The effect of waiting times from general practitioner referral to MRI or orthopaedic consultation for the knee on patient-based outcomes

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Objectives: The purpose of this study was to test for the effect of waiting time from general practitioner (GP) referral to MRI or to orthopaedic consultation on outcomes of patients with knee problems, and to test whether any characteristics of trial participants predicted waiting time to MRI or orthopaedics.

Methods: We undertook secondary analyses of data on 553 participants from a randomised trial who were recruited from 163 general practices during November 2002 to October 2004.

Results: Of the patients allocated to MRI, 263 (94%) had an MRI, and of those referred to orthopaedics, 236 (86%) had an orthopaedic consultation. The median (interquartile range) waiting time in days from randomisation to MRI was 41.0 (21.0–71.0) and to orthopaedic appointment was 78.5 (54.5–167.5). Waiting time was found to have no significant effect on patient outcome for both the Short Form 36-item (SF-36) physical functioning score ($p=0.570$) and the Knee Quality of Life 26-item (KQoL-26) physical functioning score ($p=0.268$). There was weak evidence that males waited less time for their MRI ($p=0.049$) and older patients waited longer for their orthopaedic referral ($p=0.049$). For patients who resided in the catchment areas of some centres there were significantly longer waiting times for both MRI and orthopaedic appointment.

Conclusion: Where patients reside is a strong predictor of waiting time for access to services such as MRI or orthopaedics. There is no evidence to suggest, however, that this has a significant effect on physical well-being in the short term for patients with knee problems.

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In the UK National Health Service (NHS), the Department of Health developed the NHS Plan in 2000, which described a programme of investment in the NHS with sustained increases in funding [1]. The emphasis was on providing more and better-paid staff, improving local hospitals and surgeries, and reducing waiting times. Specifically, for waiting times, the aim was to improve patient access to primary care with initiatives such as NHS direct, the 24-h telephone helpline and a target of being able to see a general practitioner (GP) within 48 h. This policy continued with the NHS Improvement Plan in 2004, with the aim to reduce waiting times to 18 weeks from GP referral to hospital treatment and for primary care trusts to control over 80% of the NHS budget [2]. In

addition, waiting time for diagnostics had been identified as “hidden waits”, which needed increased resources in access to diagnostic tests to enable faster and more appropriate access to health care. Where appropriate, GPs were to refer patients direct to a diagnostic facility, cutting out patient waits associated with accessing diagnostic services via a hospital consultant. Special attention was given to increasing capacity in the provision of MRI. There are now over a million MRI examinations performed in England each year, and this number is expected to rise [3]. The UK government has invested £2400 million in upgrading diagnostics and reducing waiting times for diagnostic tests [4].

Each year in the UK 15% of patients consult GPs for musculoskeletal disorders [5]. Imaging of the knee is a common musculoskeletal application of MRI [6]. There is evidence for the technical [7] and diagnostic performance [8] of MRI for patients with injuries to menisci and ligaments. There has been uncertainty, however, about the appropriate use of MRI, in particular when it should enter the diagnostic pathway for patients with suspected

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internal derangement of the knee [9, 10]. We conducted a multi-centre, pragmatic randomised controlled trial called DAMASK (Direct Access to MRI: Assessment of Suspect Knees) to evaluate early access to MRI through GP referral and a provisional orthopaedic outpatient appointment compared with direct referral to an orthopaedic specialist who could request MRI for patients if necessary [11]. The results of this study were that early access to MRI significantly improves GPs' confidence in their diagnosis and management plans [12], brings about a statistically significant but small clinical benefit to patients' knee-related quality of life [13] and represents cost-effective use of NHS resources (£5480 per quality-adjusted life year gained) [14]. The primary analysis for the DAMASK trial was pragmatic in that even though data were collected on the time that patients waited from randomisation to MRI or orthopaedic appointment, this was not included as a covariate in the analysis. This is because the aim was to reflect what actually happened in clinical practice rather than to statistically control for the effect of waiting times on patient outcome.

As UK government policy has been to increase investment in order to reduce waiting times from GP to hospital treatment and increase access to diagnostics such as MRI, this paper reports the results of the *a priori* planned secondary analyses of the DAMASK trial data. These analyses were to test for the effect of waiting time from GP referral to MRI or to orthopaedic consultation on outcomes of patients with knee problems, which also informs whether adjusting for waiting times altered the findings of the trial. In addition, we have tested whether characteristics of trial participants were predictors of waiting time to MRI or orthopaedics.

