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Active functional restoration and work hardening program returns patient with 2½-year-old elbow fracture-dislocation to work after 6 months: a case report

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The rehabilitation of elbow fracture and dislocation is not generally considered a mainstream chiropractic concern. The clinician who is able to successfully manage the elbow articulation will rely upon his/her knowledge of functional anatomy, pathobiomechanics, history and examination principles, when selecting the appropriate treatment available. A case is presented of an individual that sustained a radial head fracture and dislocation following a motor vehicle accident. Subsequent to receiving 1½ years of physiotherapy for post-surgical complications (decreased range of motion, pain, stiffness and tingling to the 4th and 5th fingers), the patient was referred to a multidisciplinary clinic for a Work Hardening/Conditioning Program. This article discusses the need for active functional restoration vs. passive therapy, work hardening regimens and outcome measures. After 6 months of rehabilitation and 3 years following his motor vehicle accident, the patient has successfully returned to his previous work environment. A summary of the sequential steps in providing appropriate management has been provided.
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KEY WORDS: fracture, elbow, work hardening, functional restoration.

La rééducation fonctionnelle à la suite d'une fracture et d'une luxation du coude n'est généralement pas considérée comme un sujet principal en chiropratique. Le clinicien qui peut traiter avec succès l'articulation du coude se fie à sa connaissance de l'anatomie fonctionnelle, de la biomécanique pathologique et des principes d'antécédents et d'examen lors du choix de traitement possible. On a présenté un cas où le patient a subi une fracture de la tête radiale et une luxation lors d'un accident de véhiclue motorisé. Après avoir suivi une physiothérapie d'un an et demi pour des complications post-opératoires (zone motrice réduite, douleurs, raideur et picotements dans les 4e et 5e doigts), le patient a finalement été référé à une clinique multidisciplinaire pour suivre un programme de réentraînement à l'effort ou de conditionnement au travail. Cet article traite du besoin de rétablissement fonctionnel actif (par opposition à la thérapie passive), de traitements de réentraînement à l'effort et d'analyse des résultats. Six mois de rééducation et trois ans après son accident, le patient a repris son ancien travail. On a également fourni un sommaire des étapes séquentielles d'un traitement approprié.
(JACC 2002; 46(1):22–30)

MOTS CLÉS : fracture, coude, réentraînement à l'effort, rééducation fonctionnelle.

Case report

A 33-year-old male presented to a multidisciplinary rehabilitation clinic upon referral from his physiotherapist for injuries sustained in a motor vehicle accident two years and six months earlier. The patient was riding his bicycle when a vehicle traveling approximately 40 km/hr attempted to make a left turn after running a stop sign. The driver's side wheel well made direct contact with the bicycle causing the patient to be vaulted over the hood of the car, and ultimately causing him to land on the right side of

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his body. Prior to losing consciousness, the patient recalled that the driver dragged him by both arms as she (i.e. the driver), went into a state of panic.

The patient's injuries consisted of lacerations to the head, knees and feet. Injury to the left elbow included an undisplaced fracture of the distal medial epicondyle and a fracture-dislocation of the proximal radius. The patient recalled sustaining a fracture to the left elbow 20 years previously.

The patient was hospitalized for 3 days following surgery, and was released with a hinged brace specifically designed for his left elbow. Six weeks after the accident, he returned to his duties as a Dangerous Goods Handler. He recalled that while attempting to lift pails of dangerous chemicals, he noted his "left elbow stretching and separating". Immediately, he experienced pain and numbness in his elbow, 4th and 5th fingers of the left upper extremity.

His family doctor referred him for physiotherapeutic treatment (ultrasound, electrical muscle stimulation, ice and heat) for 8 weeks which he claimed had no effect on his symptoms of persistent elbow and finger discomfort. Following further orthopedic and neurological consultation, additional surgery was suggested. He declined however, and decided to return to physiotherapy where he was treated with ultrasound and EMS (electrical muscle stimulation) and seen three times per week for 1½ years.

