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A systematic review of the clinical efficacy of sacroiliac joint stabilization in the treatment of lower back pain

Systematická analýza klinické efektivity stabilizace sakroiliakálního skloubení v rámci terapie bolestí zad

Abstract

Aim: Sacroiliac joint (SIJ) dysfunction is a chronic disorder, representing a significant cause of lower back pain. This study aims to present an evidence-based systematic analysis of published literature concerning the surgical management of SIJ dysfunction within the last 10 years. Its main goal is to demonstrate the clinical efficacy of SIJ arthrodesis via preoperative and postoperative analysis of patient pain and disability scores, as well as presenting the incidence of surgery-related complications. *Methods:* The PRISMA algorithm was used to stratify online search results into 27 studies, which made up our dataset. The parameters collected included study design, number of follow-up patients, surgical complications and preoperative and postoperative Visual Analogue Scale (VAS) and Oswestry Disability Index (ODI) scores. A random effects meta-analysis model was used to analyze the selected data, statistical heterogeneity was assessed using the inconsistency I test, publication bias was analyzed using the funnel plot and Egger's test. *Results:* The mean (95% CI) values of the preoperative VAS and ODI scores were 7.86 (7.65–8.07) and 55.1 (49.8–60.5), resp. These values improved postoperatively to a mean (95% CI) score of 3.23 (2.89–3.58) for VAS and 30.7 (25.9–35.5) for ODI. The total number of recorded surgical complications was 7.04%. The mean (95% CI) incidence of wound complications was 3.87% (2.44–6.09) and the mean (95% CI) proportion of screw dislocation or malposition was 4.32% (3.18–5.81). The proportion (95% CI) of patients requiring a second operation was 5.19% (3.93–6.83). *Conclusion:* This study demonstrated that patients indicated for sacroiliac stabilization showed significant improvement in VAS (by 4.6 points) and ODI (by 25 points) scores. These findings suggest that SIJ stabilization is a feasible and effective treatment option for this group of patients. Furthermore, overall morbidity of the procedure was lower than in previously reported studies and is expected to decrease with improvement in surgical technique and navigational imaging.

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Souhrn

Cíl: Dysfunkce sakroiliakálního skloubení (sacroiliac joint; SIJ) je chronické onemocnění zodpovídající za významné množství případů bolestí zad. Následující práce prezentuje systematickou analýzu odborných článků založených na důkazech týkajících se chirurgického managementu dysfunkce SIJ publikovaných v průběhu posledních 10 let. Jejím hlavním cílem je prezentovat výsledky stran klinické efektivity chirurgické artrodézy SIJ srovnáním předoperačního a pooperačního hodnocení bolesti, a také incidencí chirurgických komplikací. *Metodika:* Stratifikace datového souboru byla provedena pomocí algoritmu PRISMA, jehož výsledkem byla skupina 27 studií. Sledovanými parametry byly design studií, počet zařazených pacientů, výskyt chirurgických komplikací, předoperační a pooperační hodnocení Visuální analogové škály bolesti (VAS) a hodnoty Oswestry Disability Index (ODI). Metaanalýza byla provedena na základě modelu s náhodnými efekty, statistická heterogenita byla analyzována pomocí I2 indexu, publikační bias byl analyzován pomocí Eggerova testu a funnel plotu. *Výsledky:* Průměrné (95% CI) předoperační hodnoty VAS a ODI dosahovaly 7,86 (7,65–8,07) a 55,1 (49,8–60,5). Pooperačně došlo k poklesu VAS na průměrnou hodnotu 3,23 (2,89–3,58) a poklesu ODI na průměrnou hodnotu 30,7 (25,9–35,5). Celková incidence chirurgických komplikací byla 7,04 %, přičemž průměrná incidence ranných komplikací byla 3,87 % (2,44–6,09) a průměrný výskyt dislokace či malpozice šroubů byl 4,32 % (3,18–5,81). Celkem 5,19 % (3,93–6,83) pacientů vyžadovalo reoperaci. *Závěr:* Naše práce demonstrovala významné zlepšení předoperačních hodnot VAS (o 4,6 bodů) a ODI (o 25 bodů) u pacientů, kteří podstoupili chirurgickou stabilizaci SIJ. Tyto výsledky naznačují, že stabilizace SIJ může být u těchto pacientů využitelná a efektivní metoda. Navíc celková morbidita tohoto výkonu se jeví jako nižší, nežli popisovaly předchozí práce. Můžeme očekávat, že v důsledku zlepšujících se chirurgických technik a navigačních metod se bude chirurgická morbidita tohoto výkonu nadále snižovat.

Introduction

Sacroiliac joint (SIJ) dysfunction is defined as a chronically painful SIJ, which is essentially stable and has become disabling to the patient [1]. This clinical condition is increasingly recognized as a significant cause of lower back pain, for which it is responsible in 15–30% of cases [2–4]. This percentage is most likely higher in patients with a history of surgical procedures of the lumbar spine [5–7]. Although the incidence of SIJ dysfunction is relatively high, it commonly remains an unrecognized source of lower back pain, consequently resulting in significant patient disability. Diagnosis of SIJ dysfunction is mostly made per exclusionem, after ruling out more common causes of lower back pain such as lumbar disc disease or spinal stenosis. The diagnosis is confirmed by a combination of clinical manoeuvres and diagnostic intra-articular joint injections [8]. Therapeutic management of this condition is initially conservative, consisting of anti-inflammatory medication, physical therapy and therapeutic injections. In cases where conservative management fails, a surgical therapeutic strategy may be considered. Although several surgical approaches and implant systems are described in the literature, surgical immobilization of the affected joint remains a controversial topic within the neurosurgical and orthopaedic medical communities. A number of review papers attempting to demonstrate the efficacy of these procedures have been published within the last five years [9–11]. This review aims to present an evidence-based systematic analysis of published literature concerning surgical management of SIJ dysfunction within the last 10 years. Its main goal is to demonstrate the clinical efficacy of SIJ arthrodesis via preoperative and postoperative analysis of patient pain and disability scores. The secondary goal is to present the incidence of surgery-related complications in order to quantify morbidity of the procedure.

