of events may result: 'stretched' ligaments increase joint laxity, increasing the risk of hyper flexion injury (to the disc), and increasing the risk of local instability leading to injury of unisegmental structures, and ever increasing shearing and bending loads on the neural arch. It would appear that the most appropriate injury intervention strategies must appreciate the complexities of tissue overload.

The objective of injury avoidance strategies is to ensure that tissue adaption stimulated from exposure to load, it has to keep pace with and ideally exceed, the accumulated tissue damage. Thus, exposure to load is necessary but in the process of accumulating micro-trauma, the applied loads must be removed to allow the healing-adaption process to gradually increase the failure tolerance to the necessary level. Tissue loading, and the risk of injury forms an optimum 'u' shaped relationship, where the determination of the safety optimum for individual tissue loading encompasses both the art and science of medicine and biomechanics.

In summary, the injury process need not only be associated with very high loads but rather, with relatively low loads that are repeated or sustained, justifying the need for rigorous examination of injury and tissue loading for substantial periods of time prior to the culminating injury event. It is important to recognize that simply focusing on a single variable such as one-time load magnitude may not result in a successful index of risk of injury, particularly across a wide variety of activities.

WHAT REALLY CAUSES INJURY?

Understanding the cause of injury is important for developing prevention strategies. While it is out of the scope of this paper, it is acknowledged that the etiology,

pathogenesis and pathology that causes pain and impairment are highly linked together such that injury today changes the biomechanics and in fact the course of normal aging leading to 'degenerative' conditions later (Kirkaldy-Willis (1988) provides an excellent, if not older, review on this topic). The important point is that biomechanists must consider not only the application of the single load but repeated and prolonged loads to tissues that sometimes may be altered from previous load exposure and possible injury.

Vertebrae

Countless studies over the years have demonstrated that a neutral spine under compressive load results in bony failure (e.g. Brinckmann *et al.* (1989) provides a nice review)—specifically end plate fracture and damage to underlying trabeculae (e.g. Fyhrie and Schaffler, 1992) (Fig. 4)—and that repeated loading reduces the ultimate strength (Hansson *et al.*, 1987). Disc herniation is an extremely rare occurrence when the motion unit is compressed in a neutral posture. High-velocity compression results in often catastrophic vertebral burst fractures although this is not associated with occupational disorders (Adams and Dolan (1995) provide a nice review on this topic).

Disc herniation

Disc herniation from one-time application of load is extremely difficult to produce although it was achieved by Adams and Hutton (1982) with the application of compression to a spine deviated into hyperflexion and lateral bending. Herniation is more consistently produced under many cycles of combined compression, flexion and torsional loading (cf. Gordon *et al.*, 1991; Yang *et al.*, 1988) and tends to occur in younger specimens (cf. Adams and Hutton, 1985) with no visible gross signs of 'degeneration'. Epidemiological data also links herniation with

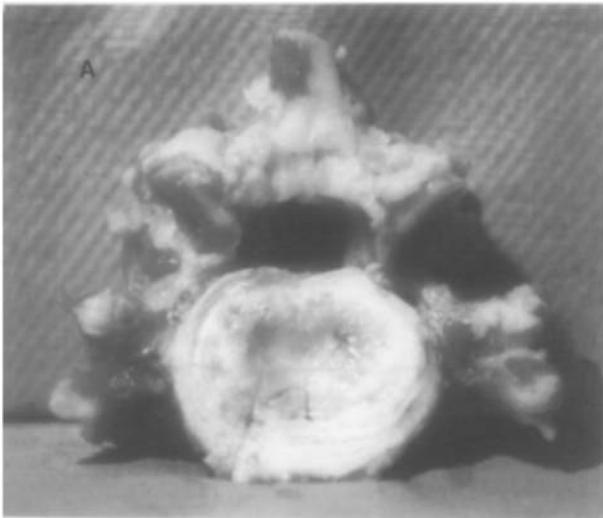


Fig. 4. End plate fracture (A) and intrusion of nuclear material (shown at the tip of the scalpel) into the vertebral body (B) from compressive loading of a spine in a neutral posture. These are porcine specimens from our laboratory.

sedentary occupations and the sitting posture (Videman *et al.*, 1990). In fact, Wilder *et al.* (1988) documented annular tears in young calf spines from prolonged simulated sitting postures and cyclic compressive loading (e.g. truck driving environment). Older spines appear not to exhibit 'classic' extrusion of nuclear material but rather are characterized by delamination of the annulus layers, and radical cracks which appear to progress with repeated loading (e.g. Goel *et al.* (1995), provides a nice modelling and experimental review). In summary, it appears that disc herniation is the result of cyclic loading, or prolonged and sustained loading, in deviated spine postures. The notion that disc herniation in an occupational or athletic setting is the result of a single event appears unlikely.

Ligaments

A similarly interesting story unfolds with bony failure and ligamentous injury. King (1993) noted that soft tissue injuries are much more common during high-energy



Fig. 5. Longitudinal ligament avulsion from a flexion-shear test (shown at the tip of the scalpel) on a porcine specimen.