Methods and materials

We conducted a pragmatic randomised trial in urban, mixed and rural sites across northeast Scotland, north Wales and Yorkshire, covering a broad socio-economic spectrum. The total population of these geographical areas is around 2 million people registered in over 600 general practices. Northern and Yorkshire Multi-Centre Research Ethics Committee approved the study (reference number MREC/1/3/59).

Interventions

Direct access to MRI (experimental intervention)

The aim at each hospital was to perform imaging within 12 weeks of GP referral using standard commercially available MRI machines and imaging protocols. The GP also made a provisional orthopaedic appointment at the time of randomisation, which, depending on the findings of MRI, could be kept or cancelled at their discretion. We attached an educational message to radiologists' reports reminding the referring GP that the decision to proceed to orthopaedic referral or to continue with conservative treatment in primary care depended on both the MRI and clinical findings. Educational seminars (duration 2 h) were also delivered to GPs about

MRI, clinical diagnosis and conservative management of suspected internal derangement of the knee.

Referral to orthopaedic specialist in secondary care (the control)

The aim was to ensure that the orthopaedic appointment was within 9 months of GP referral. Orthopaedic specialists could request an MRI examination for patients in the control group if clinically indicated.

Recruitment, randomisation and follow-up

Patients were recruited from general practices between November 2002 and October 2004. In each practice, GPs or practice nurses asked eligible and consenting patients to complete a baseline questionnaire before contacting a remote telephone randomisation service at York Trials Unit to ensure immediate and unbiased allocation of treatments. As the trial was pragmatic in design, to reflect the consequences of routine GP access to MRI, blinding of patients or professionals to treatment allocation was neither desirable nor possible. Follow-up of patients was by postal questionnaires at 6, 12 and 24 months after randomisation. This was to ensure that the evaluation covered all events, including arthroscopy. An evidence-based strategy was used to maximise response rates, including pre-notification letters, a monetary incentive, and postal and telephone reminders [15].

Referral process

Data were collected from hospitals on the number of MRI, orthopaedic appointments and arthroscopies attended, and patient waiting times from randomisation to MRI, orthopaedic consultation and arthroscopy.

Health outcomes

We used a generic measure, the Short Form 36-item (SF-36), a popular health profile validated for use in the NHS, which has been found to be responsive to changes in the health of patients referred for MRI of the knee [16]. In the absence of an appropriate patient-assessed health instrument specific to the knee with satisfactory evidence for reliability, validity and responsiveness [17], we developed our own instrument called Knee Quality of Life 26-item (KQoL-26) [18]. The primary outcome measures were the physical functioning scale of the SF-36 and KQoL-26.

Statistical analysis

For the analysis of the effect of waiting time on patient outcome, data were collected at four times: baseline, 6, 12 and 22–24 months. The analysis was "by intention to treat" in that all patients properly randomised were included even if they did not receive their allocated intervention. To take account of repeated measures within patients, the analysis used the PROC mixed procedure in SAS v. 9 (SAS Institute Inc., Cary, NC). Patient effects

Table 1. Waiting times (days) from randomisation to MRI or orthopaedic appointment

Measure	Treatment	
	MRI + orthopaedic referral: waiting time to MRI (n=263)	Orthopaedic referral: waiting time to appointment (n=236)
Mean (SD)	52.8 (53.6)	116.4 (93.9)
Median (IQR)	41.0 (21.0–71.0)	78.5 (54.5–167.5)

IQR, interquartile range; SD, standard deviation.

were fitted as random effects and all other variables were included as fixed effects [19]. The primary outcomes were the physical functioning scores of the SF-36 and the KQoL-26 at each follow-up. The model included: baseline quality of life scores, time since baseline, centre and waiting time. An interaction term between waiting time and treatment group was added to the model. This was not significant for the SF-36 physical functioning score ($p=0.836$) or for the KQoL-26 physical functioning score ($p=0.594$), so the model without the interaction was used. We examined the residuals to check the fit of the resulting models to the data.

For the analyses of whether trial participant characteristics predicted waiting times, the waiting times were logged and used in a linear regression model as the dependent variable. The predictors included in the model were gender, employment status (employed or not), age, baseline SF-36 physical functioning score and centre (as a proxy for where the participant resides), which were anonymised as centres A to I, with the latter as the reference category and the centre at which most participants were recruited. Two models were used: one for waiting time to MRI for the group randomised to MRI, and the other for the time from randomisation to orthopaedic appointment for the control group.

