SYSTEMATIC REVIEWS

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Risk Factors for Postoperative Neck Complaints After Robot-Assisted Surgery. A Systematic Literature Review

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ABSTRACT

Background: Robot-assisted and image-guided surgery have become increasingly important because it outperforms human dexterity. For procedures on sub-millimetric level, fixing the patient's head firmly is crucial. Although the neck is not the target organ of the operation, it may be at risk of postoperative complaints due to positioning or fixation. The incidence of postoperative symptoms after head and neck surgery with fixation is hardly reported and probably underestimated, in regards to the life-threatening cranial pathologies for which the surgery was required.

Methods: To identify papers on risk factors for postoperative complaints after head and neck surgery, we performed a systematic review. PubMed and Web of Science databases were searched using predefined in- and exclusion criteria. Meta-analyses and reviews were excluded. Postoperative complaints concerned pain, quality of life, discomfort, neuropraxia, and musculoskeletal problems. This review is reported according to PRISMA guidelines.

Results: Seven eligible studies were identified, only 2 concerned surgery requiring head fixation. The significant risk factors resulting from our analysis were preoperative pain (odds ratio = 2.19), expected pain (odds ratio = 2.15), short-term fear (odds ratio = 1.42), age between 45 and 59 years old (odds ratio = 1.40), pain catastrophizing (odds ratio = 1.21), and female gender (odds ratio = 0.74).

Conclusion: Six significant risk factors for iatrogenic postoperative complaints after head and neck surgery have been identified. These risk factors should be considered as possible confounding factors in future research. Little literature could be found. Upcoming robotic surgeries in the head and neck area pose a clinical need for more specific studies on postoperative iatrogenic complaints.

Keywords: postoperative pain, patient outcome, head and neck, surgery, risk factors

INTRODUCTION

The accuracy of robot-assisted and image-guided surgery has evolved significantly in the last 2 decades, which made these technologies very popular among different types of surgeons who allow them ever more frequently to be used in the operating room. Since the repeatability and reliability of a robotic system are unmatched and its precision exceeds human dexterity, it seems inevitable that a number of surgical tasks will be attributed to robotic arms. New techniques have been developed, including robotic-assisted surgery using systems such as the da Vinci Surgical System®, The New Flex® Robotic System, the MKM robotic system, and the NeuroMate.[1-3] This technology allows for extreme precision.[3] Even the littlest movement can disrupt the operation. Therefore, a good fixation and positioning of the patient are required. For example, the da Vinci System enables complex surgeries that previously could not be performed as safely and effectively as today. The minimal invasive technology results in shorter hospital stays, fewer complications, and standardized outcomes.[4] Robot-assisted transaxillary thyroidectomy (RTT) is another example of such intricate surgeries. However, during RTT, the neck has to be slightly hyperextended. Serpell et al[5] investigated the importance of neck extension during a thyroidectomy. They examined whether neck extension provides better access to the anterior neck and facilitates the operation as a result of the improved lighting of the surgical site. A statistically significant difference in thyroid height was found, but because it was so small, it was not considered clinically significant. No correlation was detected between the neck extension and the degree of exposure of the anterior neck, which makes the importance of the neck extension questionable. The degree of better exposure may not outweigh the consequences of the neck extension on the patient in terms of postoperative complaints. Too much neck extension can result in severe postoperative neck pain and other serious complications such as spinal damage and intraoperative stroke due to endangering the brain circulation.

To maintain the patient's comfort and a good postoperative quality of life (QOL), the potential consequences of the positioning and fixation of the patient must be determined. Some patients complain about neck and shoulder pain after head and neck surgery. Postoperative complaints are often not questioned or investigated when the primary operation is performed on the head or neck. Therefore, their origin often remains unidentified. However, they could potentially be caused by the positioning and fixation and/or the duration of the operation.

In recent years, ever more attention is being paid to patients' QOL after head and neck surgery. The importance of the patient's general well-being is increasingly being discussed.[6,7] Potential adverse effects of the procedure are weighed against clinical benefits, especially in elective procedures.[8] In a little less than a third of patients, QOL deteriorates after anterior skull base surgery.[9] Also after lateral base surgery, for instance, for acoustic neuroma, this has been reported: more than half of the patients indicated that their QOL got worse after the operation. Even though several studies show that the decreased QOL is only present in the first 6 months after surgery, after which it improves significantly,[6,7] reduced QOL is not to be neglected.

Various factors can determine QOL. Age can have a negative effect on health-related QOL, especially in the physical function domain.[10] Concerning gender, no significant differences between both sexes were present but in general, the Anterior Skull Base Surgery Questionnaire (ASBS-Q) scores of females were lower than males.[11] Nevertheless, Cavel et al[12] did find a significant decrease in the ASBS-Q scores of the female gender after surgery. In particular, within the non-physical QOL, most patients report to have social issues.[13] They have participation problems and observe a negative impact on their relationships. The second most affected domain of the non-physical QOL within this study was the emotional domain. Patients complained about feeling depressed, stressed, and anxious. Within the physical QOL, the main complaints are nasal symptoms (in the case of anterior skull base surgery) and fatigue. Similar complaints recur in other studies.[9,14]

Clinical observations and the lack of studies reporting on risk factors concerning postoperative complaints, more specifically pain in the shoulder and neck region, after head and neck surgery, with or without regard to the new techniques, motivated us for this study. The aim is to investigate to what extent postoperative complaints are reported in the literature and to identify risk factors for neck and shoulder complaints after head and neck surgery.