traumatic events such as automobile collision. Our own observations on pig and human specimens loaded at slow load rates in bending and shear, suggests that most frequently excessive tension in the longitudinal ligaments results in avulsion or bony failure as the ligament pulls some bone away near its attachment (see Fig. 5). Noyes *et al.* (1974) noted that slower strain rates ($0.66\% s^{-1}$) produced more ligament avulsion injuries while faster strain rates ($66\% s^{-1}$) resulted in more ligamentous failure to the fibre bundles (in the middle region of the ligament), at least in monkey knee ligaments. Similar observations were made by Yoganandan *et al.* (1989) on cervical spine ligaments loaded in pure tension at rates from 9 to $2260 mm s^{-1}$. Yet it is interesting to note that in the clinical report by Rissanen (1960) that approximately 20% of cadaveric spines possessed visibly ruptured interspinous ligaments (in their middle, not at their bony attachment) and that dorsal and ventral positions, together with supraspinous, remained intact. Given the oblique fibre direction of the interspinous complex (see Fig. 6(B)), a very likely scenario to damage this ligament would be slipping and falling and landing on one's behind, driving the pelvis forward on impact, creating a posterior shearing of the lumbar joints when the spine is fully flexed. The interspinous is a major load bearing tissue in this example of high-energy loading where anterior shear displacement is combined with full flexion. Given the available data, it is the opinion of this author that torn ligaments of the spine during lifting or other normal occupational activities, particularly to the interspinous complex, is more uncommon than common. Rather, it appears much more likely that ligament damage occurs during a more traumatic event, particularly landing on one's bending during a fall, which then leads to joint laxity and acceleration of subsequent arthritic changes. As has been often said in reference to the knee, 'ligament damage marks the beginning of the end'.

Facets and neural arch

The facets and neural arch appear to withstand approximately 2000 N of shearing load (Cripton *et al.*, 1995) and fail under shear loading and torsional loading

and hyper extension (cf. Admas and Hutton, 1981). Epidemiologically, failure of the neural arch and pars interarticularis is common among athletes who rapidly cycle between flexion and extension suggesting strain reversals of the flexible arch promotes fatigue and eventually failure (cf. Hardcastle *et al.*, 1992; Wiltse *et al.*, 1975).

AN APPROACH TO INJURY ANALYSIS THAT IS SENSITIVE TO HUMAN VARIABILITY

The purpose of this section is to describe a specific modelling approach suited for analysis of injury. While several other approaches, such as finite element modelling and clinically based studies have provided many important insights, the author has chosen to focus on a specific approach in order to discuss some selected notions of low back injury addressed later in the manuscript.

There is tendency among biomechanists, and those responsible for reducing low back injury, to try to simplify the low back system and use various surrogates for tissue load to both quantify the risk of injury and evaluate potential solutions. No doubt determining tissue load-time histories constitutes a first-order approach to examine the risk of injury and to investigate low back mechanics—but it is the most difficult approach. Simply calculating a moment about the low back constitutes a second-order approach. While the moment indicates the general demand on the low back, it does not enable analysis of individual tissue injury since the moment is not partitioned among the various tissues and is not sensitive to other parameters which affect tissue load distribution such as joint position. Some have attempted to relate injury with surrogates such as posture, repetition and 'forcefulness', but these constitute a third-order of investigation as even more unknown factors modulate the risk of injury to each individual tissue. For this reason, to investigate the biomechanics of injury, our objective has been to use a first-order approach employing sophisticated modelling to obtain individual tissue loads and combine this knowledge with tissue experimentation.

There have been several simple modelling approaches used to estimate low back loading and to establish guidelines for maximum allowable loads in industry (NIOSH lifting guidelines for example) that have been reasonably successful in demonstrating the effects of body posture on an overall index of spine load such as low back compression. However, while such an approach may be useful for addressing the most overt of violations of biomechanical principles to reduce the risk of injury in industry, this approach does not elucidate how the spine works, does not identify the individual differences that lead some people to injury, does not address the many subtle mechanical characteristics of the spine that are important when considering injury. Deeper insight into the biomechanics of the low back is aided with a much more anatomically complex approach. The anatomical design of the various tissues of the low back contain many subtleties which work to support loads in a safe way but they may lead to tissue overload if the advantages in design go unrecognized. However, this complex ap-

proach introduces many unknown muscle, ligament, and other tissue forces, the number of which exceed the number of equilibrium equations necessary to solve for their force magnitudes. Two methods have been utilized to distribute forces among the many muscles; optimization and models driven from biological signals, both of which have unique assets and liabilities. The optimization approach utilizes a mathematical convergence algorithm that iterates through incremented muscle forces until a unique solution (or set of muscle forces) is produced that fulfils an objective function, for example, minimum compression of the intervertebral joint. In producing a unique solution, the mechanical constraints of the model are satisfied; in other words, the predicted muscle forces balance the reaction moments. Optimization approaches have been useful for systematically studying apparent muscle co-activation (Hughes *et al.*, 1995)—which in fact may not be co-activation at all during the support of three simultaneous moments about the several joints of the low back (e.g. Pope *et al.*, 1986; Stokes and Gardner-Morse, 1994). However, the same solution is predicted by the optimization approach for all conditions where the reaction moment is similar as the process is unable to distinguish between the many strategies of muscle recruitment that different people choose. Furthermore, many optimization criteria (at least linear criteria) rarely invoke the co-contraction forces in the antagonistic musculature acting about a lumbar joint (Hughes *et al.*, 1994). Therefore, while mathematical validity can be claimed by the optimization approach, biological validity is a concern—particularly when used to assess injury that results from the unique way that an individual moves or activates muscles leading to tissue overload. An alternative approach, and the one documented here, is to partition the reaction moments among the passive tissues (ligaments, disc, and other structures) and muscle based on biological signals are measured directly from the subject. For example, muscle forces are derived, in part, from activation levels measured from calibrated EMG (together with coefficients for muscle physiological cross-sectional area, stress, and instantaneous length and velocity) and the passive tissue forces are estimated from direct measures of calibrated joint angular position. In this way, the individual patterns of muscle recruitment and strategies of muscle-ligament interplay can be assessed per individual, and per task. While mathematical constraints are not always satisfied with the biological approach, and the fact remains that internal tissue force prediction can be problematic, one could argue for its suitability to assess individual injury (for a more complete discussion of the issue refer to Cholewicki *et al.*, 1995). The model of McGill and Norman (1986), which has been expanded to enable full three-dimensional analysis (McGill, 1992) more fully describes this approach to estimate tissue load time histories. Recent developments include improved abdominal architecture (McGill, 1996) and better prediction of the neural activation of deeper muscles such as psoas, quadratus lumborum and the three layers of the abdominal wall (McGill *et al.*, 1996a). While force-time histories of the individual tissues enable evaluation of injury mechanisms, the approach is limited to laboratory usage due to its very complex data collection requirements.