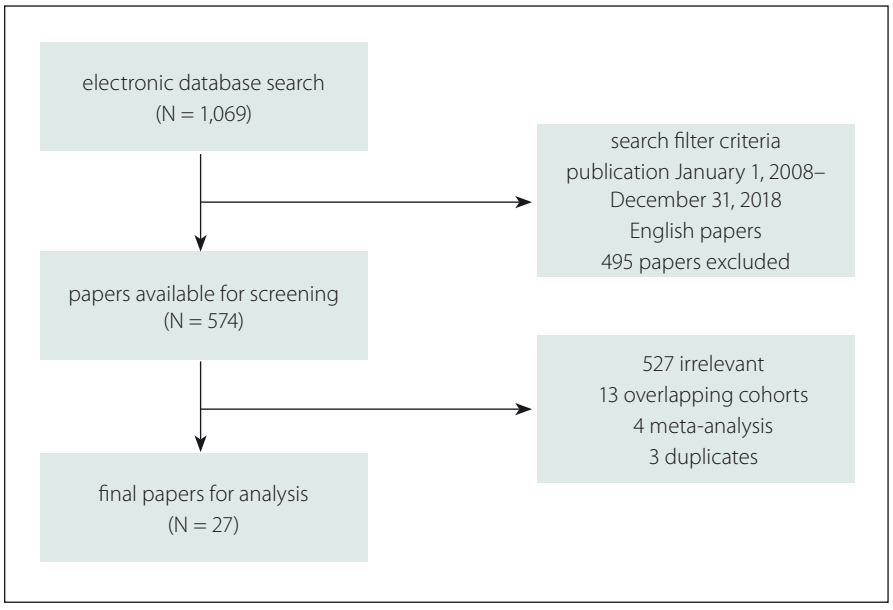

Fig. 1. PRISMA diagram of data stratification.
N – number

Obr. 1. PRISMA schéma stratifikace dat.
N – počet

Methods

We conducted a systematic review of literature concerning surgical management of SIJ dysfunction, following the PRISMA protocol (Fig. 1). The PubMed electronic database was searched using the terms "sacroiliac fusion" and synonyms (sacroiliac joint fusion, sacroiliac joint arthrodesis, sacroiliac fixation, sacroiliac joint stabilization). In addition, datasets of previous meta-analyses were screened for potentially missed papers. Inclusion criteria included original prospective or retrospective studies with cohorts of 2 or more patients, published in the English language, throughout the period from January 1, 2008 to December 31, 2018, with a minimal follow-up period of 6 months.

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Tab. 1. Basic parameters of each study group.

Main author	Year published	prospective/ retrospective	Follow-up number	Surgical approach	Mean length (min)	Blood loss (mL)	Second surgery	Screw compli-cation	Wound complica-tion	Miscella-neous	Months	VAS preop. (0–10)	VAS postop. (0–10)	ODI preop. (0–100)	ODI postop. (0–100)
Rainov et al	2018	retrospective	90	MIS lateral	17	N/A	0	0	0	0	12	8	2.5	45.3	16.4
Darr et al	2018	prospective	96	MIS lateral	46.3	N/A	1	0	0	0	36	8.15	2.62	56.3	28
Murakami et al	2018	retrospective	27	open anterior	190	130	6	3	0	7	60	8.44	2.66	N/A	N/A
Rajpal et al	2018	retrospective	24	MIS lateral	53	10.4	1	0	4	1	12	6.6	3.3	N/A	N/A
Dengler et al	2017	prospective	52	MIS lateral	57	N/A	1	3	1	0	12	7.77	3.52	57.5	32.1
Nystrom et al	2017	retrospective	49	open anterior	N/A	N/A	2	2	0	4	24	6.7	3.7	N/A	N/A
Araghi et al	2017	prospective	50	MIS lateral	57	69	1	1	0	0	6	7.62	3.51	55.5	35.3
Kancherla et al	2017	retrospective	45	MIS lateral	36	22	3	3	0	0	9	8.7	4.6	N/A	37.4
Rappoport et al	2017	prospective	32	MIS lateral	42.6	50	2	2	0	0	12	5.58	3.27	55.6	34.6
Vanaclocha et al	2017	retrospective	27	MIS lateral	48	N/A	0	0	0	0	12	7.8	2	41	20
Cross et al	2017	retrospective	19	MIS lateral	83.5	57.1	0	0	0	0	24	7.9	2.2	N/A	N/A
Duhon et al	2016	prospective	149	MIS lateral	46.6	51	8	3	6	2	24	7.98	2.67	55.2	30.9
Polly et al	2016	prospective	89	MIS lateral	44.9	32.7	3	3	5	2	24	8.23	2.67	57.2	28.7
Sachs et al	2016	retrospective	107	MIS lateral	N/A	N/A	5	4	1	2	36	7.5	2.6	N/A	28.2
Kube et al	2016	retrospective	18	MIS lateral	N/A	14.5	0	0	0	0	12	8.17	4.41	61	40.5
Bornemann et al	2016	retrospective	24	MIS lateral	42.4	N/A	0	0	0	0	24	8.43	2.7	76.8	31
Beck et al	2015	retrospective	20	posterior medial	N/A	50	0	1	0	0	12	N/A	N/A	N/A	26.2
Ledonio et al	2014	retrospective	22	MIS lateral	68	41	2	2	0	0	11	N/A	N/A	61.5	52
Ledonio et al	2014	retrospective	22	open anterior	128	681	2	2	0	0	12	N/A	N/A	61.8	47.4
Kim et al	2013	retrospective	31	MIS lateral	N/A	N/A	1	1	2	1	12	N/A	N/A	N/A	N/A
Mason et al	2013	retrospective	55	MIS lateral	N/A	N/A	2	2	0	0	12	8.1	4.5	N/A	N/A
Cummings et al	2013	retrospective	18	MIS lateral	N/A	50	1	1	1	0	12	8.9	2.3	52.7	13.2
Gaetani et al	2013	retrospective	12	MIS lateral	65	45	0	0	2	0	8	7.7	3	31.4	12
Rudolf et al	2012	retrospective	27	MIS lateral	65	N/A	2	2	6	1	12	7.6	3.31	N/A	N/A
Kibsgard et al	2012	retrospective	50	open posterior	N/A	N/A	0	0	0	0	12	N/A	4.8	N/A	33
Khurana et al	2009	retrospective	15	MIS lateral	N/A	50	0	0	0	0	9	N/A	N/A	N/A	N/A
Wise et al	2008	retrospective	13	posterior medial	N/A	100	0	0	0	0	24	N/A	N/A	N/A	N/A
Al-khayer et al	2008	retrospective	9	MIS lateral	N/A	50	0	0	1	0	24	8.1	4.6	59	45

