FACTORS PREDICTING THE OUTCOME FOLLOWING TREATMENT FOR LUMBAR SPONDYLOLYSIS

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Abstract of Study 1

Study design

A non –randomised continuous retrospective cross sectional and observational study

Objective

1) To evaluate the results of nonoperative treatment of symptomatic lumbar pars stress injuries or spondylolysis in sporting as well as non sporting individuals
2) To determine the factors responsible for non-operative method of managing symptomatic lumbar spondylolysis in young population
3) To evaluate the outcome in different types of sports
4) To establish the role of compulsory non-operative treatment for symptomatic lumbar spondylolysis in sporting individuals

Summary of Background Data

The treatment and management of symptomatic spondylolysis in sporting populations is mainly based on observation rather than experimental study. Conservative treatment in the form of bracing and avoidance of sports for at least three to six months has been recommended. Excellent or good results following bracing and physical therapy have been observed in 80% patients. Criteria for return to sport are dominated by symptom led decisions.

Methods

The research was carried out as a qualitative, descriptive and analytic study with a non-randomised cohort of patients investigated for spondylolysis in a single centre. A total number of 123 patients treated conservatively following confirmation by imaging studies (SPECT,CT or MRI scans) as having stress fractures of the lumbar pars interarticularis (PI) ranging in age from 8 to 35 years have been selected for the study. All patients attending the Back pain clinic has to follow a protocol of filling up the VAS, ODI and SF-36 questionnaires as a part of their assessment. At the time of the study these questionnaires along with the Back Pain & Sports Questionnaire (BPSQ) were sent to all but only 123 patients responded who were included in the study 1. The background data contains gender, age, date of onset of symptoms with current limitation in sport, pain in flexion or extension, type of sport, level of sport and length of treatment.

The data also contains each subject with level, number, laterality and distribution of lumbar spondylolysis, investigations, outcome with VAS, ODI, SF-36 and Back pain and sports questionnaire (BPSQ) and return to sports. We classified the individual sports into seven types depending on the major movements of the body. Descriptive and analytical statistics was performed along with correlation testing between the outcome measures and predictive factors.

Results

The mean age of onset of back pain was 21.7years (range 8-35years). Most patients were between the ages of 15&19 years (43) followed by 20&24 years (32). The Male: Female ratio was 74:49. There were 98/123 (76.9%) sporting individuals. 35/98 (35%) were professional players, 29/98 (29.5%) were semi professional and 34/98 (34.6%) were amateur sportsmen and women. Cricket (22) followed by Football (22) were the most common type of sports played. Trunk twisting movement was the common denominator in most of the patients with pars defect. The cricketers (13) with unilateral pars defect had more commonly left sided pars defect than the right (10 left vs 3 right). Right sided pars defect was more commonly observed in soccer players (7:1). Most incomplete fractures were observed at L4 in the cricketers. The non sporting group had consulted with a delay of more than six months since the onset of pain. 60% pars lesion was observed at L5 followed by L4 (11.3%), L3 (9.7%) and L2 (2.4%). At L5 most were bilateral lesions (81%). Spina bifida was recorded in 16% patients.

The mean pre and post treatment VAS score was 4.5 and 0.65 respectively (SD-0.8,$p<0.01$). The mean pre and post treatment ODI was 35.5 (SD-7.8) and 6.9 (SD-7.6) respectively ($p<0.01$). In the SF-36 scores, the mean score for the physical component of health improved from 34.9 (SD – 5.3) to 49.3 (SD -6.6) ($p< 0.001$). The mean score for the mental component of health improved from 40.2 (SD -5.2) to 52.0 (SD-6.0) ($p<0.001$). The mean BPSQ score was 52.5 (range 0-90). The mean pre-treatment and post-treatment VAS and ODI scores were slightly better in males as compared to females.

In the unilateral group, 28/36 (77%) patients had complete relief of pain by a mean time of 4.2months (range 3-7months). In the bilateral group, 47/59 (79%) patients had complete pain relief at a mean time of 6.5 months (3-12months).

In the unilateral pars defect group, 32/36 sporting individuals returned to active sports. In the bilateral pars defect group, 49/59 sporting individuals returned to active sports.There was significant difference between the sporting and the non-sporting group in their age (mean 20.7 vs 25.4 years, $p < 0.001$). There was significant difference between the two groups in all pre and post treatment outcome scores. The pre treatment VAS score had most significant correlation with post treatment ODI ($\rho = 0.634$, $p < 0.01$) and post treatment VAS scores ($\rho = 0.626$, $p < 0.01$).

