**ORIGINAL ARTICLE**

**Stiffness after knee arthrotomy: Evaluation of prevalence and results after manipulation under anaesthesia**

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**KEYWORDS**
Knee stiffness; Manipulation under anaesthesia; Prevalence; TKA; Gain in range of motion

**Summary** The aim of the present study was to determine the prevalence and the effect of manipulation under anaesthesia in patients with Total Knee Arthroplasty (TKA), ‘‘revision-knee’’ and all forms of other intra-articular surgical procedures. We aimed to determine differences in the outcome according to the number of previous surgeries and according to time of manipulation under anaesthesia (MUA).

**Patients and Methods**: One thousand three hundred and forty-four elective intra-articular surgeries (no trauma cases) were performed at our institution between 2004 and 2009. Fifty-two of them underwent MUA because of postoperative knee stiffness with a flexion less than 90°. The prevalence for stiffness after primary TKA was 4.54%, for revision-knee procedures 5.11%, and for other forms of intra-articular surgery 1.29%.

**Results**: Flexion was statistically significantly improved directly after MUA in the group after primary TKA with a mean gain of 35.13° ± 17.03°, in the group with revision procedures of 41.31° ± 9.08° and in the group with other forms of intra-articular surgery of 24.37° ± 5.21°. Patients with more than two previous operations showed significantly worse results (P = 0.039).

No statistically significant difference (P = 0.307) was seen according to time (> < 30 days) of MUA.

**Discussion**: MUA is a valuable technique to increase ROM after TKA in patients with stiff knees, for ‘‘revision-knee’’ and all other patients with reduced flexion after different forms of intra-articular knee surgical procedures (excluding trauma cases). The results were similar for early and delayed MUA relative to the last surgery. The patients can therefore undergo conservative treatment (e.g. physiotherapy) before the MUA without the risk of poorer outcome. The results after MUA in patients with many previous operations were significantly worse and so an open/arthroscopic arthrolysis should be discussed earlier for this subgroup.

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Manipulation after postoperative knee stiffness

Introduction

A reduced range of motion (ROM) after arthrotomy of the knee joint is a frustrating complication for both the patient and the surgeon. Biomechanical analyses have shown that patients require 67° of knee flexion during the swing phase of gait, 83° to ascend stairs, between 90° and 100° of flexion to descend stairs, 93° to stand up from a normal sized chair and nearly 105° to stand up from a low chair [1]. There are different types of intra-articular knee surgery. The most common procedure is the total knee arthroplasty (TKA). Other reasons for arthrotomy of the knee joint might be the surgical treatment of intra-articular infections, resection of tumor lesions, traumatic ligament tears, intra-articular fractures, etc.

Vigorous rehabilitation after all open knee surgery is important to restore an adequate range of motion (ROM).

However, the reasons for losing an adequate ROM are manifold with factors including the patient’s own healing process and formation of fibrous scar tissue.

Treatment for knee stiffness can include surgical management and/or manipulation under anaesthesia (MUA).

Different studies have shown lasting gain in flexion mobility following manipulation under anaesthesia to treat inadequate ROM after TKA [2,3].

Manipulation under anaesthesia may cause complications such as femoral supracondylar fracture, rupture of the patellar ligament, wound dehiscence and haemarthrosis and therefore the risk-benefit balance should be carefully considered [3].

The aim of this study was:

- to determine prevalence-data for the development of stiffness after different kinds of non-traumatic intra-articular surgery and to show the effects of MUA after primary TKA compared to all other patients who developed stiffness after non-traumatic intra-articular surgery;
- to assess the efficacy of MUA not only in TKA but also in different kinds of elective intra-articular surgery;
- to detect differences in ROM after MUA with regard to the number of previous surgical procedures and time point of MUA.

Patients and Methods

We performed a retrospective analysis of MUA to treat stiffness occurring after arthrotomy of the knee joint from August 1, 2004 to July 31, 2009. Because of the organisational structure of our clinic, there were no trauma cases. The included patients were divided into three groups. Group I: MUA after primary TKA. Group II: MUA after TKA revision procedures (changing of femoral/tibial or patella components). Group III: other types of intra-articular surgery (no trauma cases). All included patients had been seen again at our outpatient clinic six weeks after primary surgery and six weeks after MUA. MUA before the 30th day after surgery were included in the “early manipulation group”. The other group of patients were those who achieved a ROM of 90° until discharge but a decrease in ROM was seen after the 30th day after surgery. These patients were included in the “late manipulation group”.

The numbers of previous surgical procedures (arthrotomy and arthroscopy) before MUA were recorded. All patients who underwent MUA were divided into those who had one, two or more than two previous surgical procedures.