The patient's history revealed left elbow stiffness and pain, scar tissue irritation, weakness and 4–5th digits numbness involving the left upper extremity. Joint stiffness was intermittent in nature and aggravated by lack of movement from any position. According to the patient recurrent dislocation with excessive force to the elbow joint was something he experienced 2–3 times per month.

Examination revealed a pleasant and cooperative 33 year-old-male who appeared not to be in any visual discomfort. At the time of examination, he was wearing his custom-made functional splint, which controlled for excessive varus and valgus forces at the elbow. Scar tissue in the form of moderate keloid formation was evident about the injury site. As well, there was marked atrophy of the left flexor and extensor muscles of the elbow. The Carrying Angle of the elbow, defined as the angle formed by the long axis of the humerus and ulna resulting in an abducted position of the forearm relative to the humerus,[1] was measured as 28 degrees and 15 degrees for the left and right elbow respectively.

Range of motion of the right upper extremity was unremarkable. Ranges for the left elbow were reduced during elbow flexion to 125 degrees (N = 145–150 degrees) and supination to 75 degrees (N = 90 degrees). Orthopedic and neurological testing indicated medial laxity involving the ulnar collateral ligament with subsequent hypersensitivity of the ulnar nerve. Manual muscle strength testing for the left extremity was determined to be 5/5, however, there was related weakness present as compared to the right side. Marked guarding upon introduction of varus and valgus stress tests was noted. Tenderness was elicited during palpation of the left olecranon and medial epicondyle. Orthopedic examination of the left wrist was relatively unremarkable.

Review of the radiographic report illustrated screw and plate fixation with mild malalignment to the normal carrying angle. Dynamometer grip testing and muscle girth readings were recorded at initial intake (see Table 1) and followed with additional measurements at the time of final discharge.

In order for the patient to return to work with confidence, it was determined he would require a functional restoration program (a term coined by Tom Mayer and Vert Mooney) prior to entering the Work Hardening/Work Simulation program. The primary focus was intended to increase functional ability through techniques used to enhance strength, endurance, joint mobility and general cardiovascular conditioning.

The patient commenced the program with stretching and strengthening classes which included ice therapy followed by his choice of aerobic activity (i.e. stationary bike, treadmill, etc.). Isometric exercises preceded resistance training, as the transition was made after the patient acquired full range of motion and experienced only minimal pain and tenderness of the left elbow. The hinged brace was worn with any movement that introduced a lateral stress to the elbow joint.

Progressive resistance exercises, as described by Wilk and colleagues (1993),[2] were utilized with the intention of enabling the patient to slowly reach relatively normal strength bilaterally.

In the final stage of active functional restoration (full ROM, no pain and tenderness upon strength testing), the hinged brace was set aside. The patient was cautioned, however, as to the possibility of recurring dislocation upon greater demands to the elbow joint. The patient was com-

Table 1
Dynanometer and Girth measurement

	INTAKE	MID-POINT	DISCHARGE
Jaymar Dynanometer Reading			
Maximum Left hand	36 Kg	53 Kg	54 Kg
Maximum Right hand	53 Kg	61 Kg	59 Kg
Girth Measurement			
Left Arm	33.50 cm	34.50 cm	34.75 cm
Right Arm	35.50 cm	34.00 cm	35.00 cm
Left Forearm	31.00 cm	32.50 cm	32.50 cm
Right Forearm	32.00 cm	33.00 cm	33.00 cm

mitted to entering a Work Hardening program and did not consider surgery as an option. Within appropriate limits, treatment included plyometric exercise (throwing and catching a medicine ball), high speed/high energy strengthening and variations of eccentric muscular contractions.[2]

Aggressive exercise protocols were tolerated well with only minor setbacks. The patient experienced slight pain, joint laxity and occasional tingling in the fingers during vigorous exercises. Such symptoms lasted for 5–10 minutes, whereas, elbow stiffness remained unless there was constant movement. There was no report by the patient of elbow dislocation since the onset of treatment. Subsequently, the patient commenced the Work Hardening Program.

