Abstract: Background. Unclear cervicofacial masses are common presentations that often require tissue sampling to guide therapy. While open biopsy is invasive, fine-needle aspiration cytology includes a high rate of nondiagnostic samples.

Methods. A retrospective analysis on 181 core-needle biopsies in 88 patients was performed to determine the diagnostic efficacy of ultrasound-guided core-needle biopsies in the head and neck.

Results. We experienced 100% success in obtaining high-quality histopathologic specimens. The target tissue was correctly sampled in 80 of 88 patients. In these patients the sensitivity, specificity, and accuracy rate of core-needle biopsies in differentiating benign from malignant cervicofacial lesions was 98.1%, 100%, and 98.8%, respectively.

Conclusions. Ultrasound-guided core-needle biopsies can be recommended as a safe and reliable technique in the diagnosis of cervicofacial masses with a high diagnostic yield. It obtains tissue samples of high quality and represents a sufficient alternative to open biopsy even in the diagnosis of lymphoma.

Keywords: core-needle biopsy; ultrasonography; lymphoma; head and neck neoplasms; biopsy techniques

Lymphadenopathies and unclear masses in the neck or face is a common presentation in both diseases of benign and malignant origin, with very lengthy differentials. Patients with cervicofacial masses can be divided into a group of patients with known malignancy in whom metastatic disease is a concern and a group of patients with cervicofacial masses arising de novo. When lymphadenopathy arises de novo, the prevalence of malignancy is low. Especially children and adolescents have a high incidence of nonspecific benign lymphadenopathy, with a lengthy list of inflammatory and infectious differentials and a low incidence of therapeutically significant pathology.1–4 Lymphoma and metastatic spread from primary squamous cell carcinoma of the head and neck are the most common causes of malignant cervicofacial lymphadenopathy, but primary tumors outside the head and neck region may also metastasize to the neck.1–4

In the treatment of patients with unclear masses in the neck and face, obtaining accurate preoperative diagnosis is important for managing these patients appropriately. Imaging techniques
like high-resolution sonography as well as CT and MRI play an important role in the evaluation of persistent cervicofacial masses. However, despite recent technical developments, it is often still impossible to reliably differentiate lesions of malignant origin from benign masses by imaging techniques alone. Therefore, tissue diagnosis remains a standard requirement, and tissue sampling is often essential to establish a diagnosis and to guide therapy.2,5,6

The 2 sampling techniques most commonly used in the head and neck are the open excisional biopsy and fine-needle aspiration cytology (FNAC).2–4,7,8 Open biopsy and lymph node excision provides material suitable for histological analysis but is invasive and may entail general anesthesia and hospital admission.1–3,7 Disadvantages of FNAC include a high rate of nondiagnostic samples and incomplete classification of lymphoma.1–4,6,8–12 The core-needle biopsy represents a safe and cheap alternative to the established ways of tissue sampling. As the histologic architecture of the lesion is preserved, it provides a sample that is adequate for histopathologic as well as immunohistochemical examination.1,3,4,9–13 This technique has been used very successfully by interventional radiologists for many years but has found little attention in the head and neck region so far.1,2,4,7,10,12,14,15–23 In the head and neck, the image guidance technique most commonly used has been ultrasound. The real-time capability and ease of use makes ultrasound the procedure of choice.6,10,24,25 The purpose of this study was to evaluate the effectiveness of ultrasound-guided core-needle biopsies in the diagnosis of unclear cervicofacial masses in the head and neck. The utility of this method was investigated in patients with and without a clinical history of malignancy, and the clinical usefulness of core-needle biopsies in the more challenging diagnosis of lymphoma is described.

MATERIALS AND METHODS

The study was performed in accordance with the guidelines of the Helsinki Declaration of 1975, as revised in 1983, and the study protocol was approved by the local institutional review board (Ethics Committee of the Albert-Ludwigs-University of Freiburg).