MAIN POINTS

- There is little literature on postoperative neck complaints after robot-assisted surgery, indicating they might be underreported.
- Several modifiable risk factors for postoperative complaints have been identified. These can be addressed preoperatively to improve patient outcomes.
- These risk factors do not appear to depend on procedural aspects such as the patient's positioning and duration of surgery.

METHODS

The systematic review is reported in conformity with the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) guidelines.[15] In case of clinical homogeneity, a meta-analysis was performed.

Eligibility Criteria

This review includes studies concerning postoperative complaints after head and neck surgery. More specifically, studies were taken into consideration if they reported on positioning pain, postoperative pain, and neuropathy in adults (18+) and when the intervention consisted of elective surgical procedures, computer-assisted surgery, and surgery in the head and neck area. The required outcomes were pain, QOL, discomfort, neuropraxia, and musculoskeletal problems. Only articles in English and Dutch were used.

Studies were excluded when their study populations consisted of animals, children, or were conducted by healthcare workers (e.g. doctors or nurses who perform and assist this type of surgery) reporting the complaints. Studies regarding patients who underwent spinal, dental, sinonasal, or endonasal surgery or surgery in any other region than the head and neck area were excluded as well. Studies with fatal outcomes and extreme complaints, such as facial nerve dysfunction or lower limb complaints, were also ruled out. Books, reviews, meta-analyses, or expert opinions were not used (Table 1).

Literature Search and Study Characteristics

The search strategy was constructed in PubMed and Web of Science and completed in September 2021. The strategy's method of construction is presented in Figure 1. For the screening of the articles, EndNote X9 and Rayyan[16] were used.

To create the search strategy, multiple terms were used. Some appeared to be too specific, others gave too much bias. For example, the most important excluded term is "neurosurgery" [MeSH Terms]. It resulted in 15 810 articles when used on its own and was the main cause of bias. Hence, it was left out of the search strategy. The terms "traction neuropathy" and "Operative Time" [Mesh] did not provide any additional result. The terms "Surgical Fixation Devices" [Mesh] and "skull base surgery," as the only term to describe the intervention, were too specific and offered too few results.

The first search strategy applied in PubMed was constructed as follows: ("pain, postoperative" [MeSH Terms] OR "patient positioning"[MeSH Terms] OR "positioning pain" OR "postoperative neuropathy" OR "skull base" [MeSH Terms]) AND (skull base surgery OR "Elective Surgical Procedures"[MeSH Terms] OR