Over a series of experiments examining the mechanics of a variety of tasks, some generalizations can be made regarding the generation of three-dimensional moments about the low back and the resultant compressive loading of the lumbar spine. Equivalent compressive loads can be estimated about single axes using the following single equivalent moment arms to balance three-dimensional moments: extension 5–6.5 cm; flexion 4–4.5 cm; lateral bend 3–4 cm; axial twist 1–3 cm (McGill *et al.*, 1996b). The major reason for diminishing moment arms when generating moments other than extension (resulting in larger compressive penalties for the generation of a given moment) is the general increase in agonist–antagonist co-contraction (particularly for axial twist).

Our model output has enabled analysis of several issues, some of which are addressed in the following sections.

STOOP VS SQUAT LIFTING: DOES IT MATTER?

Let's revisit this old issue of lifting style. For many years, there has been an emphasis in industry to recommend that workers bend the knees and not the back (i.e. squat) when lifting. The fact that many workers prefer to stoop, may be due to the long recognized fact that there is an increased physiological cost in squatting (Garg and Herrin, 1979) and that relatively few jobs can be performed in this way. Several studies have attempted to evaluate the issue of stoop vs squat lifting postures based mostly on comparisons of low back compression but were unable to uncover a clear biomechanical rationale for the promotion of either. Perhaps the issue is much more complex than has been realized. From a tissue load distribution perspective, the following example demonstrates the shifts in tissue loading, predicted from our modelling approach, which has quite dramatic affects on shear loading of the intervertebral column. First, the dominant direction of the pars lumborum fibres of longissimus thoracis and iliocostalis lumborum are noted to act obliquely to the compressive axis of the lumbar spine producing a posterior shear force on the superior vertebra. In contrast, the interspinous ligament complex acts with the opposite obliquity to impose an anterior shear force on the superior vertebra (see Fig. 6). This is one example where spine posture determines the interplay between passive tissues and muscles which ultimately modulates the risk of several types of injury (see Marras *et al.*, 1995). For example, if a subject holds a load in the hands with the spine fully flexed sufficient to achieve myoelectric silence in the extensors (reducing their tension), and with all joints held still so that the low back moment remains the same, then the recruited ligaments appear to add to the anterior shear to levels well over 1000 N, which is of great concern from an injury risk viewpoint (see Fig. 7). However, a more neutral lordotic posture is adopted and the extensor musculature is responsible for creating the extensor moment and at the same time it will support the anterior shearing action of gravity on the upper body and hand-held load. Disabling the ligaments greatly reduces shear loading. Here is an example where the spine is at much greater risk of sustaining shear injury (> 1000 N) than compressive injury

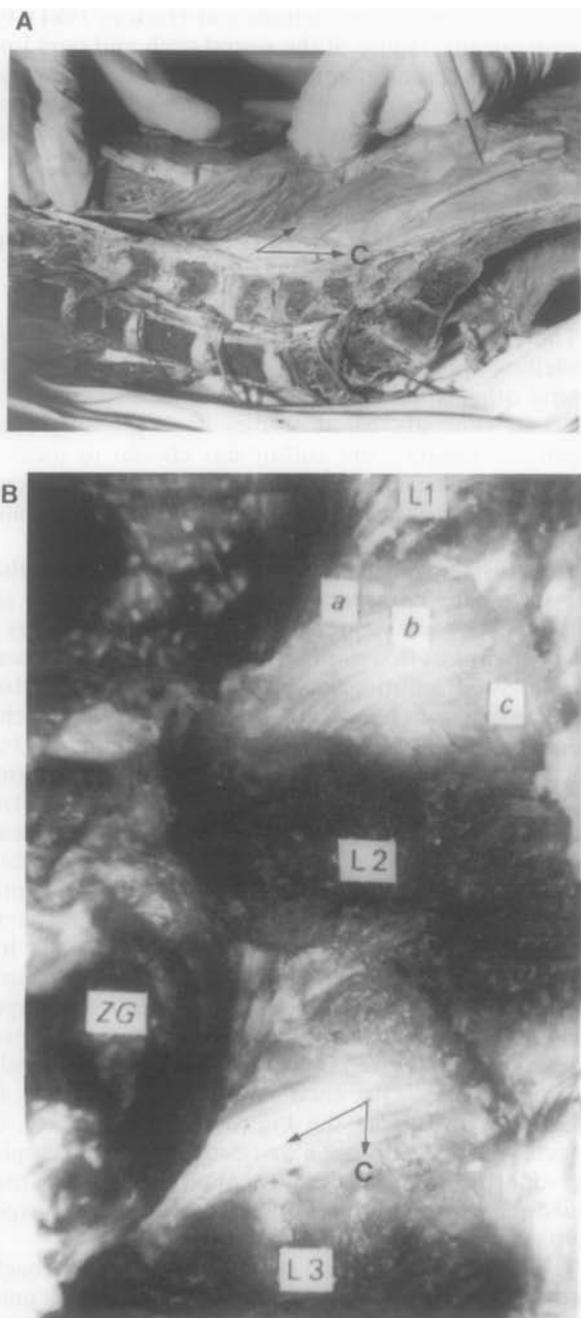


Fig. 6. (A) Pars lumborum fibres of iliocostalis lumborum and longissimus thoracis creates a posterior shear force on the superior vertebra while (B) in contrast the interspinous ligament imposes an anterior shear when strained in flexion (published with permission originally published in Heylings (1978)). The general oblique line of action of the muscle and ligament is shown compared to the compressive axis (c).