ODI – Oswestry Disability Index; MIS – minimally invasive surgery; N/A – not available; VAS – Visual Analogue Scale

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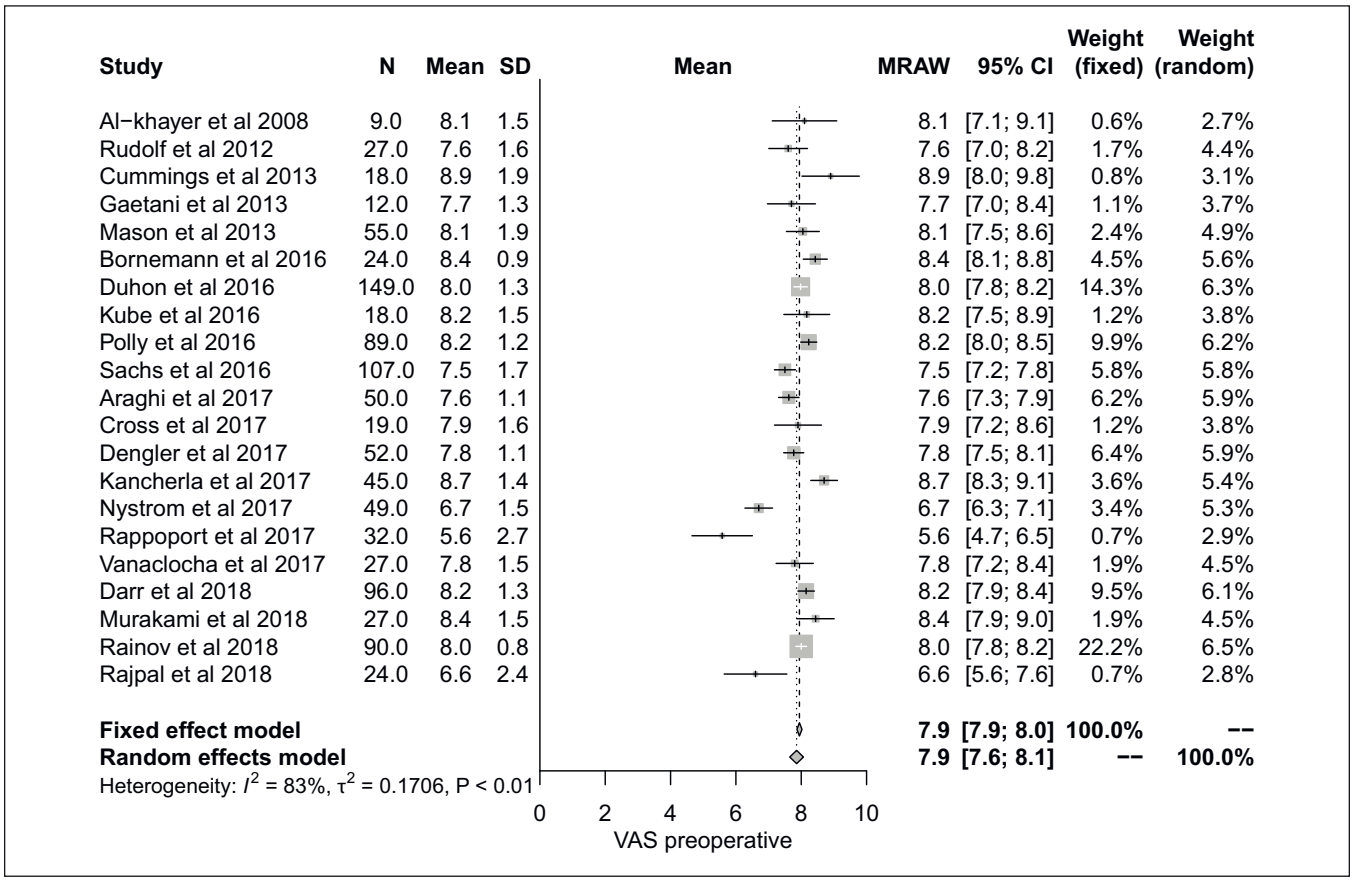

Fig. 2. Forrest plot of preoperative Visual Analogue Scale score.