Four months after entering the clinic, the patient participated in a Functional Abilities Evaluation (FAE). A Job Task Analysis was performed with the aid of an occupational therapist, vocational consultant and employer assessor. A detailed job description was essential for the design of the work program. Assessment with the Baltimore Therapeutic Equipment (BTE) Work Simulator was used to determine the patient's consistency of effort. Scores were compared to L. Matheson protocols.[3] Lower and upper body strengths were assessed with the use of the Physical Agility Test (PAT) unit.

As a candidate for a Work Hardening regimen, goals (see Table 2) were carefully constructed to compliment the patient's work environment. As a Dangerous Goods Clerk, he supervised loading and unloading of freight. Occasionally, however, he would lift materials weighing 10 to 50 lbs.

A final Functional Abilities Examination (FAE) was performed at discharge with acceptable results (see Table 3). Overall strength improvement was noted in lifting, carrying, pushing and pulling activities. There were also improvements in handling, reaching forward, bending and overhead tasks.

After six weeks of Work Hardening and four months of active rehabilitation, the patient was discharged. It was decided that his job requirements could be met and that he was able to return to regular duties provided that when he

Table 2
Program Goals

Work Hardening Program Goals:
1. Improve strength level in lifting capacity (unload/load) at different heights including overhead tasks.
2. Improve strength level in carrying capacity (variation in distance, objects, unilateral and bilateral)
3. Improve functional tolerance in coordination or manipulation with bilateral activities and in overhead tasks
4. Cardiovascular endurance conditioning
5. Dexterity tasks (Minnesota Turning Test) involving counting, weighing, sorting packaging and unpacking
6. Education in proper biomechanics in any setting (work/leisure)

Table 3
Summary Assessment – Functional Ability Evaluation (FAE)

	Intake FAE	Discharge FAE
Sitting:	30 min.	No difficulty
Standing:	Limited	Increased considerably
Walking:	Unlimited	No difficulty and unlimited
Lifting: (Lower strength)	Moderate 57 lbs. (BTE)	Improved Max. 100 lbs. Only 50lbs. is required(BTE) Endurance increased
(Upper strength)	Moderate 67 lbs. (BTE)	Improved Max. 81 lbs. only 50 lbs. is required (BTE) Endurance increased
Carrying:	Max. 30 lbs. for 15 feet	Min.50 lbs.@ 540 feet for 1.56min
Pushing/ Pushing:	No difficulty (BTE)	Very easy -push/pull torque of 315 inch/pound on BTE work Simulator for at least 5 minutes
Crouching:	No difficulty (PAT)	No difficulty (PAT)
Kneeling:	No difficulty	No difficulty
Crawling:	No difficulty	No difficulty
Climbing:	No difficulty	No difficulty
Twisting:	No difficulty	No difficulty
Reaching:	forward No difficulty Minnesota Rate of Manipulation Task (MRMT) & Purdue Pegboard (PP)	No difficulty (MRMT & PP)
Bent	Minimal difficulty	No difficulty
Overhead	Moderate difficulty (PAT)	No difficulty (PAT)
Handling:	Slow coordination	Improved coordination

lifted heavy weights, he would do so with the aid of his co-workers.

He was instructed to wear the hinged brace to prevent excessive loading / fatigue to the elbow joint should his work routine change due to increased demands at the job site.

Five months and two weeks later, having actively participated in a multidisciplinary rehabilitation program, the patient had returned to work subsequent to a motor vehicle accident, which had taken place three years earlier.

Clinical implications

Extremity cases are by no means rare to the chiropractor. However, the notion that chiropractors devote their attention solely to the back must be dispelled. As musculoskeletal doctors, chiropractors should not avoid such extremity cases but rather embrace them.