(3000 N) suggesting that compression, as an index of risk, was not the best choice of index.

The issue of whether to stoop or squat becomes much more complex when one considers the type of injury, the distribution of load among the tissues, and the modulation of failure tolerance as a function of spine posture. In fact, the case could be made that the important issue is not whether it is better to stoop lift or to squat lift but rather the emphasis could be placed on placing the load

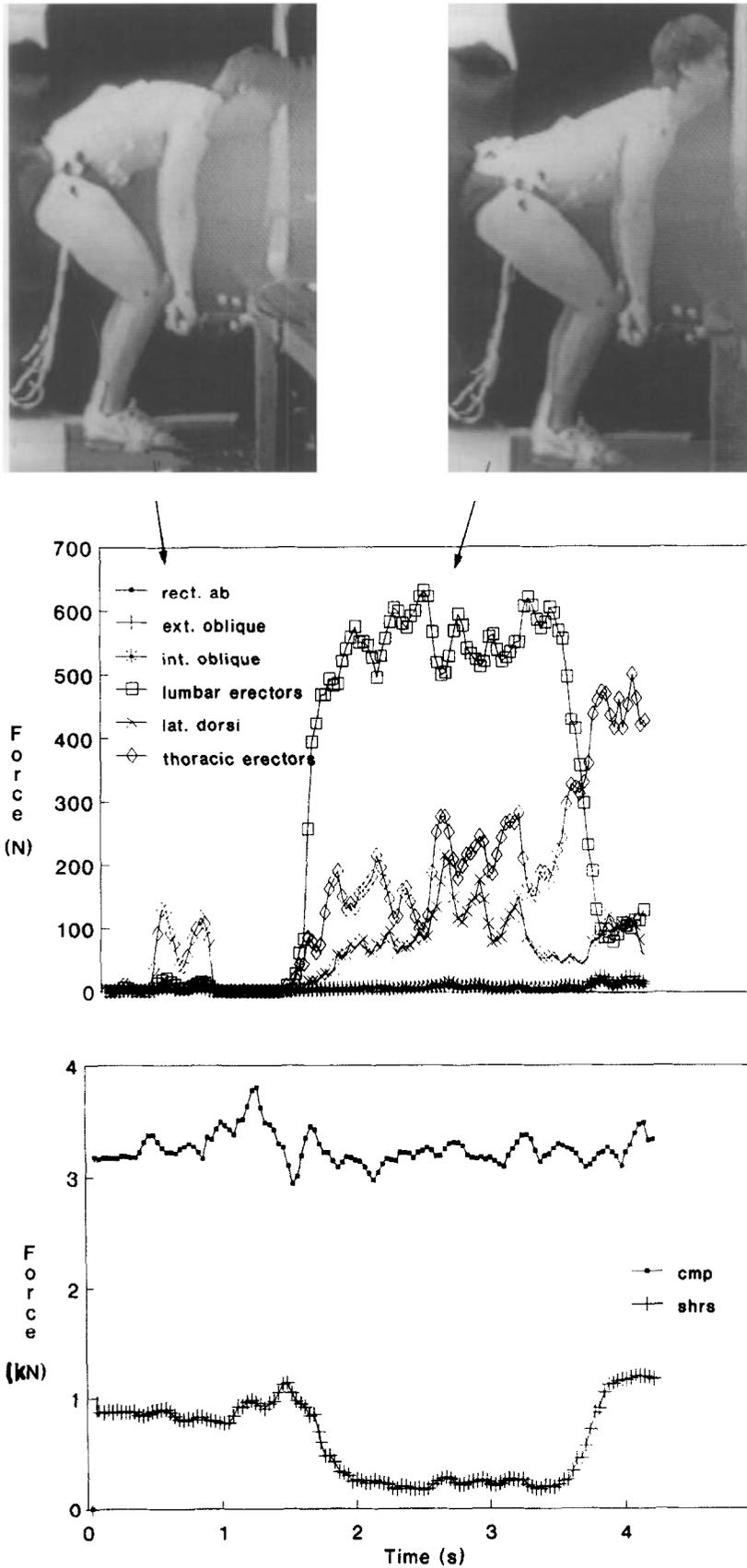


Fig. 7. The fully flexed spine is associated with myoelectric silence in the back extensors and loaded posterior passive tissues, and high shearing forces on the lumbar spine. A more neutral posture recruits the shear supporting pars lumborum extensors, disables the shear imposing interspinous ligaments, and reduces the net shear on the spine.

close to the body to reduce the reaction moment (and the subsequent extensor forces and resultant compressive joint loading) and to avoid a fully flexed spine to minimize shear loading. In fact, sometimes it may be better to squat to achieve this, or in cases where the object is too large to fit between the knees, it may be better to stoop, flexing at the hips but always avoiding full flexion to minimize posterior ligamentous involvement. (For a more comprehensive discussion see McGill and Norman (1987, 1988), Potvin *et al.* (1991) and McGill and Kippers (1994)).