Results

Patient flow and follow-up

Of 647 practices approached to take part in our trial, 285 (44%) accepted the invitation. From November 2002 to October 2004 we recruited 553 eligible and consenting patients from 163 general practices; practices recruited between 1 and 23 patients, with 58 (36%) recruiting 4 or more patients. Of the 279 patients allocated to MRI, 263 (94%) had an MRI; of the 274 referred to orthopaedics, 236 (86%) had an orthopaedic consultation. At 6 months, 469 (85%) of patients returned questionnaires;

and at 12 and 24 months, 471 (85%) patients returned questionnaires.

Baseline data

The mean (standard deviation, SD) age of all participants in the DAMASK trial at randomisation was 39.7 (10.3) years; 36% were female; 99% were white; 89% were employed; and 79% and 31% had menisci and ligament injuries, respectively. The mean (SD) SF-36 and KQoL-26 physical functioning scores at randomisation were 54.9 (23.8) and 59.1 (19.0), respectively, on a scale of 0–100, where 100 represents best health.

Effect of waiting time on patient outcome

Table 1 shows that the median (interquartile range) waiting time in days from randomisation to MRI was 41.0 (21.0 to 71.0) and to orthopaedic appointment was 78.5 (54.5 to 167.5). Table 2 shows that for the primary analysis patients randomised to MRI had mean SF-36 physical functioning scores that were better by 2.81 [95% confidence interval (CI) –0.26 to 5.89] than those directly referred to orthopaedics (not statistically significant; $p=0.072$). When waiting time was included as a covariate in the secondary analysis the mean difference in SF-36 physical functioning scores between the two treatment groups remained not statistically significant ($p=0.072$). The log of waiting time as a covariate in this analysis had a negative effect on patient outcome, but was not statistically significant [estimate=–0.627, standard error (SE)=1.1, $p=0.570$]. Patients randomised to MRI had mean KQoL-26 physical functioning scores that were better by 3.65 (95% CI 1.03 to 6.28; statistically significant $p=0.007$). When waiting time was included as a covariate in the secondary analysis the mean difference in KQoL-26 physical functioning scores between the two treatment groups was now not statistically significant ($p=0.058$). The log of waiting time as a covariate again had a negative

Table 2 Mean adjusted scores for primary outcomes over 24 months

Outcome measures	MRI + orthopaedic referral mean (SE)	Orthopaedic referral mean (SE)	Mean difference (95% CI)	p-value
Primary analyses				
SF-36 (n=517)	72.23 (1.50)	69.41 (1.52)	2.81 (–0.26 to 5.89)	0.072
KQoL-26 (n=517)	75.72(1.28)	72.07(1.30)	3.65 (1.03 to 6.28)	0.007
Secondary analyses ^a				
SF-36 (n=476)	71.33 (1.80)	68.03 (1.91)	3.30 (–0.30 to 6.89)	0.072
KQoL-26 (n=476)	74.82 (1.55)	71.83 (1.65)	2.99 (–0.10 to 6.08)	0.058

CI, confidence interval; KQoL-26, Knee Quality of Life 26-item physical functioning score; SE, standard error; SF-36, Short Form 36-item physical functioning score.

^aIncluding a variable for waiting time that was logged as the distribution was skewed.

effect on patient outcome, but was not statistically significant (estimate = -1.05, SE = 0.95, $p = 0.268$).

Effect of trial participant characteristics on waiting times

Table 3 presents the results of the analyses as to whether characteristics of trial participants predicted waiting times for MRI. Gender was of borderline significance ($p = 0.049$), with males having a shorter waiting time than females. In addition, for participants who reside in the catchment areas of some centres (B, C, D, E and H) there were significantly longer waiting times than for centre I. Table 4 shows that there was borderline significance that increasing age was associated with increased waiting time for an orthopaedic appointment ($p = 0.049$). Again, where the participant resides (centres B, E and H compared with I) was associated with significantly longer waiting times.

Discussion

The rationale for the DAMASK trial was that NHS patients wait too long to be seen by an orthopaedic specialist, which could be detrimental to patients' well-being. A potential advantage of GP access to MRI for patients with knee problems is that patients could be managed conservatively in primary care. This could avoid unnecessary orthopaedic referrals and thus reduce hospital waiting times for those patients who need a consultation [11].