The specialist assessing the elbow joint should have a good working knowledge of the functional anatomy and biomechanics of this structure.

For example, a good knowledge base of elbow biome-

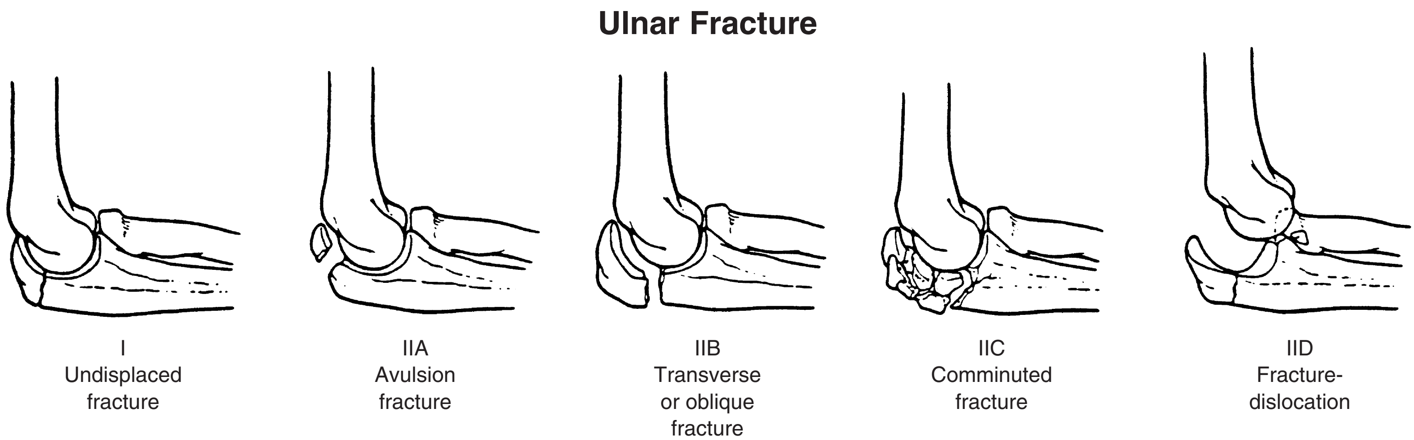

Figure 1* The classification system for olecranon fractures as developed by DeLee et al.[14]
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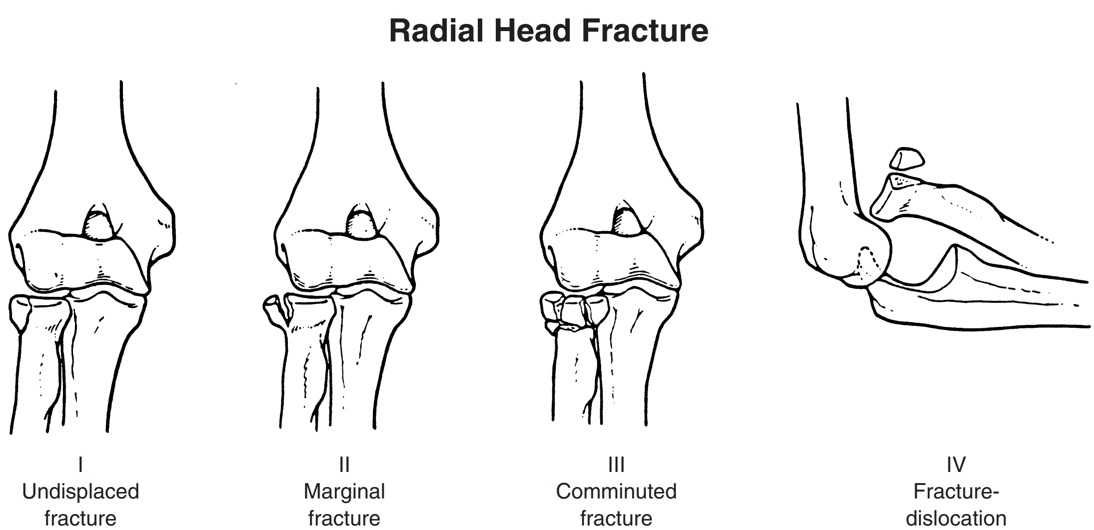

Figure 2* The classification system for radial head fractures as developed by Mason[15] and modified by Johnston.[16]
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chanics as in pitching, is recommended when treating today's athlete.[4] Many of the concepts for treating athletes resemble those of everyday patients.