MOTOR CONTROL CONSIDERATIONS AS A CAUSE OF INJURY

While injury from large exertions is understandable, explanation of how people injure their backs performing rather low load, benign appearing, tasks is more difficult—but the following is worth considering. The ability of the joints of the lumbar spine to bend in any direction is accomplished with large amounts of muscle co-contraction. Intuition would suggest that such co-activation patterns increase the compressive load penalty imposed on the spine when generating the torque necessary to support the upper body posture and external load. Perhaps the co-contracting muscles have another role. The lumbar ligamentous spine will fail under compressive loading in a buckling mode at about 90 N (Crisco *et al.*, 1992). The spine can be likened to a flexible rod—under compressive loading it will buckle. However, if guy wires are connected to the rod, like the rigging on a ship's mast, the supporting wires add more compression but the rod is able to bear a much higher compressive load as it stiffens and becomes more resistant to buckling. A number of years ago, we were investigating the mechanics of power lifter's spines while they lifted extremely heavy loads using video fluoroscopy for a sagittal view of the lumbar spine (Cholewicki and McGill, 1992). The range of motion of the power lifter's spines were calibrated and normalized to full flexion by first asking them to flex at the waist and support the upper body against gravity with no load in the hands. During their lifts, although they outwardly appeared to have a very flexed spine, in fact, the lumbar joints were two to three degrees per joint from full flexion, explaining how they could lift such magnificent loads (up to 210 kg) without sustaining the injuries which we suspect are linked with full lumbar flexion. However, during the execution of a lift, one lifter reported discomfort and pain. Upon examination of the video-fluoroscopy records, one of the lumbar joints (specifically, the L4/L5 joint) reached the full flexion calibrated angle, while all other joints maintained their static position (2–3° from full flexion). This is the first observation that we know of reported in the scientific literature documenting proportionately more rotation occurring at a single lumbar joint, and it would appear that this unique occurrence was due to an inappropriate sequencing of muscle forces (or a temporary loss of motor control wisdom). This motivated the work of my colleague and former graduate student Jacek Cholewicki to investigate and continuously quantify stability of the lumbar spine throughout a reasonably wide variety of

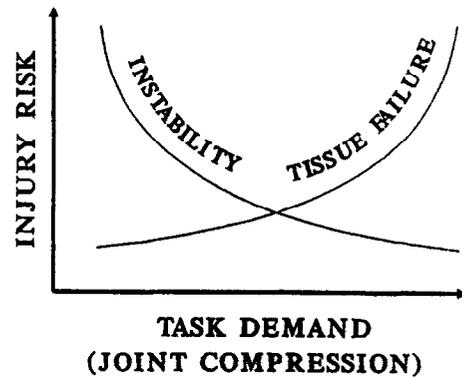


Fig. 8. While injury from high loading tasks is easier to rationalize, injury from low loading tasks appears to reduce spine stability and increases the possibility of injury from errors in motor control, and the resulting joint displacement and tissue overload.

loading tasks (Cholewicki and McGill, 1996). Generally speaking, it appears that the occurrence of a motor control error which results in a temporary reduction in activation to one of the intersegmental muscles, perhaps for example a laminae of multifidus, could allow rotation at just a single joint to the point where passive, or other tissue, become irritated or even more traumatically injured. Cholewicki noted that the risk of such an event was greatest when there are high forces in the larger muscles with simultaneous low forces in the small intersegmental muscles (a possibility with our power lifter) or when all muscle forces are low such as during a low level exertion. Thus, a mechanism is proposed, based on motor control error resulting in temporary inappropriate neural drive, that explains how injury might occur during extremely low load situations, for example, picking a pencil up from the floor following a long day at work performing a very demanding job (see Fig. 8).

CHANGES IN SPINE MECHANICS THROUGHOUT THE DAY

While several scientists have documented the diurnal change in spine length, Dolan *et al.* (1993) were one of the first to postulate an increased risk of injury early in the morning due to fully hydrated discs, higher bending stiffness and documented stresses associated with bending at this time of the day. In fact, it is critical in our modelling work when we examine subjects early in the morning that we recalibrate their torso stiffness throughout the test session as the spine becomes more flexible in bending which requires the disc stiffness and ligament rest length be reset to facilitate reasonable predictions of tissue load distribution. This knowledge may prove useful in the future for management, and those responsible for the design of work to reduce the risk of injury, to design jobs so that the most demanding bending loads on the low back are not conducted early in the morning (or shortly after rising from bed).

IS SITTING STRESSFUL FOR THE SPINE?

Epidemiological evidence presented by Videman *et al.* (1990) documented the increased risk of disc herniation

for those who perform sedentary jobs characterized by sitting. Known mechanical changes associated with the seated posture include the increase in intra-discal pressure when compared to standing postures (Andersson *et al.*, 1975), increases in posterior annulus strain (Pope *et al.*, 1977), creep in posterior passive tissues (McGill and Brown, 1992) which decreases anterior-posterior stiffness and increases shearing movement (Schultz *et al.*, 1979), and posterior migration of the mechanical fulcrum (Wilder *et al.*, 1988) which reduces the mechanical advantage of the extensor musculature (resulting in increased compressive loading). This has motivated occupational biomechanists to consider the duration of sitting as a risk factor when designing seated work in the interest of reducing the risk of injury. A recently proposed guideline has suggested a sitting limit of 50 min without a break, although this proposal will be tested and evaluated in the future.