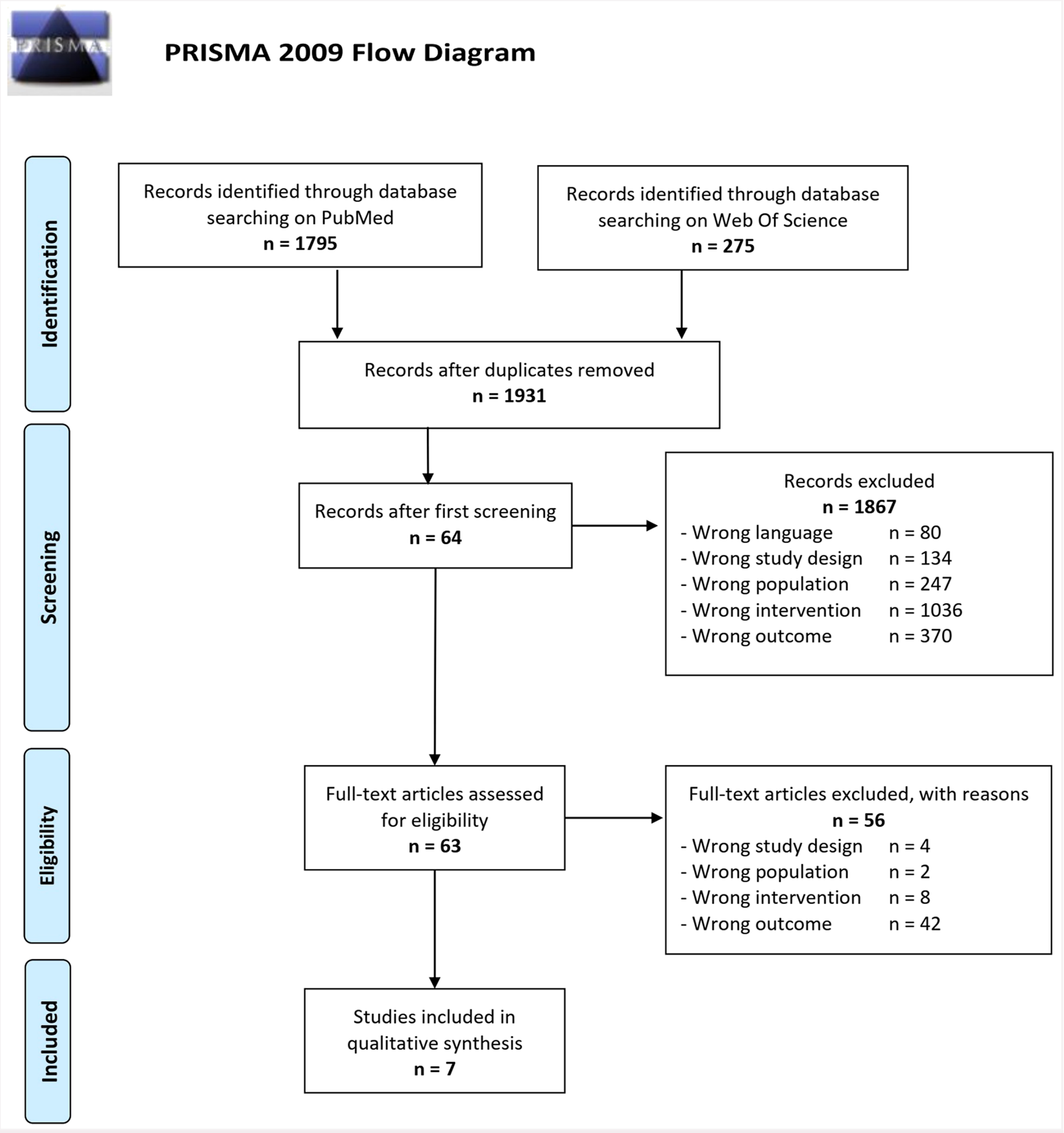

Figure 1. PRISMA flowchart of the study selection procedure.

"Surgery, Computer-Assisted"[Mesh]) AND ("Pain" [MeSH Terms] OR "discomfort" OR "Quality of life" [MeSH Terms]). This search produced 1024 articles. A second search syntax implemented in PubMed resulted in 771 articles. This syntax had the following construction: ("pain, postoperative" [MeSH Terms] OR "patient positioning" [MeSH Terms] OR "positioning pain" OR "postoperative neuropathy" OR "skull base" [MeSH Terms]) AND ("head and neck surgery" OR "thyroidectomy") AND ("Pain" [MeSH Terms] OR "discomfort" OR "Quality of life" [MeSH Terms]). No limitations were used in PubMed. The search strategy for Web of Science was constructed in the following way: ("pain postoperative" OR "patient positioning" OR "positioning pain" OR "postoperative neuropathy" OR "skull base") AND ("skull base surgery" OR "Elective Surgical Procedures" OR "Surgery, Computer-Assisted") AND ("Pain" OR "discomfort" OR "Quality of life"). This resulted in 275 articles. No limitations were used in Web of Science.

Table 1. Keywords Used in the Search Strategy by the PICO Method[49]

Subject	Text Words	MeSH Terms	Inclusion Criteria	Exclusion Criteria	Free Keywords
P	People with postoperative complaints after head and neck surgery	Pain postoperative, Patient Positioning, skull base	People: Adults 18+	Animals, children, and complaints from healthcare workers or families/parents	Positioning pain, Postoperative neuropathy
I	Head and neck surgery	Elective surgical procedures, Surgery computer assisted	Neurosurgery, skull base surgery, elective surgery, ENT, all surgical procedures in the head and neck area	Abdominal surgery/ laparoscopy, oncologic, dental surgery, spinal surgery, endonasal surgery	Skull base surgery
C	/	/	/	/	/
O	Risk factors for musculoskeletal complaints	Pain, quality of life	Discomfort, pain, musculoskeletal problems, quality of life, neuropraxia	Extreme complaints such as fatal cases, lower limb complaints, dysphagia and anosmia	Discomfort
S	No systematic review, meta-analysis, or book	/	All other study designs	Books, reviews, meta-analyses, expert opinion, editorials	/
L	Dutch, English	/	Dutch, English	All other languages	/

P, population; I, intervention; C, comparison; O, outcome; S, study design; L, language.
The terms in the column "key words" and "MeSH terms" are combined with "OR". "AND" is placed between the rows "PICO".

As a first step, EndNote was used to collect the articles and remove any duplicates. One hundred and twenty-eight duplicates were found and removed. After that, the articles were transported to Rayyan, where 11 additional duplicates were removed. The 1931 remaining articles were screened based on the title and abstract. The reason for exclusion was decided in the following order: language, study design, population, intervention, and outcome. The flowchart is presented in Figure 1. During the initial screening, 73 articles were discussed with a third person (V.T.) with broader knowledge about this specific subject. Ultimately, 1867 articles were excluded based on the in- and exclusion criteria and 64 articles were included for further screening on the full text. Of 1 article, no full text could be obtained.[17] The entire screening process was double-blinded (E.R., N.VB., and L.J.).

Risk of Bias Assessment of the Studies

Risk of bias assessment was applied to detect possible flaws in the design, conduct, analysis, or reporting so that underestimations or overestimations of the effect of interventions could be established. Such assessment allows to determine the reliability of the articles' results or whether they should be considered dubious.[18] The assessment happened double-blinded (E.R., N.VB., and L.J.).