The elbow is a complex joint due to its intricate functional anatomy. The ulna, radius and humerus articulate in such a way as to form four distinctive joints. Surrounding the osseous structures are the ulnar collateral ligament complex, the lateral collateral ligament complex and the joint capsule. Four main muscle groups provide movement: the elbow flexors and extensors and the flexor-pronator and extensor-supinator groups.[1,5,8]

Physical examination of the elbow should include inspection/observation, palpation, range of motion assessment (passive and active), muscle testing, neurological assessment and special tests (Tinel's sign, test for tennis elbow, and golfer's elbow, adduction/abduction stress tests, etc.).[6,7] Radiographic examination and its variations such as Magnetic Resonance Imaging (MRI) can be very useful. Depiction of muscles, ligaments and tendons as well as the ability to directly visualize nerves, bone marrow and hyaline cartilage, are advantages of MRI, relative to conventional imaging techniques. It is suggested that

MRI may be useful when patients have not responded well to conservative therapy and therefore surgical intervention and additional diagnoses would be under consideration.[9]

Dislocations of the elbow joint are not uncommon and usually result from a fall on the outstretched arm. The literature refers to the most common presentation as being posterolateral.[10] Immediate reduction of the joint is usually performed under regional or general anaesthesia.[10,11] When dislocation occurs, reduction is frequently performed on site by traction of the forearm as the elbow is flexed to 30 degrees along with counter-traction on the humerus.[12] It is suggested that further emergency procedures be conducted to rule out possible complications such as fracture and vascular compromise.[10,12] As was evidenced in the current report, prior childhood injuries have been known to predispose individuals to recurrent elbow dislocation.[13]

Fractures most frequently accompany dislocations. DeLee et al. and Mason followed by Johnston (see Figures 1 and 2) have developed a classification system for olecranon and radial head fractures respectively.[14,15,16]

Other sequelae are nerve complications such as neuritis/ neuropraxia, and compression palsy. Neurovascular complications after dislocation occur in up to 5% of cases.[17] These nerve palsies usually occur as a result of a traction injury with the ulnar nerve being the most likely nerve susceptible to trauma.[18]

These complications are said to resolve after a short period however, careful monitoring is necessary to ensure no deterioration of function.[17,18]

Elbow stiffness occurs from a variety of conditions such as prolonged immobilization, soft-tissue trauma, thermal injury, infection, intra-articular or extra-articular fracture, inflammatory arthritis or degenerative osteoarthritis, and heterotopic bone formation.[10,21] Most often emergency surgical procedures such as open reduction and fixation are necessary treatment for the fractured and / or dislocated elbow. Joints that have stiffened and have not gained full mobility after trauma for various reasons may also be considered good candidates for surgery.[21,22]

Discussion

The rehabilitation specialist, like the surgeon, has a role to play in delivering effective management and treatment. Contemporary chiropractors have positioned themselves as the profession to specialize in the management of neuromusculoskeletal disorders. Manipulation/ mobilization is now a widely accepted treatment approach (RAND, Manga, etc.), however, treatment must be delivered in a time-targeted fashion. There tends to be an overemphasis on passive modalities beyond the necessary stages of healing. Excessive use of modalities may even be deleterious to the patient.[23] Consensus guidelines and conferences such as the Agency for Health Care Policy and Research Guidelines, the Mercy Center Conference, the British Standards Advisory Group Guidelines of Low Back Pain are specific in their distinction between active and passive care.[23] As well, the Ontario Insurance Commission via the Quebec Task Force prepared the Commissioner's Guideline, on February 15 1996 to help those involved understand reasonable therapy and expenses for a person who has sustained a whiplash injury in an automobile accident. The full report is published in the April 15, 1995 edition of Spine and is also available in summary from the Ontario Insurance Commission as "Commissioner's Guideline No. 1/96".