Conclusion

A treatment protocol of rest for 4-6 weeks followed by the functional restorative program has excellent or good outcome in 85% sporting individuals with symptomatic pars defect. Male sporting individuals have better outcome than females. Unilateral pars lesions have a better outcome than bilateral pars lesions. Bracing may not be required in most patients if the pain subsides on restriction of activity. Full functional recovery to previous level of activity is possible with the help of dynamic spinal stabilization exercises and physical therapy. The individuals involved in trunk twisting sports should be evaluated carefully for muscle imbalance in the lumbar spine and they should have altered techniques of sporting activity without compromising the performance in the rehabilitation phase.

Abstract of Study 2

Study Design

A non –randomised continuous retrospective observational study

Objective

1) To identify the most significant determinant of surgical intervention in lumbar pars defect
2) To identify the independent factors that predict a successful outcome following surgery for lumbar pars defect in young sporting individuals
3) Can we establish an outcome predictive model based on these significant factors responsible for a successful outcome?

Summary of Background Data

Most athletes or young active professional sportsmen or women would like to return to their previous level of sports since they may be earning their livelihood through the sport. Early onset of symptoms and conservative treatment in these patients may lead to a good clinical outcome but it is difficult to predict which group or which individuals will require surgical repair of the defect. Young athletes to have returned to competitive sports after surgery have been reported only in few previous papers. The first cohort from this series was published in 2003. ODI (Oswestry Disability Index) and SF-36 (Short form) scores were used to evaluate the final outcome for the first time in lumbar spondyloysis for outcome analysis.

Methods

A total number of 55 patients treated operatively following confirmation by imaging studies (SPECT,CT or MRI scans) as having stress fractures of the lumbar pars interarticularis (PI) ranging in age from 8 to 35 years have been selected for the study. All patients attending the Back pain clinic has to follow a protocol of filling up the VAS, ODI and SF-36 questionnaires as a part of their assessment. At the time of the study these questionnaires along with the Back Pain & Sports Questionnaire (BPSQ) were sent to all but only 50/55 patients responded. The background data contains gender, age, date of onset of symptoms with current limitation in sport, pain in flexion or extension, type of sport, level of sport and length of treatment. The data also contains each subject with level, number, laterality and distribution of lumbar spondylolysis, investigations, outcome with VAS, ODI, SF-36 and Back pain & sports questionnaire (BPSQ) and return to sports.

Descriptive and analytical statistics was performed along with correlation testing between the outcome measures and predictive factors. Multiple regression analysis was carried out with post-operative ODI as the dependent variable to identify the predictor variables and develop a regression equation to predict the outcome. Receiver operating characteristics (ROC) estimation was also carried out combining the conservative (Study 1) and operative (Study 2) group to identify the significant predictor of surgery.

Results

The mean age of onset of back pain was 18.3 years, ranging from 8 to 35 years. For analyzing further to assess the significance of age in the treatment of spondylolysis we divided the patients into five groups of age. The groups were: 1) 8-14 years, 2) 15-19years, 3) 20-24 years, 4) 25-29 years and 5) >30 years. We had 10 patients in Group 1, 24 patients in group 2, 11 patients in group 3, 7 patients in group 4 and 3 patients in group 5. The Male: Female ratio was 40:15 (73% male). There was 52/55 (94%) subjects were involved in sports of which most common sport was Football (22) followed by cricket (8), gymnastics (3), swimming (3), athletics (3) tennis (3) and others. 27/52 (52%) were professional players, 14/52 (27%) were semi professional and 7/52 (13.5%) were amateur sportsmen and women. The number of patients in the *kicking* sports was 26/52 (50%) and *throwing and trunk twisting* sports were 2/52 (3.8%) and 24/52 (46.2%) respectively. The mean duration of symptoms before surgery was 5.7 months (3 to 36).

The lumbar levels were 43/55 (78%) at L5, 3/55 (5.5%) at L4 and 4/55 (7.2%) at L3. Multiple level involvements were observed in 5/55 (9%). Modified Buck's screw repair of the pars defect was carried out in 44 patients (33M:11 F). Unilateral repair was performed in 8 patients (7M:1F) and bilateral repair was performed in 36 patients (26M:10F).