CI – confidence interval; MRAW – untransformed (raw) means; N – number; SD – standard deviation; VAS – Visual Analogue Scale

Obr. 2. Forrestův plot předoperačního skóre Vizuální analogové škály bolesti.

CI – interval spolehlivosti, MRAW – netransformovaný průměr; N – počet; SD – standardní odchylka; VAS – Vizuální analogová škála

In several cases, patient cohorts of two or more papers were identical or overlapped. In these cases, only the most recent papers with the largest cohort sizes were included in our dataset.

Analyzed parameters

The extracted data included study design, original number and number of patients followed up, patients with previous lumbar spine surgical procedures, SIJ dysfunction diagnosis, surgical technique, length of surgery, blood loss, surgical complications, length of follow-up, patient pain and disability scores. For analytic purposes, surgical complications were grouped into three categories: wound complications (infection, haematoma, poor healing, etc.), screw malposition or dislocation and miscellaneous. Furthermore, patients requiring an additional surgical procedure due to a surgical complication formed an additional group. Patient pain scores were analyzed using the Visual Analogue pain Scale (VAS), as this was the most common scale utilized in the analyzed papers. The VAS was recorded on a scale of 0–10, the data from the studies which used the 0–100 scale were divided by a 10 constant, in order to group the data effectively. Various methods for documentation of disability were utilized within the study groups, such as the European Quality of Life-5 Dimensions questionnaire, the Short Form Health Survey and the Oswestry Disability Index (ODI). The ODI was the most frequently used out of these, and as such was the parameter we chose to focus on in our paper. In several cases, pain and disability scores were reported at several follow-up points. In these cases, scores recorded at the longest follow-up period were used in our study.

Statistical assessment

Statistical analysis was performed using R and R markdown software (R Development Core Team, Vienna, Austria). A random-effects meta-analysis (RMA) model was used to calculate the mean preoperative and postoperative values of VAS and ODI, on the basis of VAS and ODI values presented by each individual study. Not all the studies presented standard deviation (SD) intervals along with their VAS and ODI values, the missing data were calculated using multiple imputation in R. Statistical heterogeneity was assessed using the inconsistency I test, with values from 25–50% indicating moderate heterogeneity and values above 50% suggesting high heterogeneity. Publication bias was analyzed using the funnel plot and Egger's test.

Results

The electronic database search yielded a total of 1,069 papers, which were reduced to 574 available for analysis after filtering out non-English papers and papers published beyond the set time frame. Furthermore, 527 studies were excluded due to their irrelevance, 13 had overlapping cohorts, 4 were systematic reviews and 3 were duplicates. This left 27 papers as our final dataset, which represented 1,192 surgically treated patients

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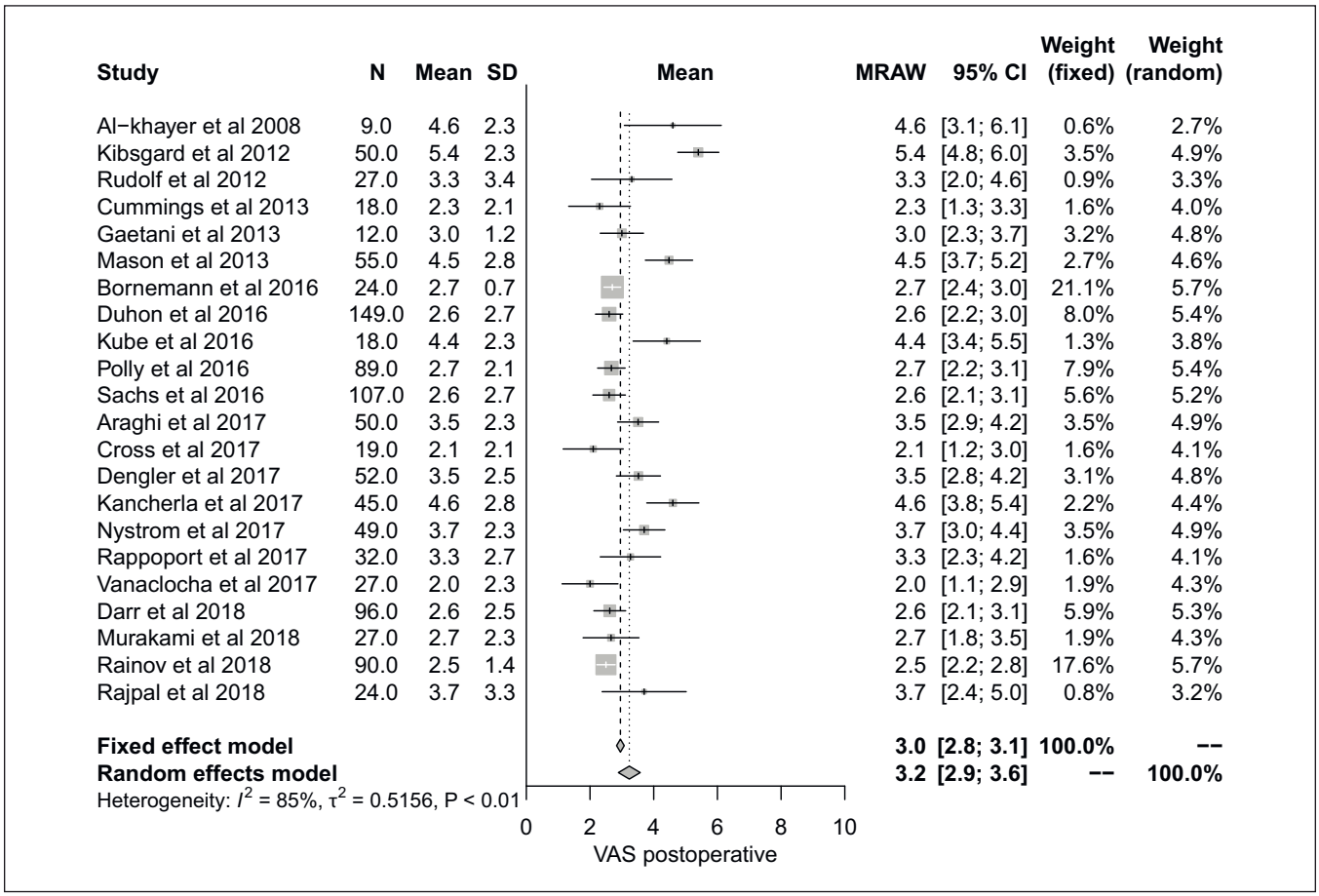