Patients. Between April 2003 and April 2006, 181 ultrasound-guided core-needle biopsies were performed at our institution on 88 patients with unclear cervicofacial masses. None of the patients had undergone fine-needle aspiration (FNA) before. The age of the patients ranged from 17 to 100 years, with an average age of 64.5 years. Thirty-one (35.2%) patients were female and 57 (64.8%) were male. A total of 88 patients composed the study population and included 34 (38.6%) patients with a clinical history of malignancy (23 carcinoma and 9 lymphoma) and 54 (61.4%) patients without a previous history of malignant disease. Most of the biopsies were performed under ultrasound guidance. The number of tissue cores obtained ranged from 1 to 5 (mean, 2.06).

Technique. Before core-needle biopsy was performed, each patient underwent a careful sonographic examination of the head and neck, to record the number and distribution of enlarged lymph nodes and to evaluate the sonographic features of the target. Color-coded duplex sonography was used to ensure that the mass was not a highly vascularized tumor, and to find a safe pathway to the region of interest. In patients with multiple enlarged lymph nodes, we chose to biopsy the dominant or most abnormal lymph node based on size and sonographic appearance. Most of the biopsies were performed on an outpatient basis under local anesthesia, unless the patient was hospitalized for underlying diseases or the biopsy was performed during general anesthesia that was done for another reason. Informed consent for the procedure was obtained from all patients before biopsy. A coagulation screen was not routinely performed unless there was a history suspicious for bleeding.

Patients were placed in a supine position. At the puncture site, local anesthetic was injected subcutaneously. Additional local anesthetic was instilled under ultrasound guidance along the intended track of the biopsy needle. To facilitate the needle insertion, we performed a small skin incision of 2 to 3 mm. The needle was inserted through the incision, and a freehand technique was used to perform the biopsy with real-time ultrasound guidance. At our department, we use side-notch needles of 10 cm length with 3 different diameters (12 gauge = 2.05 mm; 14 gauge = 1.63 mm; 16 gauge = 1.29 mm). An appropriate needle throw of 15 or 22 mm may be chosen depending on the dimension of the target to avoid penetration. When the spring-loaded automatic biopsy gun (Bard Magnum, Bard Inc., Covington, GA) is fired, an inner trocar with a sample notch is
thrust forward, followed almost instantaneously by a similar forward thrust of the outer cannula, which shears off a core of tissue with minimum crushing of the specimen (Figure 1). Multiple specimens from single or multiple nodes or masses may be obtained depending on the suspected cause of the cervicofacial mass and the quality of the core specimen as assessed by inspection. The specimens were preserved either in formalin for histopathologic examination or in saline for immunohistochemical studies. After the procedure, the puncture site was manually compressed for 2 to 5 minutes, and an adhesive bandage was applied. With the Bard Magnum biopsy gun, the entire procedure takes approximately 15 to 20 minutes. The patient was monitored for 30 minutes and discharged only if there were no signs or symptoms suggestive of complication, mainly bleeding and increased pain. Oral or intravenous antibiotics were not necessary in the immunocompetent patient.

Statistics. The final diagnosis in all cases was defined as the result of secondary histologic examination of excised specimens, either for diagnostic purpose or as part of definitive therapy, as the result of the patients clinical course, or the result of other laboratory studies like serologic testing or microbiological examination. A biopsy was regarded as adequate only when the sample yielded sufficient material for histological analysis, the diagnostic target tissue was obtained and a diagnosis concerning the unclear cervicofacial mass could be made. An inadequate sample was defined as cases of sampling error as well as cases in which the lesion was correctly sampled, but the provided material was insufficient for histological analysis and to render a diagnosis. A biopsy result was considered to be false-negative when the tissue sample was thought to be adequate, but histologic examination indicated benign disease when the final diagnosis was of malignancy. A biopsy result was defined to be false-positive when the tissue sample was thought to be adequate, but histologic examination indicated malignancy when the final diagnosis was of benign disease.