Different checklists were used for the (non-)randomized controlled trials (RCT) and cohort studies. For the studies by Fregoli et al.[19] Lang et al.[20] Ryu et al.[21] and Song et al.[22] version 2 of the Cochrane risk-of-bias (RoB 2) tool for randomized trials (RoB 2) was used. The RoB 2 is structured into 5 domains of bias, each consisting of a series of questions. Each domain can be judged as "high" or "low" risk of bias or can express "some concerns."[23] For the studies by Klimek et al.[24] Sommer et al.[25] and Wattier et al.[26] the Newcastle-Ottawa Quality Assessment Scale (NOS) for cohort studies was used.[27] This tool assesses the risk of bias by means of a star rating system, with a maximum of 9 points. No clear cut-off values are known for the NOS. Therefore, we used values described by Pheeters et al.[28] A score of 7 or higher was considered as good quality, a score between

Table 2. Risk of Bias Assessment: RoB 2 for Randomized Trials

	Randomization Process	*Deviations from Intended Interventions*	*Missing Outcome Data*	*Measurement of the Outcome*	*Selection of the Reported Result*	*Overall*
Fregoli et al (2017)[19]	–	+	+	?	?	–
Lang et al (2014)[20]	+	+	+	+	+	+
Ryu et al (2013)[21]	–	+	+	+	+	–
Song et al (2016)[22]	–	+	+	+	+	–

+ low risk of bias
? some concern
– high risk of bias

Table 3. Risk of Bias Assessment: Newcastle Ottawa Scale for Cohort Studies

	Selection				Comparability	Outcome			
Reference	1	2	3	4	5	6	7	8	Score
Klimek et al (2006)[24]	★	★	★	★		★	★	★	7
Sommer et al (2010)[25]	★	★	★	★			★	★	6
Wattier et al (2016)[26]	★	★	★	★			★	★	6

5 and 7 was moderate, and a score lower than 5 was defined as poor quality.

RESULTS

After the full-text screening, 7 articles out of 63 were included. The list of studies and the corresponding exclusion criteria at each stage are represented in Figure 1 (flow diagram).

These articles have been evaluated on the risk of bias. The results are presented in Tables 2 and 3.

Postoperative pain after head and neck surgery, which is the most important clinical outcome, is mentioned in each of the included articles. The study characteristics of all articles are presented in Table 4. The measured pain scores, which range between 0 and 46.1 mm on the Visual Analogue Scale (VAS), can be found in Table 5. The highest pain scores on the VAS were assessed in the recovery room or on the first day after surgery. Comparing the pain scores from the different studies over time, a decrease at every postoperative measurement can be observed. Klimek et al[24] noticed significant differences in the pain scores on day 1 (VAS 24.1 ± 21.9), day 3 (17.2 ± 20.3), and day 5 (11.8 ± 17.1). The studies by Fregoli et al.[19] Lang et al.[20] and Ryu et al[21] all discerned significant differences in postoperative pain scores in one of the first postoperative measurements among their intervention groups; however, no differences between the postoperative measurements were calculated for each group separately. In the study by Wattier et al.[26] a pain intensity Numerical Rating Scale

Table 4. Study Characteristics

	Population	Intervention	Comparison	Outcome
Fregoli et al [19]	Patients undergoing total thyroidectomy	Robot-assisted transaxillary thyroidectomy (RTT)	Conventional thyroidectomy (CT)	Pain (VAS), operative time, complications
Klimek et al[24]	Patients undergoing different types of elective neurosurgical procedures	Elective neurosurgical procedures	/	Perioperative pain character, pain intensity (VAS)
Lang et al[20]	Patients undergoing elective open thyroidectomy	Open thyroidectomy with neck extension	Open thyroidectomy without neck extension.	Pain score (VAS) at postoperative day 0, day 1, first clinic visit; operating time, blood loss; recurrent laryngeal nerve (RLN) injury; hypoparathyroidism
Ryu et al[21]	Patients undergoing total thyroidectomy	Robot-assisted transaxillary thyroidectomy (RTT)	Conventional thyoridectomy (CT)	Pain (VAS), operative time, postoperative hospital stay
Sommer et al[25]	Patients undergoing heterogeneous surgical procedures	Elective surgical procedures	/	Pain score (VAS), predictors acute postoperative pain
Song et al[22]	Patients with papillary thyroid carcinoma undergoing selective neck dissection and total thyroidectomy	Conventional selective neck dissection and total thyroidectomy	Robotic selective neck dissection and total thyroidectomy	Postoperative pain and paresthesia in the neck and anterior chest area (scale 0-4), cosmetic satisfaction (scale 1-5)
Wattier et al[26]	Patients undergoing partial or total thyroidectomy	Open partial or total thyroidectomy	/	Pain (NRS, QDSA), neuropathic pain (DN4, NPSI), preoperative anxiety and need for preoperative information (APAIS)

APAIS, Amsterdam Preoperative Anxiety and Information Scale; DN4, Douleur Neuropathique en 4 Questions (Neuropathic Pain Interview in 4 questions); NPSI, neuropathic Pain Symptom Inventory; NRS, Numerical Rating Scale; QDSA, Saint-Antoine Pain questionnaire; VAS, Visual Analogue Scale.