Efficiency and effective management of the injured patient is necessary to produce optimal results. Health care providers are hard-pressed to deliver cost-effective care. Today, many patients and third party payers are demanding the best possible care for their money. The shift in health care from case management to cost-contained outcome management, has propelled the study and use of valid and reliable outcome tools. Outcome assessment which has many benefits (see Table 4) may be defined as measuring the symptom and/or function of a patient's clinical status.[25] Implementing these measurements begins at the initial intake in order to establish a baseline. Patient directed questionnaires are completed at different periods during various phases of care. Questionnaires which assess areas of perceived pain, psychosocial, lifestyle/disability and job dissatisfaction are available throughout the literature and can be examined in greater detail.[24,25,26,27]

We chose to implement such methods on a bi-weekly schedule. Some of the tools used were the Pain Diagram, Visual Analog Scale (VAS), Numerical Pain Scale (NPS), Physical Activity Readiness Questionnaire (PAR-Q), the P.A.C.T. Spinal Function Sort, Chiropractic Satisfaction Questionnaire (CSQ-8). Assessment of the information from these components suggested that treatment received had been effective in the case of the current report. The

Table 4
Benefits of Outcome measurement[24]

OUTCOME ASSESSMENT BENEFIT
1. Documentation of improvement to the patient, clinician, and third parties.
2. Justification for the type, duration, and frequency of care.
3. Indication of the point of maximum therapeutic improvement.
4. Suggestions to modify the goals of treatment when necessary
5. Help in uncovering problems in care, including patient non-compliance
6. A database for clinical research and effectiveness of care over time.
7. Assistance in establishing practice guidelines for specific patients and conditions.

patient's overall feeling of improvement towards good health is depicted in his self-perceived reports. At the commencement of the work hardening program, our patient scored 149/200 on the P.A.C.T. Spinal Function Sort. The purpose of this survey is to indicate a person's level of function with respect to 50 Activities of Daily Living. Upon discharge, the patient scored a perfect 200/200 demonstrating his ability to perform all 50 activities illustrated without difficulty.

It is not suggested that all chiropractors need to become rehabilitation specialists, however, chiropractors should attempt to follow the rehabilitation paradigm in their practices. Understanding the guidelines and reports (AHCPR, Mercy, RAND, WAD, Manga, etc.) compels practitioners to follow treatment protocols which promote active therapy as opposed to passive therapy. Practitioners that choose to provide traditional chiropractic care are essential to health care, but must understand that active rehabilitation protocols are needed from the beginning. Reaching the subacute stage (between 1 and 4 weeks) requires some form of active therapy and treating chiropractors who are unable to provide active therapy, should continue to provide the appropriate care but be willing to refer patients to a treatment center which provides active functional restoration. Mercy guidelines emphasize the need "to proceed to the rehabilitation phase as soon as possible, to minimize dependency on passive forms of treatment/care."[24]

Our patient presented to the clinic after receiving 1½ year of physiotherapy which included, but was not limited to, ultrasound, interferential current, diathermy, heat and cold therapy. He had been off work for 2½ years with minimal progress. Despite the chronicity and existent complications, he did not appear to fall into the chronic pain patient model. The exercise treatment regime was tolerated well and he approached the program with enthusiasm and determination. There were no psychosocial signs of fear avoidance, job dissatisfaction, anxiety, depression, etc. The fact that our patient had been off work for almost three years, did not deter his remarkable recovery.