For the statistical analysis of core-needle biopsy results, we calculated sensitivity, specificity, and accuracy from: (a) data that included all biopsy results and considered inadequate samples as incorrect, as well as from (b) data that included only biopsy results from correctly sampled lesions. For the comparison of statistical data describing the efficacy of the core-needle biopsy procedure, it is reasonable to exclude cases of sampling error from the calculation, as sampling error is highly dependent on the investigator’s sophistication concerning core-needle biopsy sampling and on the inclusion criteria of the sampled targets, particularly the size and deepness of cervical lymph nodes.2,12 Furthermore, if the procedure fails to sample a cervical lymph, this usually becomes apparent from the content of the tissue core during histopathologic examination, and therefore does not present a failure leading to incorrect treatment.

RESULTS

Biopsies performed with the automatic biopsy gun Bard Magnum yielded high-quality tissue cores (Figure 2). The core biopsy samples provided sufficient material for histological analysis without crushing artifacts in all 88 patients (100%). Therefore, sample adequacy was highly dependent on the question, whether target tissue was obtained or not. In our study, the lesion was correctly sampled, and therefore, the specimens deemed adequate in 80 patients (91%). As in our study, all samples provided high-quality tissue cores; inadequate samples included only the 8 cases (9%) in which the target tissue was failed.

Figures 3 and 4 provide an overview of all benign and malignant final diagnosis including the
distribution of false-negative and inadequate core-needle biopsy samples. The final diagnosis resulted in a malignant causation of the lymphadenopathy or unclear cervicofacial mass in 58 patients (65.9%) and in a benign causation in 30 cases (34.1%).

In the 30 cases in which the final diagnosis was benign, the target tissue was inadequate by core-needle biopsies in 2 patients (Figure 3). Secondary histologic examination in these 2 patients revealed reactive lymph nodes without signs of malignancy. In all of the 28 cases in which the target tissue was obtained, a specific diagnosis could be made from histopathologic examination of the core-needle biopsy specimens. This resulted in the diagnosis of reactive lymphadenopathy in most of the cases; but also, tissue from, for example, salivary gland tumors, lymph node tuberculosis, lymph node sarcoidosis, or lymph node actinomycosis was correctly sampled and evaluated (Figure 3). No false-positive result, in which core-needle biopsies would have indicated malignancy in a benign causation, was found within the 30 patients having a final benign diagnosis.

In 58 patients, final diagnosis indicated in malignancy, including 33 cases of squamous cell carcinoma and 16 cases of lymphoma (Figure 4). The target tissue was inadequate by the automated core-needle biopsy procedure in 6 patients. Secondary histologic examination of excised specimens in these 6 patients revealed squamous cell carcinoma and lymphoma in 3 cases each. Within the remaining 52 tumor patients in whom core-needle biopsy specimens were rated as adequate, histopathologic examination failed to diagnose malignancy in 1 patient. This single false-negative result from the core-needle biopsy procedure by means of the Bard Magnum biopsy gun was found in a patient with an enormous space-occupying mass of the pterygoid fossa originating from the parotid gland. Core-needle biopsies had indicated infiltration of basal cell adenoma; subsequent surgical resection, however, resulted in the final diagnosis of a basal cell carcinoma.

The study population included 16 patients with the final diagnosis of malignant lymphoma. In 3 of these patients, the target tissue was inadequate by means of the core-needle biopsy procedure. Within the 13 patients in whom the target tissue was correctly sampled and deemed as adequate, we analyzed whether full classification of lymphoma was possible from the core-needle biopsy specimens and whether oncological treatment was instituted from the core-needle biopsy results alone. In 12 of the 13 patients, full subclassification of lymphoma was possible and chemo-
therapy could be initiated on the basis of the core-needle biopsy results. In 1 patient presenting with a mantle-cell lymphoma, lymph node excision was performed before chemotherapy, in addition to core-needle biopsy, but did not reveal any further information regarding the institution of treatment.