Table 5. Pain Scores (VAS and NRS)

Article	VAS and NRS Mean ± SD			*P*
Fregoli et al[19]	RTT*	CT*		
	VASrr: 1.79±2.07	VASrr: 2.50±1.18		<.0001
	VAS 8 AM: 2.11±2.02	VAS 8 AM: 1.65±1.06		.504
	VAS 8 PM: 1.37±1.94	VAS 8 PM: 0.61±0.73		.076
	VAS 8*AM: 0.87±1.70	VAS 8*AM: 0.30±0.53		.473
	VAS 7: 0.86±1.77	VAS 7: 0.18±0.53		<.01
Klimek et al[24]	Max anticipated**: 35.7±22.1			/
	Day 1**: 24.10±21.90			
	Day 3**: 17.20±20.30			
	Day 5**: 11.80±17.10			
Lang et al[20]	Group I*	Group II*		
	Day 0: 4.61±2.15	Day 0: 4.61±2.57		.720
	Day 1: 3.08±1.69	Day 1: 2.38±1.58		.022
	First visit: 0.78±0.99	First visit: 0.57±1.06		.026
Ryu et al[21]	RTT*	CT*		
	Postop 30 minutes: 2.60±0.91	Postop 30 minutes: 3.04±0.93		.0660
	Postop 4 hours: 4.42±1.27	Postop 4 hours: 4.87±1.29		.0549
	POD 1: 3.04±1.28	POD 1: 3.82±1.27		.0006
	POD 2: 2.02±0.91	POD 2: 2.64±1.15		.0052
	POD 3: 1.27±0.62	POD 3: 1.73±0.91		.0338
	POD 10 : 1.23±1.11	POD 10: 0.87±0.74		.0932
Sommer et al[25]	/			
Song et al[22]	/			
Wattier et al[26]	DN4 < 3$^{\Delta}$	DN4 ≥ 3 (3 months)$^{\Delta}$	DN4 ≥ 3 (6 months)$^{\Delta}$	
	PO: 0.7±1.5	PO: 0.9±1.8	PO: 1.0±1.5 /	**<.01**
	3 months: 0.52±0.93	3 months: 2.74±2.78	6 months: 2.95±2.03	**<.01**
	6 months: 0.23±0.66			**<.01**

*VAS score 0-10; **VAS score 0-100; ΔNRS score 0-10; VAS, Visual Analogue Scale; NRS, Numerical Rating Scale; SD, standard deviation; DN4, Douleur Neuropathique en 4 Questions (Neuropathic Pain Interview in 4 questions); RTT, robot-assisted transaxillary thyroidectomy; CT, conventional thyroidectomy.
Numbers in bold represent p-values < 0.05

(NRS) and Neuropathic Pain Questionnaire Interview (DN4) were used to measure pain. The incidence of persisting neuropathic pain after thyroidectomy, which was defined by a DN4 score ≥3, was 12% at 3 months and 9% at 6 months. Values for pain intensity in the group with persisting neuropathic pain were rather low, with a mean NRS of 2.74 ± 2.78.

The likelihood of developing a VAS > 40 after an operation on the base of the skull, dependent on various risk factors, was assessed in the study by Sommer et al.[25] The significant odds ratios (ORs) comprise age 45-59 years versus 60+ years (OR = 1.40), being female (OR = 0.74), preoperative pain (OR = 2.19), expected pain (OR = 2.15), short-term fear (OR = 1.42), and pain catastrophizing (OR = 1.21). Klimek et al[24] concluded that patients with preoperative pain presented significantly higher postoperative pain scores. Also, the nature of the pain in these patients was different. The pain after surgery reported by patients with preoperative pain was significantly sharper and more often referred pain. No correlations or ORs have been calculated. Wattier et al[26] found that preoperative levels of anxiety and the preoperative need for information are significantly higher in patients with postoperative pain at 3 and 6 months after thyroidectomy. The results are presented in Table 6.

DISCUSSION

Our systematic review resulted in only 7 articles that report postoperative pain after head and neck surgery and only a few mentioned clamping of the head during surgery.

There is consensus about the measurement method of postoperative pain since most articles measured pain using the VAS. However, the reported overall postoperative pain scores are rather low. Klimek et al[24] even mentioned that patients often report no pain after craniotomy.[24] These results therefore question pain intensity as the actual problem after head and neck surgery. This would suggest that the issue in postoperative pain lies elsewhere, for example, in the location or in the character of the pain.

Important Risk Factors for Postoperative Complaints

Six important risk factors for postoperative complaints after head and neck surgery were mentioned in the studies we