Rehabilitation protocol after arthrotomy of the knee joint was the same for all cases. It consisted of a 3—1 femoral block for pain management, walking with the physiotherapist on postoperative day 1, active and passive flexion on day 2 with the physiotherapist, continuous passive motion twice a day. The 3—1 femoral block was removed on day 3.

The ROM was documented by independent physiotherapists, using a goniometer. The measurements were done pre operatively and, every day during the postoperative in-patient period and six weeks postoperatively in the outpatient clinic.

All patients had to achieve a ROM of more than 90° before leaving hospital. If a ROM of more than 90° was not achieved, the patient’s length of hospital stay was prolonged up to 14 days. If a ROM of 90° still wasn’t achieved after this time, and anatomical reasons for a decreased ROM (malpositioning of femoral/tibial components, osteophytes) were excluded, the patients were encouraged to undergo immediate manipulation under anaesthesia.

Manipulation protocol

Before induction of a general anaesthesia, all patients received a 3—1 femoral block. The hip was flexed to 90°. The knee was gently flexed and extended seven to eight times until palpable lysis of adhesions was completed and a ROM of 120° to 130° was achieved. The knee was held in this position for 20 to 30 seconds. It was then flexed and extended into the maximum position for several times. After manipulation, x-rays of the knee joint were taken to demonstrate an eventual iatrogenic fracture.

As soon as the patients left the recovery room the physiotherapist showed them active-assisted ROM-exercises. During the following days the patients were treated with active and passive exercises and continuous passive motion. The ROM was documented daily and the femoral block was stopped and the catheter removed on day 3. Cryotherapy with ice-packs placed on the knee was used every day at the discretion of the physiotherapy staff.

Statistical Analysis

All data were organized with ”Microsoft Office Excel” and analyzed with ”PASW SPSS 17”. A P-value of less than 0.05 was considered significant. A Kolmogrov-Smirnov-test and a quantile-quantile-plot were used for testing group variance and normal distribution. Two-sample t-test were used for side-by-side comparisons of preoperative flexion and flexion before MUA; flexion before MUA and flexion after MUA; flexion before MUA and flexion six weeks after MUA; flexion after MUA and flexion six weeks after MUA. A one-factorial variance analysis (Anova) and the Turkey-Kramer-test were used to determine factors influence the outcome after MUA.
Figure 1  Distributions of procedures (no traumatic cases) 2004 to 2009 with prevalence of MUA. TKA: total knee arthroplasty; RPR: retropatellar replacement.

Results

One thousand three hundred and forty-four knee joint procedures were performed at our institution during the inclusion period. In 867 (64.5%) patients, TKAs (Genesis II Smith&Nephew) were implanted. Ninety-four (6.99%) of them were axial-guided TKA (RT-Solution) to treat osteoarthritis with ligament insufficiency. Ninety-nine (7.36%) infections of the knee joint were treated with open synovectomy. One hundred and seventy-six (13.09%) were revision procedures of TKAs to change femoral/tibial components or perform retropatellar dome implantation. Thirty-nine (2.9%) of them were special mega-arthroplasties and 18 (1.34%) were soft tissue resections of the synovial tumour lesions. Thirty-two (2.38%) were resections of bony tumor lesions without endoprostheses (biological reconstructions) and 46 (3.42%) were open synovectomies (Fig. 1).

Fifty-two MUA were performed (average age 62.9 ± 12.38; 39 females, 13 males). The overall prevalence for stiffness after knee procedure was 3.86%.

The prevalence for stiffness in group 1 was 4.54%, higher in group 2 (5.11%) and very low in group 3 (1.29%).

Manipulation took place a mean of 95.17 ± 35.3 days (range 9–130 days) after primary surgery. The length of stay in hospital after MUA was nine days ± 4.3 (range 3–24 days). Demographic and clinical data for the different groups are shown in Table 1.

A statistically significant improvement in flexion was achieved immediately after MUA in all groups. and six weeks after MUA despite a significant decrease in flexion for all three groups, (Fig. 2).

Eighteen knees (34.6%) developed arthrofibrosis after primary surgery, 23 knees (44.2%) after two procedures and 11 knees (21.2%), after three or more procedures. The mean flexion after MUA in patients with one previous operation was 103 ± 10° (range 90–130°), in patients with two previous operations 102 ± 11° (range 75–120°) and in patients with more than two previous operations 94 ± 7° (range 80°–110°), (P=0.003) (Fig. 3). In 16 cases (30.7%), MUA took place in the first 30 days after TKA, in 36 cases (69.3%) after

Table 1 Demographic and clinical data of the three different groups.