THE SPINE HAS A MEMORY

There is a tendency among ergonomists to assess industrial tasks simply by examining the task at the time at which it is performed. There is evidence to suggest that certain activities modulate the subsequent mechanics of the spine such that those activities prior to performing a particular task may indeed warrant consideration. For example, for several years, it has been proposed that the nucleus within the annulus migrates anteriorly during spinal extension and posterior during flexion (MacKenzie, 1981). Due to viscous properties of the nuclear material, such repositioning is not immediate upon a postural change, but takes time. While this hypothesis was conjecture for a period of time, several experiments have been reported verifying a repositioning of nuclear material upon forced extension of the lumbar spine. Krag *et al.* (1987) demonstrated anterior movement, albeit quite minute, from an elaborate experiment that placed radio opaque markers in nucleus of cadaveric lumbar motion segments. Hydraulic theory would suggest lower bulging forces on the posterior annulus if the nuclear centroid moved anteriorly during extension. Furthermore, Adams and Hutton (1988) suggested that prolonged full flexion may cause the posterior ligaments to creep which may allow damaging flexion postures to go unchecked if lordosis is not controlled during subsequent lifts. The data of McGill and Brown (1992) showed that even after 2 min following 20 min of full flexion, subjects only regained half of their intervertebral joint stiffness, while even after 30 min of rest some residual joint laxity remained. This is of particular importance for those individuals whose work or movement patterns are characterized by cyclic bouts of full end range of motion postures followed by exertion. For example, it would appear to be unwise to perform demanding exertions following a prolonged period of fully flexed sitting or stooping.

SOME FINAL THOUGHTS ON CURRENT PRACTICE AND ISSUES FOR THE FUTURE

Some inconsistent current practice regarding low back injury continues despite some of the recent advances in

understanding. The scientific community realizes that much injury is the result of cumulative trauma—although it may be marked by a culminating event. Current practices of injury reporting usually requires workers and medical personnel to identify the single cause of injury (i.e. a herniated disc as the individual lifted and twisted) which de-emphasizes investigation of the many variables involved in accumulating trauma. Overhaul of the current injury reporting system needs to be considered. Furthermore, there is a tendency to base judgement about the risk of injury on too much load magnitude—for example low back compression. It appears that too much of anything—too much compression, too many repetitions, sitting for too long or even staying in bed too long has negative effects. Failure to recognize these relationships has led some to de-emphasize investigation of spine biomechanics in analysing the cause and treatment of low back injury (which is a mistake in the opinion of this author).

Most often, judgement regarding a back injured person's fitness to return to work is based on their trunk range of motion. Perhaps it was rationalized that back injured people have a reduced range of motion and therefore to regain that range of motion is a desirable objective. However, investigation of spine mechanics demonstrates a variety of ills associated with moving the spine to the end range of motion (including increased risk of damage to the disc, ligaments and vertebral components), not to mention moving an already injured spine to the end range of motion. In fact, while there is epidemiological evidence to support the notion that some patients do better without any medical treatment at all (cf. Faas *et al.*, 1993), it is suspected that lack of knowledge about injury leads to inappropriate prescription of rehabilitation manoeuvres and injury exacerbation. It would appear that those responsible for rehabilitating the injured must continue to question their current approaches, particularly end range of motion activities for some types of injury.

In the occupational world, labour and management alike continue to seek easy and simple solutions to the low back injury problem. After investigating the mechanics of injury to the low back for several years, this author contends that a simple approach is destined to fail. Industrial low back injury is an extremely complex issue and will only be successfully addressed by those willing to combine the wisdom of several different approaches and to form an integrative approach that is scientifically justifiable.

Several issues will dominate our investigations in the future—particularly how low magnitude loading, applied over a sufficient length of time causes low back injuries. Specific examples include investigations of sitting, vibration exposure, load exposure with rest cycles, repeated lifting and other combined movements, and even the effects of not enough loading. Several groups are working towards occupational exposure guidelines that recognize concepts of dose and trauma accumulation, and, favourable tissue adaption, using combinations of the modelling approaches mentioned in this work together with finite element approaches, epidemiology and clinically based studies, etc. To assist these efforts the medical community must become better at diagnosing which

tissue is injured. Since different tissues respond to different treatment, and in fact may be further injured by some movements, specific diagnosis is mandatory for optimal rehabilitation. Finally, there are many loading modes that cause injury—other than compression, and effort is required to understand the consequences of such loads in order to formulate clever hypotheses for injury avoidance. Our community can look forward to the future with great enthusiasm, excitement and confidence that our contributions, while providing great personal joy, will reduce some suffering of others.

Acknowledgements—Although many colleagues have contributed to work reported in this manuscript, the author wishes to acknowledge a few special colleagues who have made significant contributions over the years: Professor Robert Norman, Dr Jacek Cholewicki, Dr James Potvin, Mr Jack Callaghan, Ms Vanessa Yingling, Mr Craig Axler and Daniel Juker, MD. Further, the financial support of the Natural Sciences and Engineering Research Council over the years is gratefully acknowledged.

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CITY OF RAYTOWN
Request for Board Action

Date: 17 May 2016
To: Mayor and Board of Aldermen
From: EMS, Doug Jones, Director

Resolution No.: R-XXXX-XX

Department Head Approval: _____

Finance Director Approval: _____ (only if funding requested)

City Administrator Approval: _____

Action Requested: Authorize and approve the purchase of a new cutaway Ford van chassis from Dick Smith Ford, to be delivered to Osage Ambulance/Emergency Services Supply for conversion into an ambulance. Cost is \$28,167.00, and is part of a cooperative bidding situation.

Recommendation: Approve the request as submitted.

Analysis: Based on evaluation of historical data, patterns of use, and industry trends, Public Works/Fleet Services has determined an optimum replacement schedule for Raytown EMS' ambulances in order to maximize useful life of the equipment and to obtain the greatest economy of operation and maintenance. This purchase represents the third new ambulance in the 12-year cycle. It is to replace the oldest unit in our fleet of ambulances; the unit to be replaced is approaching the 110,000 mile mark, and it is the second chassis to be mounted under that particular coach. The chassis cost is \$28,167.00; it has been budgeted, and the Sales Tax Oversight Committee has reviewed the project and found it to be within the intent of the Capital Sales Tax.