Table 6. Full Data Extraction

Article	Population (n)	Study Design	Method	Outcome	Results	Risk of Bias
Fregoli et al[19]	N = 124 Dropouts unknown Age (years): Group RT: 39.7±10.2 Group CT: 41.4±12.5	NRCT	The patients were free to choose the procedure. RTT, N = 62 CT, N = 62	Operating time; hospital length stay; pain score: in the recovery room (VASrr), on the first postoperative day at 8 AM and 8 PM (VAS 8 AM, VAS 8 PM), on day 2 at 8 AM (VAS* 8 AM), 7 days after surgery (VAS 7)	**Operative time: RTT > CT; VASrr: RTT < CT;** VAS 8 AM, VAS 8 PM, VAS* 8 AM and **VAS 7: RTT > CT**	High risk
Klimek et al[24]	N = 924 Dropouts: 25 Age (years): 51.0±16.3	Cohort study	10 different procedures with 10 or more patients. One assessment preoperative the evening before surgery and postoperative assessments on first, third, and fifth postoperative day.	Preoperative pain (VAS 0-100); pain character; maximal postoperative pain	Maximal VAS > maximal anticipated VAS Postoperative pain: preoperative pain vs no preoperative pain: VASpre > VASno and **different pain character** Patients without preoperative pain more often reported no pain. **Preoperative VAS > in patients > 40 years** Max postoperative VAS > in patients 20-39 years	Low risk
Lang et al[20]	N = 180 Dropouts: 0 Age (years): Group I: 49.2 (23.4-79.7) Group II: 52.1 (19.9-79.9)	RCT	Group I (neck extension) n = 90 Group II (no neck extension) n = 90 Neck extension was compared measuring the distance between cricoid cartilage and sternal notch and a standard shoulder roll was used for neck extension.	Pain score (VAS) on postoperative day 0, day 1 and the first clinic visit, operating time, length of the incision, blood loss, recurrent laryngeal nerve (RLN) injury, and hypoparathyroidism	VAS day 0: group I = II **VAS day 1: group I > II** There was a significant direct correlation between the gained distance after neck extension and the pain score on day 1 in group I. **VAS first clinic visit: group I > II** Operating time, distance between cricoid cartilage and sternal notch, length of the incision and blood loss were similar.	Low risk
Ryu. et al[21]	N = 90 Dropouts unknown Age (years): Group RT: 19.0±7.8 Group CT: 48.9±10.3	NRCT	The patients were free to choose the procedure. RTT, N = 45 CT, N = 45	Operating time, postoperative hospital stay, postoperative pain score (VAS) at 30 minutes, 4 hours, 1 day, 2 days, 3 days, and 10 days after surgery, analgesic use	**Mean age: RTT < CT; Operative time: RTT > CT;** Postoperative hospital stay: RTT = CT Patients requiring analgesics rescue in postanesthetic care unit: RT (46.7%) > CT (42.2%) VAS 30 minutes, 4 hours, **day 1, day 2, and day 3: RTT < CT** VAS day 10: RTT > CT	High risk

(*Continued*)

Table 6. Full Data Extraction (*Continued*)

Article	Population (n)	Study Design	Method	Outcome	Results	Risk of Bias
Sommer, M. et al[25]	N = 1490 (head and neck 295) Dropouts: 243 Age (years): 56.0±15.5	Cohort study	Preoperative assessment: PCS, BIS, LOT, and GSES Postoperative assessment of pain: 1 and 3 hours postoperative, on the day of surgery before going to sleep. After that 3/day using a pain diary	Odds ratio: VAS (0-100) >40 OR surgery head and neck = 1.0 (reference)	**Anticipated pain level intermediate vs minor: OR = 1.93** Anticipated pain level major versus minor: OR = 1.57 Age <45 years versus 60+: OR = 1.27 **Age 45-59 years versus 60+: OR = 1.40; Female: OR = 0.74; Preoperative pain: OR = 2.19; Expected pain > 40: OR = 2.15; Short-term fear ≥ 13 versus < 13: OR = 1.42** Long-term fear ≥ 10 versus < 10: OR = 1.14; **BIS ≥ 20 versus < 20: OR = 0.75;** GSES high vs low: OR = 1.01; **Pain catastrophizing ≥ 15 versus < 15: OR = 1.21**	Moderate risk
Song et al[22]	N = 66 Age (years): Robotic group: 36.7±10.5 Conventional group: 47.5±15.3	NRCT	Robotic or conventional selective neck dissection and total thyroidectomy. Decision to perform robotic surgery was based on the patient's preference, the extent of disease, and financial status. Robotic group: n = 25 Conventional group: n = 41	Cosmetic satisfaction (scale 1-5), postoperative pain and paresthesia in the neck and anterior chest area (scale 0-4) were evaluated by questionnaire 1 day, 1 week, 1 month, and 3 months after surgery.	Neck pain: 1 wk and 1 mo robotic > conventional; 1 day and 3 months robotic < conventional Neck paresthesia: 1 day, 1 week, 3 months robotic > conventional; 1 month robotic < conventional **Anterior chest pain and paresthesia: 1 day, 1 week, 1 month**, 3 months **robotic > conventional Cosmetic satisfaction 1 day, 1 week, 1 month, 3 months robotic > conventional (lower score)**	High risk
Wattier et al[26]	N = 304 Dropouts: 51 Age (years): not given	Cohort study	Partial or total open thyroidectomy, with or without lymph node resection. Pre-operative assessment on day prior to surgery, 3 and 6 month postoperative date.	Pain (NRS, QDSA), neuropathic pain (DN4, NPSI), preoperative anxiety and need for preoperative information (APAIS)	DN4 ≥ 3 (= persisting neuropathic pain): 12% (n = 31) at 3 months, 9% (n=23) at 6 months **Levels of anxiety and need for information significantly higher in patients with postoperative pain at 3 and 6 months** Anxiety > 10/20 pre-operative (n = 77) → 16 (20.8%) and 12 (15.6%) of them had a DN4 ≥ 3 at 3 and 6 months, respectively	Moderate risk

VAS*8am = VAS on the first postoperative day, text in bold represents statistically significant results (p-values < 0.05).
APAIS, Amsterdam Preoperative Anxiety and Information Scale; PCS, Pain Catastrophizing Scale; BIS, Behavioral Inhibition Scale; DN4, Douleur Neuropathique en 4 Questions (Neuropathic Pain Interview in 4 questions); LOT, Life Orientation Test; GSES, General Self-Efficacy Scale; NPSI, Neuropathic Pain Symptom Inventory; NRS, Numerical Rating Scale; (N)RCT, (Non-)randomnized controlled trial; ±, mean; bold, significant; VAS, Visual Analogue Scale; QDSA, Saint-Antoine Pain questionnaire; RTT, robot-assisted transaxillary thyroidectomy; CT, conventional thyroidectomy. VAS*8am = VAS on the first postoperative day, text in bold represents statistically significant results (p-values < 0.05)

included in this systematic review. We will discuss each of these risk factors below.