We found that waiting time from GP referral to MRI or orthopaedic appointment had a negative effect on patients' physical well-being, as measured by health-related quality of life questionnaires, but was not statistically significant. Furthermore, the mean difference in SF-36 physical functioning scores between the two groups remained not statistically significant. Therefore the results of the primary analysis appear robust to the influence of waiting times. This may be because, to the patient, the knee injury was a single event with no subsequent significant disease progression, at least during the 2-year follow-up period. When adjusting for waiting time in the analyses of the KQoL-26 physical

functioning scores, the results changed from being significant to not significant, although this was borderline. This could be explained by the reduced sample size in the secondary analyses, with subsequent loss in statistical power, and the fact that the patients included in this sample were those who had complied with treatment allocation and attended their MRI or orthopaedic appointment. These findings are consistent with other studies of orthopaedic patients, which have shown that longer waiting times for knee or hip replacement are not significantly associated with poorer health-related quality of life [20–22]. In particular, for patients waiting for primary total knee replacement due to osteoarthritis, a study found that patients randomised to longer waiting times compared with short (≤ 3 months) waiting times did not result in significantly worse health-related quality of life at time of hospital admission for operation [22]. However, while waiting for specialist diagnosis and surgery for knee injuries there is evidence from in-depth qualitative interviews at one UK centre that patients typically feel lost within the system and that their life has been put on hold, and they experience emotional reactions including anxiety, frustration, irritation and annoyance [23]. Therefore, while patients' physical well-being may not be significantly affected, they may experience emotional distress while waiting for access to services.

For the effect of trial participant characteristics on waiting times, there was weak evidence to suggest that males waited less time than females for their MRI and that older patients waited longer for their orthopaedic appointment. In clinical practice, it tends to be the radiologist who reviews the request from a GP and prioritises the patient having MRI earlier. Similarly, at the time of the study, an orthopaedic consultant would review the content of the GP referral, and may prioritise patients because of factors such as acuteness of injury, knee instability or occupational factors. Acute injuries of the knee, such as meniscal lesions, are more common in physically active young males [24], and prompt management can lead to a quick return to sport or work [25]. While this may have been a chance finding, it is possible that more males than females exist in occupational groups that are susceptible to knee injury and where further injury is likely to occur without treatment.

Table 3 Characteristics of trial participants as predictors of waiting time to MRI ($n = 251$)

Parameter	B	Standard error	Significance	95% confidence interval
Male	-0.151	0.077	0.049	-0.302 to -0.001
Age	-0.004	0.003	0.293	-0.010 to 0.003
Baseline SF-36	0.000	0.001	0.835	-0.003 to 0.003
Employed	0.098	0.101	0.332	-0.101 to 0.297
England 1 (A) ^a	0.060	0.372	0.871	-0.673 to 0.793
Scotland 1 (B) ^a	1.659	0.117	<0.001	1.428 to 1.889
England 2 (C) ^a	1.225	0.153	<0.001	0.924 to 1.526
Scotland 2 (D) ^a	0.762	0.117	<0.001	0.530 to 0.993
Wales (E) ^a	1.073	0.093	<0.001	0.890 to 1.256
England 3 (F) ^a	0.065	0.151	0.666	-0.232 to 0.363
England 4 (G) ^a	0.209	0.156	0.181	-0.098 to 0.516
Scotland 3 (H) ^a	1.204	0.125	<0.001	0.958 to 1.451

SF-36, Short Form 36-item physical functioning score.

Outcome = $\ln(\text{waiting time})$.

^aCompared with England 5 (I).

Table 4 Characteristics of participants as predictors of waiting time for an orthopaedic appointment (n=226)

Parameter	B	Standard error	Significance	95% confidence interval
Male	-0.070	0.123	0.570	-0.312 to 0.172
Age	0.011	0.006	0.049	0.000 to 0.022
Baseline SF-36	0.002	0.003	0.365	-0.003 to 0.007
Employed	-0.225	0.160	0.162	-0.541 to 0.091
Scotland 1 (B) ^a	0.911	0.193	<0.001	0.530 to 1.292
England 2 (C) ^a	0.525	0.277	0.059	-0.021 to 1.071
Scotland 2 (D) ^a	0.129	0.197	0.514	-0.260 to 0.518
Wales (E) ^a	0.768	0.170	<0.001	0.433 to 1.104
England 3 (F) ^a	-0.138	0.270	0.609	-0.670 to 0.394
England 4 (G) ^a	0.532	0.274	0.054	-0.009 to 1.073
Scotland 3 (H) ^a	0.605	0.220	0.006	0.172 to 1.038

SF-36, Short Form 36-item physical functioning score.