Fig. 3. Forrest plot of postoperative Visual Analogue Scale score.

CI – confidence interval; MRAW – untransformed (raw) means; N – number; SD – standard deviation; VAS – Visual Analogue Scale

Obr. 3. Forrestův plot pooperačního skóre Vizuální analogové škály bolesti.

CI – interval spolehlivosti, MRAW – netransformovaný průměr; N – počet; SD – standardní odchylka; VAS – Vizuální analogová škála

(Tab. 1) [12–38]. One study included two patient cohorts treated using different approaches, and as such each patient group was presented separately, forming a total of 28 patient groups for analysis [29]. Of these final papers, 6 had a prospective design and 21 were retrospective. Diagnostic criteria for SIJ dysfunction consisted of clinical signs of SIJ dysfunction including typical pain characteristics and positive provocation tests, as well as a minimum 50% pain reduction following fluoroscopically guided SIJ injections of local anaesthetics and/or steroids. Conservative treatment was attempted in all surgically treated patients, with insufficient effect on patient pain. Various surgical approaches were used within individual studies, with a minimally invasive lateral approach (MIS) being the most common (21 studies; 77.8%), followed by open approaches (3 studies; 11.1%) and posterior medial oblique approaches (2 studies; 7.4%). One study consisted of two patient cohorts, one operated on using an MIS and the second using an open approach [29]. The length of the follow-up varied amongst individual studies, ranging from 6 to 60 months.

Pain

A total of 21 studies recorded preoperative pain severity using the VAS rating. The RMA mean (95% CI) preoperative VAS score was 7.86 (7.65–8.07) with significant heterogeneity across studies (Fig. 2). Postoperative VAS was reported in 22 studies, with an RMA mean (95% CI) value of 3.23 (2.89–3.58), also with significant heterogeneity (Fig. 3). These values suggest an improvement in pain severity of approximately 4.63 following SIJ surgery.

Disability

Preoperative disability described by the ODI was reported in 15 studies. The RMA demonstrated a mean (95% CI) preoperative ODI of 55.1 (49.8–60.5), with significant heterogeneity across studies (Fig. 4). Postoperative ODI scores were recorded in 19 papers, with an RMA mean (95% CI) value of 30.7 (25.9–35.5) with significant heterogeneity amongst studies (Fig. 5).

Complications

All the studies reported their individual incidence surgery-related complications. The total incidence of preoperative or postoperative complications was 7.04% (84 cases). The RMA demonstrated the proportion (95% CI) of wound complications at 3.87% (2.44–6.09), with moderate heterogeneity amongst studies. The RMA model showed a mean (95% CI) proportion of screw dislocation or malposition of 4.32% (3.18–5.81), with low heterogeneity. Miscellaneous complications occurred only in isolated cases and as such were not analysed separately. They in-