When including all 88 biopsy results and considering inadequate samples as incorrect, sensitivity, specificity, and accuracy of the core-needle biopsy procedure for differentiating benign from malignant lesions in our study were 87.9%, 100%, and 92.0%, respectively. More reasonable regarding the comparison of statistical data delineating the efficacy of the ultrasound-guided core-needle biopsy procedure is a statistical analysis after the exclusion of the sampling error cases. When, therefore, including only biopsy results from correctly sampled lesions, we calculated sensitivity, specificity, and accuracy rate for ultrasound-guided core-needle biopsy for differentiating benign from malignant lesions of 98.1%, 100%, and 98.8%, respectively. We found no significant difference in the efficacy of the core-needle biopsy procedure comparing the statistical results from the group of patients with recurrent malignancies and the group of patients without a history of malignancy.

The core-needle biopsy procedure itself was well tolerated, with only 1 minor complication in a patient who showed a temporary facial weakness after the instillation of local anesthetic. There were no complications (such as bleeding, infection, or increased pain) requiring hospital admission.

DISCUSSION

In recent years, percutaneous image-guided needle biopsies have been increasingly used as an alternative approach to open biopsy for tissue sampling in the head and neck as well as other sites. Open surgical biopsies and lymph node excision, traditionally recommended and considered the diagnostic gold standard, especially in the diagnosis of lymphoma, usually provides adequate tissue samples for histological and immunohistochemical analysis, but may be time consuming. They require sutures and often involve hospital admission and general anesthesia. The surgeon’s schedule is usually limited, and the procedure is sometimes delayed or cancelled because of higher priority cases.

Needle biopsies are less traumatic, less time consuming, and easier to perform than open biopsies. The technique most widely used is the FNAC, which is today an established safe and inexpensive method in the diagnosis of head and neck lesions, routinely performed under local anesthesia as an outpatient procedure. In patients with a history of malignancy, the sensitivity of FNAC is high, as the objective is simply to evaluate whether malignant cells are present or not. However, disadvantages of FNAC include a high rate of nondiagnostic samples and false-negative results, as well as the difficulty of obtaining adequate material in many cases. In general, a histopathologic diagnosis of a lymph-node biopsy can be more difficult than the diagnosis of other lesions because of the lengthy list of varied benign and malignant etiologies of lymphadenopathy. Despite the ability of pathologists to render a diagnosis from small samples, cytopathology is difficult, and an extensive amount of subspecialty training and practical experience is necessary before a pathologist can correctly make a sufficient specific diagnosis from cytologic smears, particularly in the absence of a history of malignancy. Furthermore, FNAC should be performed and examined by an experienced on-site cytologist to guarantee a satisfactory specimen, which is impractical in most medical centers. The accuracy of FNAC is significantly decreased in the absence of on-site cytopathology. In patients with malignant lymphomas, histologic and immunohistochemical examination of adequate biopsy specimens is fundamental for diagnosis and management. The material obtained by FNAC is not sufficient in most of the cases for the diagnosis and exact classification of lymphoma. In benign disease, the true-negative predictive value of FNAC is low.

At our department, we no longer perform FNAC since the results have been unsatisfactory. This method turned out to be impractical at our large outpatient clinic with a heavy daily workload, as the on-site assessment by a pathologist with subspecialty training and experience in cytology has often been impossible, and this frequently ruled out short-term biopsies. We therefore established the use of core-needle biopsy systems.