Outcome=ln(waiting time).

^aCompared with England 5 (I).

Therefore, if males experience more acute injuries to the knee than females, for occupational reasons, their referral for MRI may be prioritised by the radiologist. Waiting time from GP referral to MRI or orthopaedic appointment was also strongly predicted by centre. Therefore, where patients reside can have a significant effect on how long they wait because of variation in access to NHS services. Interestingly it was mostly sites in Scotland and Wales where patients had to wait longer for MRI or orthopaedics. This variation is likely to be explained by higher demand for NHS services in some areas because of the specifics of the local population, the clinical capacity of radiology and orthopaedic departments to meet this demand and different waiting list initiatives for the three nations.

There are some limitations to this study that should be considered in terms of both internal validity and generalisability. First, the data were collected during an experiment. While the design was pragmatic, it will not necessarily reflect how GPs might prioritise patients for referral for MRI or orthopaedic appointment, as the referral decision was random. Nor will the trial realistically reflect how the patient might interact with their GP about such a referral as they were being approached to take part in a randomised trial, nor how staff at the hospital might behave in their allocation of an MRI or orthopaedic appointment. Second, it is arguable that, as the participating centres were to provide an MRI or orthopaedic appointment within a certain time frame, the trial limited the natural variation in waiting times. Nevertheless, the findings show that there was at that time considerable variation in waiting times to MRI or orthopaedics. Third, the generalisability is limited to patients with suspected internal derangement of the knee being referred for imaging or a hospital appointment. Fourth, we focused on patients' physical well-being as this was the primary outcome of the DAMASK trial. It is conceivable that patients with knee problems who have to wait longer for access to MRI or orthopaedic consultation could experience additional anxiety and stress because of pain, discomfort and not being able to undertake normal daily activities [23]. In addition, those patients who waited longer might in the meantime have visited their GP more often, consumed more medication, lost more income from work and received additional income support payments. Thus, longer waiting time

also has a potential impact on patients' mental health, and additional costs to patients, NHS and society. Finally, while this study had a 2-year follow-up period that covered all events up to and including arthroscopy, there could be longer-term consequences of waiting for appropriate access to NHS care. For example, there is a significant increase in incidence of medial meniscal tears as anterior cruciate ligament injuries become more chronic, and there is a delay in time of injury to arthroscopy [26]. Injuries to the knee can also lead to the development of osteoarthritis, and therefore increased risk of the need for joint replacement [27]. It was beyond the scope of this study to explore the impact of waiting times on the emotional well-being of patients with knee problems, the economic consequences and the longer-term effects, but these could be the focus of further research. In addition, the findings that women and older people wait longer could be areas deserving further consideration in cohort studies.

Conclusion

In terms of informing radiology practice, it appears that males with suspected internal derangement of the knee may be prioritised to have an MRI more quickly than females. This could be necessary, however, if males have more acute injuries to the knee and are in occupations where knee injuries are common and where further injury is likely to occur without treatment. Where patients reside is a strong predictor of variability in waiting time for MRI. This inequity in access to MRI is undesirable, but possibly a realistic reflection of different local circumstances. For a single event condition, such as an injury to the meniscus or ligament, waiting time to MRI or orthopaedics does not appear to result in a significant effect on patients' physical well-being in the short term.