The mean pre treatment and post treatment VAS score was 6.6 (SD-0.97) and 0.8 (SD-1.12) respectively [$p<0.01$]. The mean pretreatment ODI was 37.6 (SD -10.5) and the mean post-treatment ODI was 9.2 (SD – 13.4) [$p<0.01$]. In the SF-36 scores, the mean score for the physical component of health improved from 32.7 (SD – 7.1) to 50.1 (SD -8.8) ($p< 0.001$). The mean score for the mental component of health improved from 42.8 (SD -8.4) to 54.4 (SD-8.2) ($p<0.001$). The mean BPSQ score was 49.6 (range 15-73).

In the unilateral group with Buck's repair, 7/8 (87%) patients had complete relief of pain at a mean time of 6.5months (range 6-9months) following surgery.

In the bilateral group, with Buck's repair in single level i.e. 33/36 (93%) patients had complete pain relief at a mean time of 7.5 months (6-12months). 44/52 (84%) individuals had returned to the sports. In the bilateral pars defect group, there were 19 footballers at various levels. Of these 14 returned to the same level at which they had been competing before the onset of their symptoms. All the sporting individuals who returned to sports had their post-treatment ODI score of <10 and minimum BPSQ scores of 48.

The preoperative VAS score was significantly correlated with the post-operative VAS i.e. $\rho = 0.53$ ($p<0.01$) and both pre & post operative ODI scores i.e. $\rho = 0.51$ ($p<0.01$) and $\rho = 0.33$ ($p<0.05$) respectively.

When the regression modeling was completed the independent variables included were (preoperative ODI, preoperative SF36pcs, Buck's repair, multiple operations, professional sporting individual and pars defect at L3), the adjusted R^2 was 0.809. This indicates that the regression model is a good predictor of the outcome variable i.e. post-operative ODI. The independent variables which are selected by the regression model have significant effect on the post-operative ODI. The multiple linear equation for predicting post operative ODI scores is:

Post operative ODI score = 30.121 + (0.327 x pre operative ODI score) + (-0.581 x preoperative SF36pcs score) + (-11.872 x Bucks repair) + (26.503 x Multiple operation) + (-6.792 x professional) + (21.034 x L3 pars defect).

In the ROC estimation the area under the curve (AUC) for pre treatment VAS score was 0.94 (CI: 0.904 – 0.974, $p<0.001$). This suggests that the pre treatment VAS scores are the best indicator of a patient requiring surgery over the period of 6-12 months.

Conclusion

The outcome following direct repair of pars defect beyond 30 years of age is unpredictable. There is no difference in the functional outcome between the two genders. Preoperative VAS score of >6 is the most sensitive indicator (90%) for direct repair of pars defect. Professionalism in sports has a high impact on the outcome of an individual following surgical repair of the defect. Unilateral spondylolysis do slightly better than bilateral spondylolysis following Buck's repair. Preoperative ODI and SF-36 pcs scores are significant predictor of a good functional outcome. BPSQ scores may be able to predict the return of sporting individuals to respective sports following treatment for lumbar spondylolysis. The predictive model presented above could predict the outcome in 82.8 % sporting individuals undergoing Buck's repair.

Foreword

I am delighted to be able to write a foreword for the thesis for DM (Orth) written by Mr Ujjwal K Debnath, FRCS, titled "*Factors predicting the outcome following treatment for lumbar spondylolysis*".

I have known Ujiwal since 1999 when he became interested in reviewing spondylolytic patients treated in the Spinal Unit of which the majority of cases have been under my care. His interest has contributed significant knowledge to the management of spondylolysis. He has written extensively on this subject with four peer reviewed papers and three further papers which are likely to be published.

It is good to see a detailed analysis of the outcome of patients who complained of pain associated with lumbar spondylolytic lesions. As a surgeon, we are interested in the surgical outcome but Ujiwal has taken great care in reviewing the results of the non-operative cases and this makes most interesting reading. He has introduced a Back Pain & Sports Questionnaire (BPSQ) which evaluates patients who have failed non-operative treatment. A return to sports can be predicted in such patients undergoing surgical repair of the spondylolytic lesion if the score is greater than 48. This is a valuable indicator in discussing the outcome of surgery with these patients.