Automated core biopsy devices have become widely used in recent years. Core-needle biopsies feature the advantages of open surgical biopsies without having their disadvantages. The automatic firing system is technically simpler, faster, and easier to perform than the traditional needle aspiration. The rapid action of the cutting needle has reduced the risk of needle deflection, patient movement during the pro-
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head and neck region. Histologic verification of tumor recurrence is a key step in cases of recurrent and metastatic head and neck malignancies. In a palliative setting, minimally invasive procedures are more suitable for obtaining a tissue diagnosis than open surgical biopsies. However, metastatic tumor recurrence in the deep soft tissue of the neck can represent a diagnostic challenge because of anatomic variations as the result of surgical interventions or because of altered deep neck tissue as the result of, for example, previous percutaneous radiotherapy. Therefore, tissue cores from core-needle biopsy are adequate specimens in this setting. These advisements can also be transferred to the group of patients with tumor who are not candidates for surgery due to underlying diseases, tumor size, or tumor location. Before primary radio-chemotherapy, core-needle biopsy represents a reasonable, minimal-invasive procedure for obtaining a tissue diagnosis in these cases.2,26–29 In patients with parotid lesions, core-needle biopsy was performed only in patients who were not candidates for surgery due to advanced age or underlying diseases but who showed parotid neoplasms that were clinically suspicious of malignancy. As biopsies of parotid tumors are associated with the risk of tumor seeding, core-needle biopsy of parotid lesions can only be recommended in these situations and should otherwise not be performed.

The possible spread of tumor cells along the needle track is a feature that has often been sited to be a major complication in any type of percutaneous needle biopsies.2,3,7,14,30–34 This complication has been recognized in a series of FNA with clinically detectable metastases that could be attributed to FNA, typically located in the skin puncture wounds, however, according to Smith, detectable in fewer than 0.009% of cases depending on tumor type and anatomic location.7,32 Several studies on the problem of tumor cell displacement of core-needle biopsy procedures inside and outside the head and neck state that the seeding of tumor cells remains an unlikely event and that there is no evidence to suggest that this phenomenon is more common with larger needles.2,3,7,11,14 Grundmann et al,11 for example, performed electron microscopic examinations of core needle tips to evaluate the risk of tumor cell seeding along the needle track. As they did not find tissue remnants on the tip of the core needles, the authors concluded that tumor cell displacement is highly unlikely. The possible spread of tumor cells in core-needle biopsy

Procedure, patient discomfort, and fragmentation of the samples.1–4,6,9,11–13,15–23 Nevertheless, automatic core biopsy systems have found little attention in the head and neck region as yet. This may be due to the concern to use an automated spring-loaded cutting-needle biopsy-gun in an anatomic region, which comprises numerous large vessels and major nerves. Reviewing the international medical literature, we found only a few reported series evaluating the usefulness of core-needle biopsy devices in the head and neck.1,2,7,10,16 The use of core-needle biopsy systems allows the acquisition of core biopsy specimens, which are suitable for a range of conventional histopathological and immunohistochemical examinations. Differential diagnosis of unclear masses in the head and neck include a lengthy list of benign and malignant causations where FNAC is not sufficient, and a tissue diagnosis is fundamental to guide treatment. For example, lymphoma, granulomatous infections, salivary gland tumors, or reactive lymphadenopathy account for many of the causes of lymphadenopathy in the head and neck, and in all these cases, the diagnosis is made more completely with a tissue core rather than with cytology from FNAC.1,3,7,15 While FNAC is often sufficient, however, technically difficult and often impractical, in the diagnosis of metastatic squamous-cell carcinoma, full classification of lymphoma for example frequently requires a panel of 10 to 15 immunohistochemical stains from a specimen with a preserved tissue architecture, which can be obtained from core-needle biopsy. As it is considerably challenging at cytologic and histologic examination to differentiate lymphoma from reactive lymphoid hyperplasia, the advantages of core biopsy, compared with those of FNAC, are particularly relevant to the diagnosis of lymphoma.2,4,11,12,15,16 Especially in younger patients, reactive benign lymphadenopathy in the head and neck is a common presentation with a low incidence of therapeutically significant pathology. Nevertheless, even in younger patients, a biopsy from persistent cervicofacial masses is often required to exclude malignancy. Minimally invasive procedures are safer and faster, taking into consideration the high rate of benign causations for head and neck masses. In these cases, a tissue specimen from core-needle biopsy is much more suitable, informative, and confident than cytology from FNAC.1,2,4,12,14