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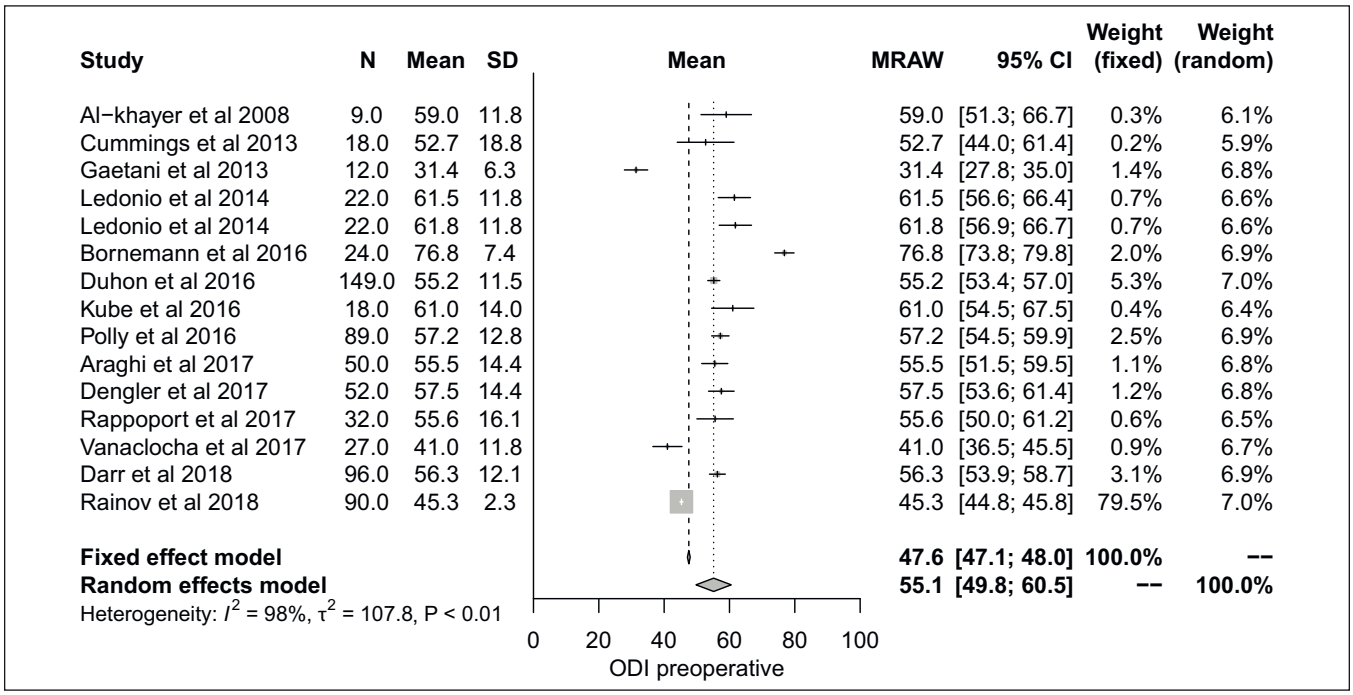

Fig. 4. Forrest plot of preoperative Oswestry Disability Index.

CI – confidence interval; MRAW – untransformed (raw) means; N – number; ODI – Oswestry Disability Index; SD – standard deviation

Obr. 4. Forrestův plot předoperačního skóre Oswestry Disability Index.

CI – interval spolehlivosti, MRAW – netransformovaný průměr; N – počet; ODI – Oswestry Disability Index; SD – standardní odchylka