Our objective for management was to return this patient to his pre-accident status and position of employment. Work Hardening/Simulation, which involves supervision, prepares the individual with a gradual build-up of activities resembling the usual work demands.

Patients must be suitable to enter this type of program and may require additional passive and active treatment prior to commencement. Our patient required preliminary active therapy prior to entering the work hardening program. Low-tech rehabilitation therapies are numerous and readily available to thedetermined practitioner.[2,27–32]

The transition to a Work Hardening Program is individually based and should be started as soon as strength and functional stability have been reached.

Evaluation is assessed with a functional ability/capacity examination. Functional Capacity Examination (FCE) is a comprehensive, objective test of a person's ability to perform work-related tasks. Issues of safety, reliability, validity, practicality and usefulness are key components to a successful examination.[33] There are widespread reports of successful work hardening programs, however, more carefully documented, randomized and controlled studies are needed to determine which programms are of optimal benefit.[34–41]

Summary

Effectiveness and management are the key principles in delivering appropriate health care. The following list was incorporated in the management of this case and is offered as a guideline for interested practitioners:

1 Take a detailed history and examination;

2 Utilize outcome assessment tools from the initial visit and thereafter on a regular basis;
3 Develop a specific diagnosis and attainable goals for the patient;
4 Rule out other possible influences (cancer, infection, fracture, cauda equina syndrome, etc.);
5 If necessary, refer to other specialists and/or other diagnostic testing;
6 Prepare Individual written rehabilitation report with clearly delineated diagnosis, objectives and goals, treatment and therapy to be administered, treatment duration, barriers to recovery, and prognosis, etc.;
7 Discuss goals, objectives and costs with patient, third party payer, case manager, vocational consultant, and employer, etc.;
8 Appropriately manage with time-targeted passive modalities, manipulation and/or adjunct therapies;
9 Identify complicating factors and those patients, which have the potential to develop Abnormal Illness Behaviors, or the tendencies of becoming become Chronic Pain patients;
10 Quick transition to an Active Functional Restoration program which incorporates Iow or high- technical rehabilitation principles and addressing key areas such as stretching, strengthening, proprioception, stability cardiovascular conditioning, stress management and educational principles;
11 Approved candidates to enter a Work Hardening/Simulation program to include Functional Capacity Evaluation, job evaluation (vocational and case management), job description and ergonomic analysis;
12 Discharge when Functional Capacity Evaluation has been performed to optimal levels;
13 Return the rehabilitated worker to original or new work position in full or graduated return-to-work transition;
14 Follow up to determine patient status;
15 Analyze Outcome Assessments to develop objective principles and protocols for future patients.

The above is presented as a guideline only. It is not to be assumed that rehabilitation protocols must follow these 15 steps. Many practitioners may accomplish their objectives with fewer or more steps.

Conclusion

A case of fracture and dislocation to the elbow following a motor vehicle accident has been presented. Key issues pertaining to the elbow joint and particularly with respect to the case at hand, have been presented. Rehabilitation protocols and principles involving work hardening/simulation and active functional restoration have been discussed. The need for outcome measures and sequential objectives is highly recommended in establishing reputable multidisciplinary rehabilitation centers. Understanding when and how to implement rehabilitation principles are determinants with respect to satisfactory treatment and recovery. In this case, the patient returned to work after 3 years and has had no complications to this author's knowledge. Possibly, had he presented to our clinic immediately following his accident, he may have been able to return to work much sooner and as a result, would have saved the employer, insurance payer and the tax payer considerable amounts of money. More research is needed to objectively make such claims, however, multidisciplinary rehabilitation centers are definitely part of our future. Such centers in future will require the incorporation of cardiac and neurological programs. As well, all patients should have the choice of being treated in an environment, which includes basic rehabilitation principles.

Approaching rehabilitation need not be a tedious effort. Many difficult and challenging cases present themselves to our clinics and whether we do or do not adopt rehabilitation protocols it is our obligation as primary health care professionals, to provide the best resources available for our patients.

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