Preoperative and Expected Pain

First of all, preoperative and expected pain levels, as well as their location and character, were mentioned in 2 of the articles included in this review. Preoperatively existing or pre-existing pain appears to be the most prominent risk factor for postoperative pain after surgery in the head and neck area according to Sommer et al[25] and is expected to influence the character of the pain as established in the study by Klimek et al.[24] Both the articles concluded that expected or anticipated pain is a significant risk factor for postoperative pain. Preoperative pain as well as expected pain were mostly measured with the VAS when examined in the studies.

Pain Catastrophizing and Short-Term Fear

Psychological factors also seem to have an influence on the postoperative pain scores after head and neck surgery. Sommer et al[25] mentioned pain catastrophizing as a significant risk factor after surgery in the head and neck area. Many mental factors (e.g., expected pain and pain catastrophizing) facilitate or even catalyze the development of postoperative pain. This is confirmed by the findings of Wattier et al.[26] which stated that the levels of preoperative anxiety and the preoperative need for information were significantly higher in patients with postoperative pain at 3 and 6 months after thyroidectomy. Consequently, a high degree of preoperative anxiety can be a predictor of the occurrence of chronic postoperative pain. The need for information on anesthesia and the surgical procedure may just be a reflection of major anxiety. Sommer et al[25] investigated if there was a difference in long- and short-term fear as a predictor for postoperative pain. They investigated surgical fear by means of a 10-item questionnaire with 2 subscales, 1 for long-term fear and 1 for short-term fear. The questions about long-term fear were related to consequences in the future, for example, financial problems or a bad recovery. The questions about short-term fear were related to immediate consequences, such as pain or anesthesia. Only short-term fear appeared to be a significant risk factor for the development of postoperative pain.

Age

Another risk factor mentioned by several studies is age. Klimek et al[24] investigated the differences in reported pain scores between older and younger patients. They report that older patients had more preoperative pain than younger patients, while younger patients reported more postoperative pain than older patients. Sommer et al[25] mentioned that middle-aged patients present a higher risk factor on the postoperative pain scores in comparison to patients over 60. This suggests that age does have an influence on the outcome.

Gender (Female)

Lastly, the systematic review also pointed out gender as a potential risk factor for postoperative pain after head and neck surgery. Women report less postoperative pain but only on the first postoperative day.[25] On the other hand, Klimek et al[24] conclude that gender has no influence on the VAS, but no correlations or ORs were statistically calculated. Wattier et al[26] also could not identify gender as a predictive factor of postoperative pain after thyroidectomy. They suggest that this can be explained by the higher incidence of endocrine diseases, and consequently thyroidectomies, in females.

Potential Intervention-Related Risk Factors

Based on clinical observations, 3 potential intervention-related risk factors were suspected, namely the operating time, the positioning of the patient during surgery, and the type of anesthesia. Three articles included in this study mentioned the duration of the surgery/anesthesia, but they both could not draw any conclusions from it. Fregoli et al[19] and Ryu et al[21] both reported differences in the duration of surgery and postoperative pain scores (VAS) between the robotic thyroidectomy group compared to the conventional open group, but no correlations were calculated. In the study by Lang et al[20], the operating time (from skin incision to first upper thyroid pole division, from skin incision to first visual RLN identification, and from skin incision to closure) was compared between the neck extension group and the group with no neck extension, but no significant difference was found.[20]

Positioning of the patient during surgery was the second risk factor mentioned by ear-nose-throat surgeons. Lang et al[20] discussed the effect of the positioning of the neck during thyroidectomy. It was established that not extending the neck during this surgery leads to less pain, both on the first day after surgery and on the first clinical visit 10 days after surgery. Fregoli et al[19] also measured the influence of neck extension during thyroidectomy on postoperative pain. Although they could not verify their statement, they suggest that the pain scores in the conventional thyroidectomy group are higher because the neck is more extended than in the RTT group. In view of these results, we are curious to see if more conclusions have been drawn regarding postoperative pain in relation to the positioning of the patient. To our knowledge, there are no other clinical studies in the literature investigating the positioning of the head and neck during surgery as a possible risk factor for postoperative complaints. For both the positioning of the head and neck during the operation and the duration of the operation, it has yet to be examined whether these could be a factor in the development of postoperative complaints.

A third procedure-related predictor that was identified is the type of anesthesia. Wattier et al[26] concluded that the presence of neuropathic pain was nearly 3-fold greater in patients who received only general anesthesia compared to patients who received general anesthesia combined with a superficial cervical plexus block. Local anesthetics reduce the transmission of signals to the spinal cord by blocking the conduction of impulses along nerves. This block of nociceptive inputs into the dorsal horn might then prevent central sensitization.