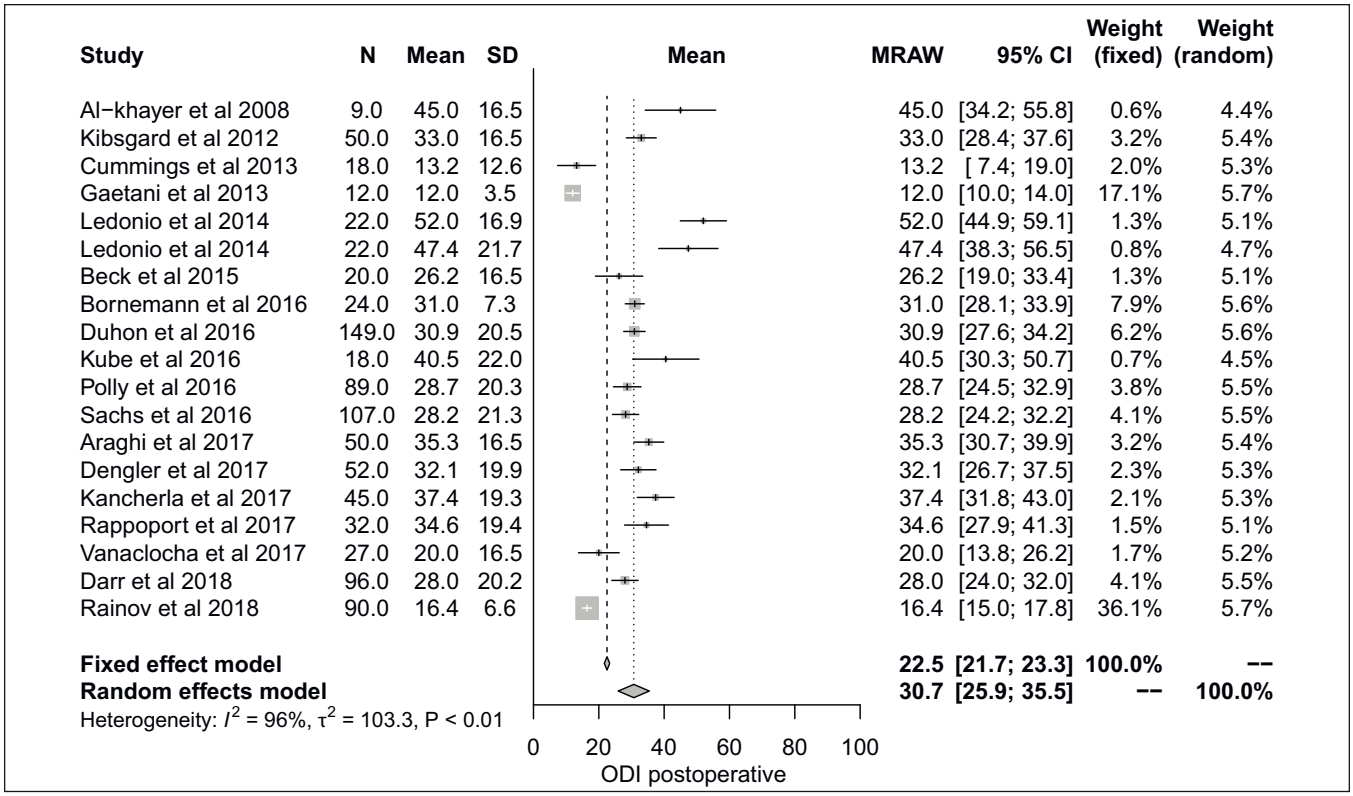

Fig. 5. Forrest plot of postoperative Oswestry Disability Index.

CI – confidence interval; MRAW – untransformed (raw) means; N – number; ODI – Oswestry Disability Index; SD – standard deviation

Obr. 5. Forrestův plot pooperačního skóre Oswestry Disability Index.

CI – interval spolehlivosti, MRAW – netransformovaný průměr; N – počet; ODI – Oswestry Disability Index; SD – standardní odchylka

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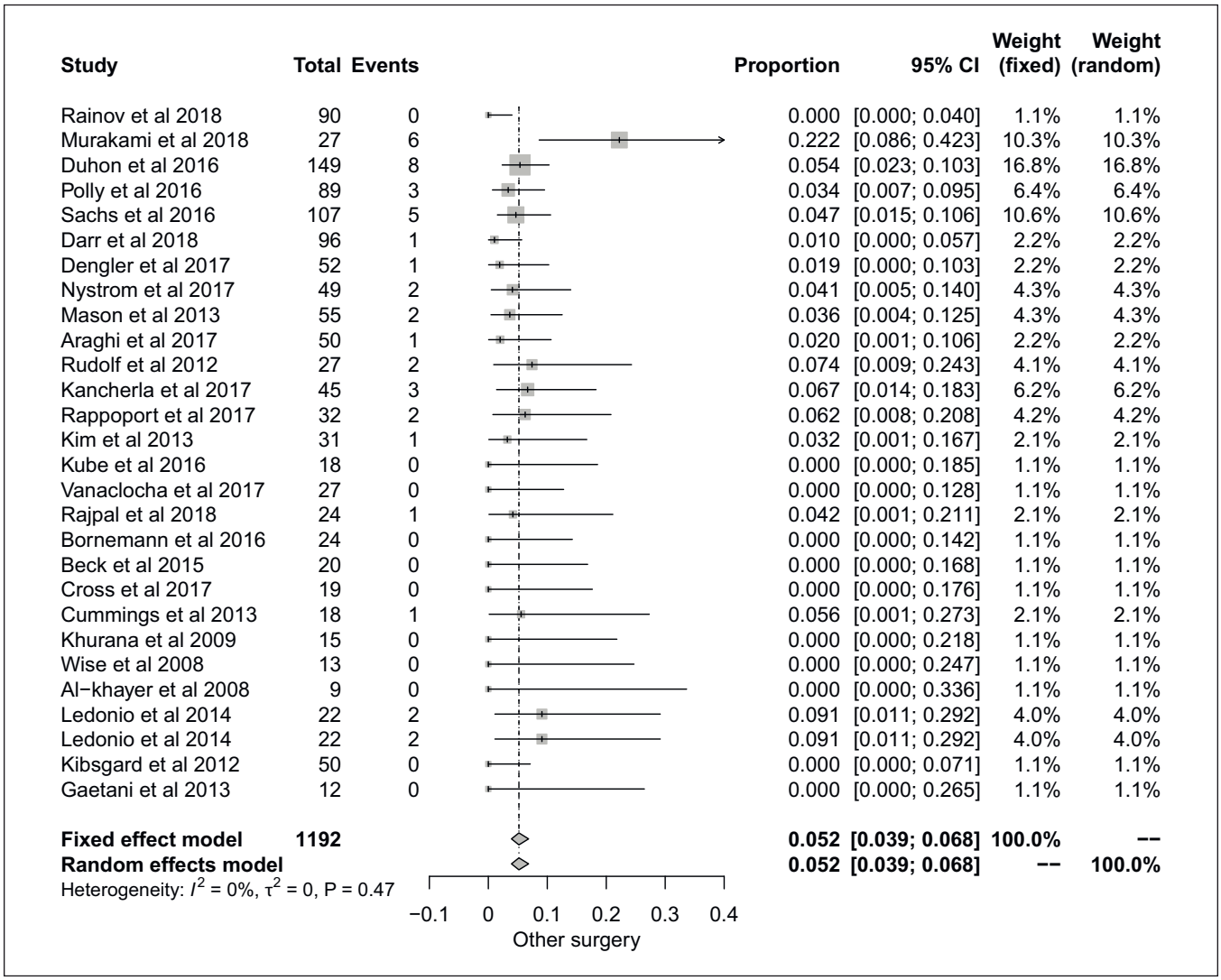

Fig. 6. Forrest plot of patients requiring an additional surgical procedure.
CI – confidence interval
Obr. 6. Forrestův plot pacientů vyžadující následný chirurgický výkon.
CI – interval spolehlivosti

cluded cases of vascular injury, urinary retention, postoperative ileus, iliac bone fracture or meralgia paresthetica. Furthermore, RMA was used to analyze the proportion of patients requiring an additional surgical procedure following SIJ stabilization. The proportion (95% CI) of patients requiring a second operation was 5.19% (3.93–6.83), with low heterogeneity across studies (Fig. 6).