Ujiwal has made an extensive review of the literature and has put together algorithms for managing patients with lumbar spondylolytic lesions both non-operatively and operatively. This data is valuable for young surgeons beginning their career and needing information on the management of such cases.

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Declaration

This research on lumbar spondylolysis including the descriptive analysis has been carried out as a registered candidate at the University of Nottingham. I have undertaken the work contained within this thesis from designing to the final analysis of the results. The idea, data collection, final analysis, interpretation and conclusions drawn from this study are my own ably guided by the supervisors. Statistical outputs were provided by the statistician. This work has not been submitted in any previous application to this or any other University for higher degree as far as my knowledge.

Acknowledgements to those individuals who collaborated and assisted in this study are made overleaf.

Acknowledgements

This dissertation would never have been written if it had not been for the encouragement, support, and assistance I received from a large number of people.

I would like to thank my principal collaborator cum clinical supervisor for this work, Professor Brian J C Freeman previously based at Queens Medical Centre, University of Nottingham from 2000-2007. He has been a constant source of encouragement as a friend and colleague. We have published few papers together while doing this study. I had been fortunate enough to have been his last trainee as a Spinal Fellow at the Queens Medical Centre, Nottingham before he left for taking up the Professorial chair and Head of the Unit at the University of Adelaide.

I owe my sincere gratitude to Ms Brigitte Scammell, Head of the department in the Division of Orthopaedics & Accident Surgery, University Hospital, Nottingham. At first I thank her for helping me to have the preliminary idea approved by the university. She then acted as my academic supervisor. Her constant support, periodic supervision and timely insight into the chapters have led to the completion of this thesis.

I owe my sincere thanks to Mr John K Webb, Consultant Spine Surgeon, Spinal Unit at QMC, Nottingham for his periodic advice regarding the subject. I also thank him for a large cohort of surgical patients of Buck's repair performed by him. I also have sincere thanks to Mr S M H Mehdian, Consultant Spine Surgeon, Spinal Unit, QMC, Nottingham for his constant support to do research and publication. A special thanks to Mr Michael P Grevitt, consultant Spine Surgeon, Spinal Unit, QMC, Nottingham for his timely review of my papers before publication with valuable comments for improvement in the script.

I owe my special thanks to the Spinal Unit for appointing me as a Spinal Fellow in 2007-08. Without this appointment it would have been impossible to accomplish this mammoth work which I had started in 1999, then working as a Senior House Officer in this unit. I have my sincere regards for Professor R C Mulholland, who was the Special Professor in Orthopaedics and Accident Surgery during 1999 for his thoughts and ideas on lumbar spondylolysis. My special thanks to all my colleagues who helped in this difficult times tp pursue writing my thesis.

I am obliged to Mr J Hegarty, Clinical auditor in Spinal Unit for helping me with constant supply of case notes. He also used his resources towards the development of the BPSQ scoring system. I sincerely acknowledge Mr Michael Seagrave, Statistician for giving time and helping me with the analysis and interpretation of the large volume of data evolved. I also thank Mr Keith Streb, Medical Photographer for organizing the photographs included in the thesis.

I owe my special thanks to my friend Dr Jeffrey R McConnell, MD, Consultant Spine Surgeon, Allentown, PA, USA, who has been a constant source of moral support for this academic venture on spondylolysis.

My sincere thanks to the Programme Director of Orthopaedic training in Wales, Mr Mark Holt, and my senior Consultant colleagues in Wales, Mr Christopher Wilson and Mr Declan O'Doherty to have allowed me to complete the Spine Fellowship with a faith that I shall be able to complete this thesis.

I do wish to send my prayers to my mentor, Late Professor R N Mitra, Spine Surgeon (1919-1995) who had encouraged me to be a Spine Surgeon when I had just started my career as Orthopaedic Surgeon in India.

I have my sincere prayer towards my dear departed father, Mr Uddharan Debnath (1935-1984) who would have been proud to see his son's achievements.

No words of acknowledgement is sufficient to describe one person whose unqualified love and support helped me to survive ups and downs of this life, my dear mother, Mrs Hemnalini Debnath. Last but not least, I want to thank my sister and my two beautiful niece, friends, and dear ones for love and support.