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References

1. Department of Health. The NHS plan: a plan for investment, a plan for reform. London, UK: The Stationery Office; 2000.
2. Department of Health. The NHS improvement plan: putting people at the heart of public services. London: The Stationery Office; 2004.
3. Department of Health. Hospital activity statistics: imaging and radiodiagnostic files [cited 7 March 2008]. Available from: www.performance.doh.gov.uk/hospitalactivity/data_requests/imaging_and_radiodiagnostics.htm
4. Barrett A. Waiting times for scans to decrease, vows Department of Health. *BMJ* 2005;331:256.
5. Office of Population Censuses and Surveys. Morbidity statistics from general practice: fourth national study 1991–92. London, UK: Stationery Office; 1995.
6. Mackenzie R, Dixon AK, Keene GS, Hollingworth W, Lomas DJ, Villar RN. MRI of the knee: assessment of effectiveness. *Clin Radiol* 1996;51:245–50.
7. Mackenzie R, Logan BM, Shah NJ, Keene GS, Dixon AK. Direct anatomical-MRI correlation: the knee. *Surg Radiol Anat* 1994;16:183–92.
8. Fisher SP, Fox JM, Del Pizzo W, Friedman MJ, Snyder SJ, Ferkel RD. Accuracy of diagnosis from magnetic resonance imaging of the knee: a multi centre analysis of one thousand and fourteen patients. *J Bone Joint Surg* 1991;73A:2–10.
9. Southgate J, Thomas N. MRI should be used selectively (letter). *BMJ* 1995;312:849.
10. Mackenzie R, Edwards D, Dixon AK. Patients should be seen by an experienced orthopaedic clinician (letter). *BMJ* 1996;312:849–50.
11. Brealey SD, Atwell C, Bryan S, Coulton S, Cox H, Fylan F, et al. The DAMASK trial protocol: a pragmatic randomised trial to evaluate whether GPs should have direct access to MRI for patients with suspected internal derangement of the knee. *BMC Health Serv Res* 2006;6:133.
12. DAMASK Trial Team. Influence of magnetic resonance of the knee on GPs' decisions: a randomised trial. *Br J Gen Pract* 2007;57:622–9.
13. DAMASK Trial Team. Effectiveness of GP access to magnetic resonance imaging of the knee: a randomised controlled trial. *Br J Gen Pract* 2008;58:e1–8; discussion 774.
14. DAMASK Trial Team. Cost-effectiveness of magnetic resonance imaging of the knee for patients presenting in primary care. *Br J Gen Pract* 2008;58:e10–6.
15. Edwards P, Roberts I, Clarke M, DiGuseppi C, Pratap S, Wentz R, et al. Increasing response rates to postal questionnaires: systematic review. *BMJ* 2002;324:1–9.
16. Hollingworth W, Mackenzie R, Todd CJ, Dixon AK. Measuring changes in quality of life following MRI of the knee: SF-36, EuroQol or Rosser Index? *Qual Life Res* 1995;4:325–44.
17. Garratt AM, Brealey S, Gillespie WJ in collaboration with the DAMASK Trial Team. Patient-assessed health instruments for the knee: a structured review. *Rheumatology (Oxford)* 2004;43:1414–23.
18. Garratt AM, Brealey S, Robling M, Atwell C, Russell I, Gillespie W, et al on behalf of the DAMASK Trial Team. Development of the Knee Quality of Life (KQoL-26) 26-item questionnaire: data quality, reliability, validity and responsiveness. *Health Qual Life Outcomes* 2008;6:48.
19. Brown H, Prescott R. Applied mixed models in medicine. Hoboken, NJ: Wiley; 2006. pp. 215–33.
20. Williams JI, Llewellyn-Thomas H, Arshinoff R, Young N, Naylor CD and the Ontario Hip and Knee Replacement Project Team. The burden of waiting for hip and knee replacement in Ontario. *J Eval Clin Pract* 1997;3:59–68.
21. Kelly KD, Voaklander DC, Johnston DWC, Newman SC, Suarez-Almazor ME. Change in pain and function while waiting for major joint arthroplasty. *J Arthroplasty* 2001;16:351–9.
22. Hirvonen J, Blom M, Tuominen U, Seitsalo S, Lehto M, Paavolainen P, et al. Evaluating waiting time effect on health outcomes at admission: a prospective randomised study on patients with osteoarthritis of the knee joint. *J Eval Clin Pract* 2007;13:728–33.
23. Robling MR, Pill RM, Hood K, Butler CC. Time to talk? Patient experiences of waiting for clinical management of knee injuries. *Qual Saf Health Care* 2009;18:141–6.
24. Poulsen MR, Johnson DL. Meniscal injuries in the young, athletically active patient. *Phys Sportsmed* 2011;39:123–30.
25. Bollen S. Epidemiology of knee injuries: diagnosis and triage. *Br J Sports Med* 2000;34:227–8.
26. Keene GCR, Bickerstaff D, Rae PJ, Paterson RS. The natural history of meniscal tears in anterior cruciate ligament insufficiency. *Am J Sports Med* 1993;21:672–9.
27. Noyes FR, Mooar PA, Matthews DS, Butler DL. The symptomatic anterior cruciate- deficient knee. Part I: the long-term functional disability in athletically active individuals. *J Bone Joint Surg Am* 1983;65:154–62.