Discussion

The main goal of surgical management of SIJ dysfunction is mechanical immobilization of the SIJ via arthrodesis, because pathological intra-articular movements may trigger sensory nerve endings within the joint, which then acts as a pain generator [39]. Various surgical techniques have been described in the literature in order to achieve this goal, however, the efficacy of these procedures remains controversial within the neurosurgical and orthopaedic communities. This is demonstrated by a recent paper by Bina et al, who have questioned the credibility of SIJ dysfunction diagnosis, limited follow-up, as well as the efficacy of SIJ stabilization in achieving arthrodesis, thus limiting SIJ movement [40]. Our study aimed to analyze the current clinical efficacy of SIJ stabilization by comparing mean preoperative VAS and ODI scores of patient cohorts published within the last 10 years. Furthermore, surgery-related complications presented in these studies were collected in order to quantify the relative morbidity of these procedures.

Pain severity

All patient cohorts within our study reporting VAS scores demonstrated an improvement in pain severity. Mean preoperative and postoperative VAS values were 7.86 and 3.23, resp., which shows an improvement of approximately 4.6 on the VAS scale. The VAS is the most common tool for recording patient pain. The advantages include its simple nature and widespread use. The main disadvantage is that the numerical values lack a direct clinical meaning. This has resulted in the implementation of the minimum clinically important difference (MCID), as a means of

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determining the threshold of achieving effective treatment. MCID of VAS for lower back pain vary within individual studies; mostly they range around a decrease of 2.0 [41–45]. Therefore, an improvement of 4.6 in VAS scores shows a significant decrease in the pain levels of the patients in our study.

Disability

The most common means of documenting disability was the ODI, which was preoperatively recorded in 15 studies and postoperatively in 19 studies. The ODI is a validated questionnaire targeted towards patients with lower back pain and remains the most common tool for documenting disability in these patients. A recent paper by Copay et al demonstrated that ODI could serve as a valid measure of SIJ dysfunction in addition to degenerative spinal disorders [46]. The preoperative and postoperative values of ODI were 55.1 and 30.7, resp., which demonstrates postoperative improvement by approximately 25 points. The MCID for ODI varies between 8–15 points between individual papers [41,42,46]. Nonetheless, a decrease by 25 points represents a significant improvement in disability.

Surgical complications

The extent of surgical morbidity of SIJ stabilization procedures is dependent on several factors including surgical technique, imaging and guidance tools and the surgeon's experience. In our dataset, the total incidence of complications reported was 7.04%, which falls into the range of 3.5–21.0% reported by previous studies [47–49]. The most common surgical complications were screw malposition or dislocation (4.32%). The rate of these complications is expected to decrease in future with improvement in imaging and navigation techniques. Wound complications occurred in 3.87% of cases and included wound infections or significant postoperative haematomas. In a real world, this number is most likely higher, due to underreporting of these complications, as they are often managed in an out-patient manner. Overall, 5.19% of the patients required a second procedure due to a surgical complication. This statistics is mostly related to the number of malpositioned implants, which was the most common indication for a second surgery. A decrease in the number of malpositioned/dislocated implants will most likely result in a decrease of the number of patients requiring additional surgery.

Strengths and weaknesses of the study

The strengths of our study include a high number of analyzed studies compared to similar reviews [9–11]. Furthermore, six of the studies analyzed are prospective in design, thus strengthening the validity of our results. All the studies utilized a similar algorithm in diagnosing SIJ dysfunction and mostly recorded VAS and ODI as measurements of pain and disability. Each study addressed the incidence of individual surgical complication as well as the number of patients requiring additional surgery.

The weaknesses of our study include a high heterogeneity of individual studies in various fields, the most important represented by different strategies in recording pain and disability scores. A small number of studies did not use the VAS and ODI as means of describing pain and disability and some studies recorded only the postoperative values of these scales. Furthermore, pain and disability were assessed in a wide range of follow-up visits (6–60 months), which may affect the final value of these scores. Another weakness is combining studies utilizing an open as well as a MIS surgical approach. Due to the fact that both approaches are in essence different, varying surgical and clinical results may be present. Finally, only three of the analyzed papers had a follow-up of more than 24 months, thus limiting our interpretation of truly long-term results of SIJ stabilization.

Conclusion

In conclusion, our study collected data from 27 published studies, which represents 1,192 surgically treated patients with SIJ dysfunction. We demonstrated that patients diagnosed with SIJ dysfunction, who did not benefit from conservative therapy, showed significant improvement in VAS (by 4.6 points) and ODI (by 25 points) scores, following surgical arthrodesis of the SIJ. These findings suggest that SIJ stabilization is a feasible and effective treatment option for this group of patients and that it complements similar reviews performed in the past. Furthermore, the total complication rate in our study is 7.04%, which is lower than in the majority of previously published studies. A further decrease in surgical complications can be expected, especially with the improvement of minimally invasive surgical techniques and navigation imaging. Further prospective randomized studies with long-term follow-up are necessary in order to support surgical management of this group of patients.

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