Alternatives: Not approve the request.

Budgetary Impact:

- Not Applicable
- Budgeted item with available funds
- Non-Budgeted item with available funds through prioritization
- Non-Budgeted item with additional funds requested

Amount Requested: \$28,167.00
Account Number(s):
Fund: Capital Sales Tax
Department: Emergency Services
City Program:
Department Program:
Object Code:

The amount budgeted for fiscal year 2015-2016 is \$28,167.00.

Additional Reports Attached: Quote and cooperative bid documents for chassis.

==>

Dealer: F53013

2016 ECONOLINE

Page: 1 of 2

Order No: 6500 Priority: E1 Ord FIN: QQ933 Order Type: 5B Price Level: 640
Ord PEP: 782A Cust/Flt Name: RAYTOWN, MO PO Number:

		RETAIL	DLR INV			RETAIL	DLR INV
E4F	COM CUTAWAY VAN	\$32005	\$29684.00	18A	EXT UPGRADE PKG	\$105	\$94.00
	176" WHEELBASE				.CHROME BUMPERS		
PQ	RACE RED			21A	CPTNS CHRS DUAL	95	86.00
M	CLOTH CPTS CHRS	NC	NC	903	PWR WINDOWS/LKS	465	420.00
E	MEDIUM FLINT			552	CUTAWAY INSULAT	85	77.00
782A	PREF EQUIP PKG			15T	TRACTION CONTRL	225	203.00
	.STANDARD TRIM			162	FLR VINYL, FRT		
587	.ELEC AM/FM CLK			20F	14500# GVWR	NC	NC
593	.LT/CONVEN GRP						
596	.AIR BAG/PASS-2D				TOTAL BASE AND OPTIONS	37850	34608.54
	.INSTR CLUSTER				TOTAL	37850	34608.54
646	.16" WHITE WHLS				*THIS IS NOT AN INVOICE*		
99S	6.8L EFI V10ENG	1050	949.00				
44P	ELEC 6-SPD AUTO				* MORE ORDER INFO NEXT PAGE *		
T67	.LT225/75RX16E B						

2016 ECONOLINE

Page: 2 of 2

Order No: 6500 Priority: E1 Ord FIN: QQ933 Order Type: 5B Price Level: 640
Ord PEP: 782A Cust/Flt Name: RAYTOWN, MO PO Number:

		RETAIL	DLR INV			RETAIL	DLR INV
41H	ENG BLK HEATER	\$75	\$68.00	63G	EXT HVY DUTY 78	NC	NC
425	50 STATE EMISS	NC	NC	656	FUEL TANK 55 GL		
47A	AMBUL PREP PKG	1910	1724.00	942	DAYTIME LIGHTS	45	40.00
	.4.56 LS XF3			948	KEYLESS/ALARM	225	203.00
	.FRT LICENSE BKT				SP FLT ACCT CR		(461.00)
	.SPARE TIRE/WHL				FUEL CHARGE		12.54
	.FRAME PUCKS				PRICED DORA	NC	NC
	.EXT HD 225-AMP				DEST AND DELIV	995	995.00
	.BATTERIES-DUAL						
	.FRT MAX GAWR				TOTAL BASE AND OPTIONS	37850	34608.54
52S	USER SWITCHES	85	77.00		TOTAL	37850	34608.54
525	CRUISE CONTROL	240	216.00		*THIS IS NOT AN INVOICE*		
54E	MIRRORS,TRL TOW	230	208.00				
57X	AUX HTR-A/C CON	15	13.00				
625	RRVIEW MIRROR	NC	NC				

\$ 28.167 each

Dug Lofton
Dick Smith Ford
816-353-1495



**CITY OF INDEPENDENCE, MISSOURI
NOTICE OF RENEWAL**

Vehicles – 2016 Model 251-14-7

Date: October 29, 2014

Phone: 816-353-1495

Vendor: 24462
Dick Smith Ford
9505 E 350 Highway
Raytown, MO 64133

Fax: 816-358-4406
E-Mail: glofton@dicksmithford.com
Contact: Greg Lofton
Title: Fleet Manager

Price Agreement Period: 11/1/2015 — 10/31/2016

Renewal Options: Final year.

Status of Certificates: *Please remember to keep your certificates current*

Insurance N/A

Occupation License N/A

Vehicle Item Numbers: 1, 2, 3, 4, 10, 12, 13, 15, 16, 17, 18, 21, 22, 23, 24, 25, 26, 27, 28, 34, 35, 37, 39, 41, 42, 44
Added in 2015: 21-2015, 26-2015, 28-2015
F.O.B: 1 Vehicle: \$0.70/mile over 25 miles
3 or more vehicles: \$0.10/mile over 25 miles

(Vehicles Model Year 2016) Mid-America Council of Public Procurement Joint Bid
Lead Agency: City of Independence

Detailed Specifications are located at: www.macpp.org

Tom Conrow, Procurement Specialist, (816) 325-7092

Russell M. Pankey, Purchasing Manager
Finance Department, Purchasing Division

Using Departments: All Departments
Cooperative
File

CITY OF RAYTOWN
Request for Board Action

Date: 17 May 2016
To: Mayor and Board of Aldermen
From: EMS, Doug Jones, Director

Resolution No.: R-XXXX-XX

Department Head Approval: _____

Finance Director Approval: _____ (only if funding requested)

City Administrator Approval: _____

Action Requested: Authorize and approve the purchase of a new ambulance conversion from Osage Ambulance/Emergency Services Supply, to be mounted on the new chassis from Dick Smith Ford. The cost is \$109,575.00, and is part of a cooperative bidding situation.