Risk of Bias

Several elements from the risk of bias assessments must be taken into account. The studies by Fregoli et al.[19] Ryu et al.[21] and Song et al[22] all have a high risk of bias in the randomization process domain. This results in an overall high risk of bias, calculated by the algorithm of the RoB 2. However, it should be considered that the randomization process bias can be explained by the fact that the treatment could not take place blinded in these studies. The study by Lang et al[20] was the only RCT with an overall low risk of bias.

Using the NOS for cohort studies, the study of Klimek et al[24] can be regarded as of good quality. The studies by Sommer et al[25] and

Wattier et al[26] both had a score of 6 out of 9, thus can be considered of moderate quality. It must be noted that all 3 cohort studies scored low on in the comparability category of the scale.

Comparison with Literature

When comparing the results to other literature, we see that many risk factors are also found in studies regarding other surgical procedures. Several other studies indicated expected pain as a risk factor for postoperative pain in many different surgical procedures, as well as preoperative pain. These can be monitored in the hospital and if present, treatment can be considered. However, the character and the location of the pre- and postoperative pain differ greatly and strongly depend on the type of surgery.[29-31] In addition, these risk factors were often described in relation to the development of chronic pain, which is not comparable to any risk factors in relation to acute postoperative pain. Therefore, considering risk factors from other surgical procedures and drawing conclusions from them should be treated with caution.

It has been established by several studies that a baseline of poor mental health has a significant influence on the outcome in various types of surgical interventions.[32,33] Pain catastrophizing, evaluated with the Pain Catastrophizing Scale (PCS), was one of the mental health factors that was found to be a risk factor for the development of postoperative pain.[25] Although several studies in the literature have mentioned PCS as a possible predictor of postoperative pain related to other surgical procedures,[34-36] Wright et al[36] stated that it was only a poor predictor and Ruscheweyh et al[35] connected it to the development of chronic postoperative pain. For the assessment of mental health, there was no agreement throughout the studies. A wide range of different questionnaires was used.[33] More research is needed to determine the best way to assess mental health after surgery and to identify the most effective questionnaire(s). Preoperative anxiety and stress are also correlated to developing postoperative complaints.[30,37,38] Anxiety and stress and their influence on preoperative pain are beyond the scope of this article but must be considered as risk factors for the development of postoperative pain.

Contrary to the results of our review, in literature, the female gender was often described as a significant predictor for postoperative pain after various types of surgery.[39-41] A qualitative systematic review on the predictors of postoperative pain and analgesic consumption also found conflicting results from different studies.[42] Considering the influence of age and gender on postoperative pain is important for counseling before the surgery. However, age and gender neither can be a reason to change the suggested surgery nor can these factors be influenced.

The intervention-related risk factors of our review were also found in the literature about other surgical procedures. Several studies within the literature have mentioned operating time as a risk factor for postoperative complaints.[43,44] Moreover, operating time was also found to be correlated to postoperative analgesic consumption.[45]

The use of local anesthetics to prevent postoperative pain has been supported by several other studies. For example, spinal anesthesia in cesarian sections has been found to reduce the risk of chronic pain when compared to general anesthesia.[46] A Cochrane review reported that epidural analgesia and paravertebral blocks reduce chronic pain 6 months after thoracotomy and breast cancer surgery.[47]

Future Directions

We were able to identify 6 significant risk factors for iatrogenic postoperative complaints after head and neck surgery. In future research in the field of head and neck surgery, these risk factors should be considered as possible confounding factors. This would result in increased validity.

All risk factors previously discussed were consistent with the literature on other types of surgery. However, some other predictive factors that are often described in literature on other types of surgery were not extensively investigated in the articles included in this review. For example, depression, stress, preoperative anxiety, and habitual analgesic use are other predictors of postoperative pain that are often described in literature.[30,37,38,41,48] Future research could investigate if these general risk factors affect postoperative neck complaints after head and neck surgery.[49]

The indication for the surgery may be a determining factor. The handling and acceptance of postoperative complaints could possibly differ between various surgical procedures. For example, the surgery to restore hearing versus the removal of a life-threatening tumor has a completely different impact on a patient and perhaps also on the patient's perception of pain. This should be kept in mind for any future additional research.

Assessment

This systematic review demonstrates that the information about risk factors for postoperative pain after head and neck surgery or neurosurgery is scarce. More literature can be found on other surgical procedures when the search domain is expanded to find risk factors that are common in all types of surgery. Further research should focus on whether these risk factors can be linked to the location of the injury/surgery and, through comparable or additional literature, also apply to the development of neck and shoulder complaints.

CONCLUSION

Postoperative pain after head and neck surgery is present but usually rather of low intensity. Little information can be found on the general pain intensity of postoperative pain after head and neck surgery and should therefore be examined in more detail. Preoperative pain, short-term fear, age, female gender, expected pain, and pain catastrophizing have been identified as possible risk factors. In order to increase the validity of future research on head and neck surgery, these risk factors should be considered as possible confounders. These factors are also mentioned to be frequent risk factors for postoperative complaints after other surgical procedures. Based on clinical observations, operation time, positioning of the patient, and type of anesthesia may also play a role in the development of postoperative complaints. Further research is required to establish if these risk factors and other cognitive factors, for example, depression and anxiety, have an influence on the outcome after head and neck surgery.

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