<table>
<thead>
<tr>
<th>Group</th>
<th>n</th>
<th>Sex</th>
<th>Age in years</th>
<th>Days between surgery and MUA</th>
<th>Number of previous operations</th>
</tr>
</thead>
<tbody>
<tr>
<td>Primary TKA</td>
<td>39</td>
<td>f: 32m: 7</td>
<td>64.15±11.18 (range 42–82)</td>
<td>75.70±62.20 (range 12–218)</td>
<td>1: n = 17; 2: n = 14; &gt;3: n = 8</td>
</tr>
<tr>
<td>Revision TKA</td>
<td>9</td>
<td>f: 7m: 2</td>
<td>66.44±8.79 (range 52–78)</td>
<td>43±41.03 (range 9–120)</td>
<td>1/: 2: n = 7; &gt;3: n = 2</td>
</tr>
<tr>
<td>All others</td>
<td>4</td>
<td>f: 1m: 3</td>
<td>42.75±14.68 (range 29–62)</td>
<td>25.67±13.61 (range 15–41)</td>
<td>1: n = 1; 2: n = 2; &gt;3: n = 1</td>
</tr>
</tbody>
</table>

n: number of cases; f: female; m: male.
Manipulation after postoperative knee stiffness

Figure 2  Evolution of "Range of motion" over time (flexion in degree) for group I (primary TKA), group II (revision procedure) and group III (other types of knee surgery). ***P < 0.0001

Figure 3  Flexion after manipulation under anaesthesia (all three groups together) with regard to number of previous operations. * P = 0.03

30 days. No statistical significance in absolute flexion after MUA was detected between "early" and "late" manipulations (P = 0.3) (Fig. 4).

Complications

One female patient with osteoporosis developed a periprosthetic-tibial fracture during the MUA and the primary TKA was changed into a revision TKA.

Discussion

Stiffness after primary TKA has a reported prevalence of 2% to 13% [4–8]. In the present study the prevalence for knee stiffness after TKA is 4.5% and supports the prevalence-data published by Kim et al. [9]. After knee procedure without arthroplasty, the prevalence of stiffness is very low (1.29%). The reasons why stiffness develops are poorly understood and are described as being multifaceted. Considering prevalence, the existence of an endoprosthesis might be an important factor for developing stiffness. The integrity of the ligaments could also have an influence on the development of stiffness as there was no prevalence for MUA in the rotational hinge-TKA group.

The present study indicates that MUA results in significant improvement of flexion not only after primary TKA but also after other types of intra-articular surgery. This is consistent with the findings of former studies which focused on MUA after TKA [10–12].

A reason for the decrease of ROM six weeks after MUA might be a lack of physiotherapy after leaving the hospital or an abnormal inflammatory response caused by MUA. Otherwise there is still a statistically significant improvement.
in flexion after MUA in all groups compared to the flexion before MUA. These results support the findings by Keating et al. [2].

To our knowledge, no previous study has shown the results after MUA in patients with revision-knee and other intra-articular surgeries. This is the first study which shows similar findings in these two groups. Considering the data provided, it is obvious that MUA has also a great benefit in improving flexion in "revision-knees" and after all kinds of other intra-articular surgeries. Therefore no differentiation needs to be made between the types of previous knee operations when deciding to perform a MUA.

To our knowledge, no other study also showed the influence of previous surgery on the outcome after MUA. The prevalence of stiffness after revision-knee surgery is 5.11%. This implies that more previous operations predispose to a higher formation of motion-limiting fibrous scar tissue and adhesions. The improvement of flexion after MUA in knees with more than two previous operations is significantly worse than in knees with one or two previous operations. Considering these data, we suggest an early open/arthroscopic arthrolysis in cases with many previous operations.

In the present study no significant differences between early and late MUA is found. This finding support the results of former studies where a significant increase in flexion for early MUA and late MUA are also detected [2,4,6,8]. In contrast to these studies, we chose a period of 30 days (vs. 90 days) to differentiate between "early" and "late" MUA. These findings permit both the patient and the surgeon to use physiotherapy extensively before starting a manipulation under anaesthesia.

The limitation of the present study is that no trauma cases are included in the present study. This is a result of the organisational structure of our clinic with a separation of traumatology and elective orthopaedic surgery. Because of this, no prevalence-data and results after MUA could be provided for patients with knee surgeries after trauma. Also a follow-up of about six weeks after MUA limits the final conclusion on the outcome after MUA.

The conclusion of the present study with regard to the collective of patients analysed, is that MUA is a good tool for improving ROM after primary TKA, "revision-knee" and other types of knee surgeries (excluding traumatic cases). It doesn’t matter at which time point MUA is performed. The results after MUA in patients with many previous operations are statistically significant worse and so an open/arthroscopic arthrolysis should be discussed earlier in these cases.

Disclosure of interest

The authors declare that they have no conflicts of interest concerning this article. Funding: No benefits or funds were received in support of the study.

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