Recommendation: Approve the request as submitted.

Analysis: Based on evaluation of historical data, patterns of use, and industry trends, Public Works/Fleet Services has determined an optimum replacement schedule for Raytown EMS' ambulances in order to maximize useful life of the equipment and to obtain the greatest economy of operation and maintenance. This purchase represents the third new ambulance in the 12-year cycle. It is to replace the oldest unit in our fleet of ambulances; the unit to be replaced – a 2009 Taylor Made remount -- is approaching the 100,000 mile mark, and it is the second chassis to be mounted under this particular coach. The conversion cost is \$109,575.00; it has been budgeted, and the Sales Tax Oversight Committee has reviewed the project and found it to be within the intent of the Capital Sales Tax.

Alternatives: Not approve the request.

Budgetary Impact:

- Not Applicable
- Budgeted item with available funds
- Non-Budgeted item with available funds through prioritization
- Non-Budgeted item with additional funds requested

Amount Requested: \$109,575.00
Account Number(s):
Fund: Capital Sales Tax
Department: Emergency Services
City Program:
Department Program:
Object Code:

The amount budgeted for fiscal year 2015-2016 is \$109,575.00.

Additional Reports Attached: Quote and cooperative bid documents for ambulance conversion.
Vehicle Replacement Plan from Fleet



Public Works Department

**10000 East 59th Street
Raytown, Missouri 64133
(816) 737-6012
www.raytown.mo.us**

Ambulance replacement schedule

The City of Raytown owns and maintains three ambulances that are operated by the EMS department for the good of the community. Two of the ambulances are in service 24/7 and the third is a relief or back up ambulance to be used when an ambulance is in for service or in the event of a mass casualty situation.

The ambulance fleet represents a substantial investment and as such requires an ongoing commitment to maintenance, and a plan for replacement based on an evaluation of the historical information, current use, trends in the industry and the needs of the community.

The replacement schedule of an ambulance must include factors such as the durability of the coach and the useful life expectancy of the chassis. An ambulance platform that experiences continuous expensive breakdowns or damaged beyond repair by crash will need to be replaced on an as needed and funded basis.

The body/coach shall have a minimum life expectancy so as to allow for at least one remount/refurbish onto a new chassis. The remounting of the body to a new chassis will generally represent a 30% savings over the cost of a complete comparable unit.

The life cycle of the chassis shall be 6 years or 150,000 miles whichever occurs first for light duty class IV truck/van chassis.

The expected life cycle of the ambulance body (the coach) shall be 12 years.

When an ambulance is purchased new and complete (chassis and coach body together) this will begin the replacement clock. The newest ambulance will be the lead ambulance (301), and the second oldest ambulance will be (302) and the third ambulance (303) will be the highest mileage and oldest ambulance in the fleet.

The newest ambulance will serve 2 years as the lead unit and historically will travel the most miles. (30,000 per year)

The second oldest ambulance will serve in this position for years 3 and 4 of the life cycle and travel similar miles. (25,000 per year)



Public Works Department

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Raytown, Missouri 64133
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The oldest/highest mileage ambulance will serve as the backup ambulance for years 5 and 6 of the life cycle traveling the least miles.
(5,000 to 10,000 per year)

Year 7 the oldest ambulance will be sent to a suitable vendor for refurbishing, repainting and remounting of the body (coach) on a new chassis. This will begin the second 6 years of the life cycle of the ambulance by returning to the primary role (301). The two trucks not refurbished or replaced will be cascaded down to be 302 and 303 respectively based on age and miles.

Year 9 the oldest ambulance will be sent to a suitable vendor for refurbishing, repainting and remounting of the body (coach) on a new chassis. This will begin the second 6 years of the life cycle of the ambulance by returning to the primary role (301). The two trucks not refurbished or replaced will be cascaded down to be 302 and 303 respectively based on age and miles.

Year 11 the oldest ambulance will be sent to a suitable vendor for refurbishing, repainting and remounting of the body (coach) on a new chassis. This will begin the second 6 years of the life cycle of the ambulance by returning to the primary role (301). The two trucks not refurbished or replaced will be cascaded down to be 302 and 303 respectively based on age and miles.

Year 13 begins a new cycle with the purchase of a complete new ambulance (chassis and coach). With the purchase of the new coach the so begins the 12 year life cycle of the body (coach) and the 6 year life cycle of the chassis.



**194 Twin Ridge Road
Linn, MO
Phone: 800/822-3634
Fax: 573/897-3113**

DATE: 4/13/16
QUOTATION TO: Raytown Emergency Medical Services
DELIVERY TIME: Current Delivery slots in Dec 16
F.O.B.: Linn, Missouri - Customer pick up of ambulance from Osage Industries.
PAYMENT: Net on completion of work.

- (1) New Type III modular ambulance with a 2017 Ford E450, Deluxe series,
158" wheelbase, dual rear wheel chassis as listed herein;

Customer Supplied Ford E450 Chassis Race Red in color
Customer supplied Stryker power load system
Customer Supplied opticom

Options added to unit
Plexi glass insert on front bulkhead cabinet
Domecic refrigerator in lower ALS
Shelf for autopulse with inside and outside access
No counter in monitor area
Door unlock added to rear of the truck

TOTAL PRICE AS LISTED HEREIN - - - - - \$ 109,575

Dan Kehoe
Emergency Services Supply

Quote valid for 30 days without review