On the other hand, relapses and cervical metastasis of malignancies are frequently seen in the minimally invasive procedures are safer and more suitable and informative than cytology from FNAC.1,3,7,15 While FNAC is often sufficient, it is technically difficult and often impractical, in the diagnosis of metastatic squamous-cell carcinoma, full classification of lymphoma, for example, frequently requires a panel of 10 to 15 immunohistochemical stains from a specimen with a preserved tissue architecture, which can be obtained from core-needle biopsy. As it is considerably challenging at cytologic and histologic examination to differentiate lymphoma from reactive lymphoid hyperplasia, the advantages of core biopsy, compared with those of FNAC, are particularly relevant to the diagnosis of lymphoma.2,4,11,12,15,16 Especially in younger patients, reactive benign lymphadenopathy in the head and neck is a common presentation with a low incidence of therapeutically significant pathology. Nevertheless, even in younger patients, a biopsy from persistent cervicofacial masses is often required to exclude malignancy. Minimally invasive procedures are safer and faster, taking into consideration the high rate of benign causations for head and neck masses. In these cases, a tissue specimen from core-needle biopsy is much more suitable, informative, and confident than cytology from FNAC.1,2,4,12,14

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biopsy cannot be ruled out, but it has to be mentioned that dissemination of malignant cells remains a risk in any cancer biopsy. As the incidence of tumor cell displacement is inversely related to the interval between core-needle biopsy and excision of the biopsy canal, it is recommended to perform the subsequent surgical treatment soon after needle biopsy and to include the needle tract in a subsequent resection margin.3,7,14

We reviewed the international medical literature on studies about the diagnostic effectiveness of needle biopsy procedures in the head and neck, in general, and core-needle biopsy, in particular, to compare data with the results from our study. However, we found that there is much confusion about the definition of terms and the presentation and analysis of data. As there is no consensus in the literature about the optimal presentation and analysis of data in this field, the comparison of results and techniques from different studies is difficult. Previous studies have used different inclusion and exclusion criteria in the evaluation and statistical analysis of core-needle biopsy, particularly when defining samples as adequate or successful.2

In our study, we were able to obtain tissue from head and neck lesions that was adequate for diagnostic purposes in 100% of our patients. This is in accordance with previous studies on core-needle biopsy in the head and neck, which also experienced up to 100% success in obtaining specimens adequate for histopathological examination.1,2,7,10,11,14–16 The target tissue in our study was inadequate in 8% of the cases. Similar results of sampling error are reported in previous studies (eg, Screaton et al2 in his study of 2002 including 247 patients). However, all interventional ultrasound is operator dependent, and study results are highly contingent on inclusion criteria.2,12 Including the results from the correctly sampled lesions, we achieved a diagnostic accuracy rate of 98.8% for differentiating benign from malignant lesions by ultrasound-guided core-needle biopsy. This is in conformance with the best results of previous studies.2,7,11 In studies on FNAC, the sensitivity and accuracy rates have been reported to be low, especially in lymphoma, achieving not more than 30% to 60%. In our study, core-needle biopsy results were sufficient for full subclassification of lymphoma and the institution of chemotherapy in 12 of the 13 lymphoma patients with correctly sampled lesions. In previous studies on this topic, core-nee-

de biopsy offered the possibility to guide treatment without the need for surgical intervention in 80% of lymphoma patients. However, it has to be mentioned that some lymphoma subtypes still remain a diagnostic challenge even after surgical removal.1–4,7,10–12,15,16

In conclusion, we recommend ultrasound-guided core-needle biopsy in the head and neck as a safe, cheap, and efficient alternative to surgical biopsy with a high diagnostic yield and accuracy. It is a minimally invasive, simple, and fast outpatient procedure that can be performed under local anesthesia and provides excellent diagnostic biopsy specimens. As core-needle biopsy even allows full classification of lymphoma, our data indicate that this procedure should also be considered as a first step in the diagnosis of lymphoma. It therefore represents an optimal device in the diagnosis and treatment planning in selected unclear head and neck lesions.

REFERENCES


